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Integrating artificial intelligence within South African higher learning institutions

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Background: Artificial intelligence (AI) technology is transforming education through personalised learning and creates dynamic, adaptive learning environments that cater to each student's unique strengths and challenges. Developed countries have largely integrated AI technologies into their learning institutions, while the discipline is in its infancy in developing countries such as South Africa (SA).

Objectives: This study aims to contextualise and recommend the strategy that institutions of higher learning in SA can adopt to integrate AI into their institutions.

Method: A systematic literature review (SLR) method was followed. Publications published between 2018 and 2024 in the Multidisciplinary Digital Publishing Institute (MDPI) and Taylor & Francis Online databases using the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA). Following an initial search, 114 documents were retrieved, and, using inclusive criteria, 29 papers were chosen for analysis. The databases were selected because of their unique benefits in terms of accessibility, material breadth, and researcher-specific functions, unlike other sources.

Results: Results show that to integrate AI, the following should be considered: planning, collaborations, training, and ethical standards to guarantee responsible use and productivity. This will enhance teaching and learning, well preparing students for a future whereby AI is widely used in the workplace.

Conclusion: To integrate AI into learning institutions, a tailored approach needs to ensure that the AI technology improves teaching, enhances administrative procedures, and adheres to the institution's rules and regulations.

Contribution: This article forms a theoretical and methodological contribution to advancing knowledge that may inform policy and practice makers.

Keywords: artificial intelligence; institutions of learning; South Africa; systematic literature review; artificial intelligence technologies; PRISMA; AI Policy.

Introduction

The term artificial intelligence (AI) is a computer platform that resembles the human mind and can solve complex issues using advanced algorithms that can provide remarkable outcomes (Lainjo & Tsmouche 2023). The discipline of AI is an emerging area of study that combines scientific and engineering principles to design systems capable of exhibiting human-like intelligent behaviour (Panesar & Panesar 2021). The goal of AI is to instil non-human organisms with intelligence so that they can act wisely and creatively or enable computers to perform tasks that human minds can (Srivastava et al. 2023). In other words, AI can be defined as intelligence displayed by artificial objects, such as computer systems or agents. This technology is rapidly becoming a popular subject and a top emerging field.

Artificial intelligence has a rich and notable history since the mid-20th century and is now integrated into several aspects of people's lives, including higher learning institutions. The AI in institutions of learning has increased in recent years for a variety of reasons. This includes the potential to reduce teacher and student workloads and enhance learning outcomes (Panesar & Panesar 2021). It can provide customised educational support to pupils based on their learning progress, preferences, or individual characteristics (Bucea-Manea-Țoniş et al. 2022). Artificial intelligence technology in education encompasses various significant elements. The significance of this technology includes

student evaluations of instructional effectiveness, the implementation of automated grading systems, the facilitation of adaptive learning experiences, and the promotion of remote learning opportunities (Huang & Fang 2023). Nevertheless, the literature presents paradoxical challenges that hinder the formal integration of AI technologies in learning institutes, including concerns such as job displacement and ethical considerations (Bilad, Yaqin & Zubaidah 2023). The literature about identifying effective ways to integrate AI into educational settings in developing countries is limited (Bucea-Manea-Țoniș et al. 2022). The integration of AI technologies into educational settings also introduces a range of ethical considerations and potential risk factors that require careful examination (Ramachandiran & Salam 2021). Furthermore, the literature highlights the need for methods to enhance educational quality, customise individual lessons, and provide learning materials that improve students' learning outcomes (Ramachandiran & Salam 2021).

Integrating and maintaining AI technologies in educational systems can be a costly endeavour, which also presents potential effects to influence digital inequality in students because of these cost implications to leverage the technology (Segooa, Motjolopane & Modiba 2023). Institutions may need to allocate substantial funds towards software, infrastructure, and staff training to effectively integrate AI (Karimi & Khawaja 2023). According to a study by Zafari et al. (2022), the market research engine predicts that AI's engagement in the education sector will amount to US$5.80 billion by 2025.

The integration of AI can have adverse effects on learners by enabling them to respond to questions in a manner that is undetectable to plagiarism. This could result in students advancing and graduating based on work that does not reflect their own efforts in the traditional sense (Bozkurt et al. 2023). A significant challenge in integrating AI technology into the learning institutions, notably in South Africa (SA), like many other developing countries, is the absence of access to technical expertise and a lack of effective policies (Karimi & Khawaja 2023). Most research on AI in institutions of learning is done in developed countries, as the field is in its infancy stage in developing countries (Maphosa & Maphosa 2023).

As observed, some of the well-resourced universities in SA have a higher chance of integrating AI, while others may struggle to keep up. To address this gap, the aim of this paper was to contextualise a strategy to integrate AI into the SA learning institutions. The research objectives were (1) to explore the advantages and difficulties of 'how to' integrate AI into the institutions of learning in SA and (2) to recommend a suitable AI integration strategy for SA learning institutions to adopt. By filling this gap, this paper contributes to the body of knowledge and the development of an AI integration strategy suitable for the SA institutions of higher learning. Contextually, a methodological systematic literature review (SLR) method was used. The study referred to institutions of learning according to the *SA Higher Education (HE) Act, 1997*

(Act No. 101 of 1997). The SA HE Institutional Types Policy was established under Section 3(1) of the *HE Act Act 101 of 1997* (as modified) (Reddy 2004). The policy outlines three categories of institutions: colleges of HE, university colleges, and universities.

This paper followed a structured approach as follows: a discussion of the research methodology, inclusion and exclusion criteria, findings from the examined reviewed literature, recommendations, and conclusion.

Research methodology

This study aimed to contextualise strategies that institutions of learning in SA can adopt to integrate AI using a SLR. An SLR is a research process that uses a systematic approach to gather, identify, and critically evaluate existing research papers, conference proceedings, books, and dissertations (Okoli 2015). The method allows researchers to thoroughly synthesise existing knowledge, identify gaps in the field, and offer a systematic plan for structuring their research efforts. This method involves careful selection criteria, identification, eligibility and screening, reporting, and evaluation to ensure methodical and rigorous findings because of its nature of reliance on existing literature as the secondary data. A systematic literature review has several important roles. The method can 'identify future research priorities, answer unanswered questions, identify problems in primary studies, and generate theories about phenomena' (Page et al. 2021).

Conceptualising papers using systematic literature reviews is critical in academic research for several reasons. The objective of an SLR, as stated in a highly referenced systematic literature review, is to enhance knowledge, generate new theories, provide a summary of a research area, and identify new areas for further investigation (Okoli 2015).

Search criteria

Literature was gathered by defining the search strategy, selection criteria, and inclusion and exclusion criteria.

Search strategy

For selection criteria, identification, eligibility and screening, we adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to evaluate the credibility and applicability of the results of literature studies. The PRISMA statement aims to promote transparent and comprehensive reporting of systematic reviews (Page et al. 2021). Preferred Reporting Items for Systematic Reviews and Meta-Analyses presents a visual representation of a systematic review's flow diagram, which encompasses the process of searching databases and registers. The study workflow was based on the PRISMA four-phase diagram, as indicated in Figure 1. The four phases of the study were identification, screening, eligibility, and inclusion.
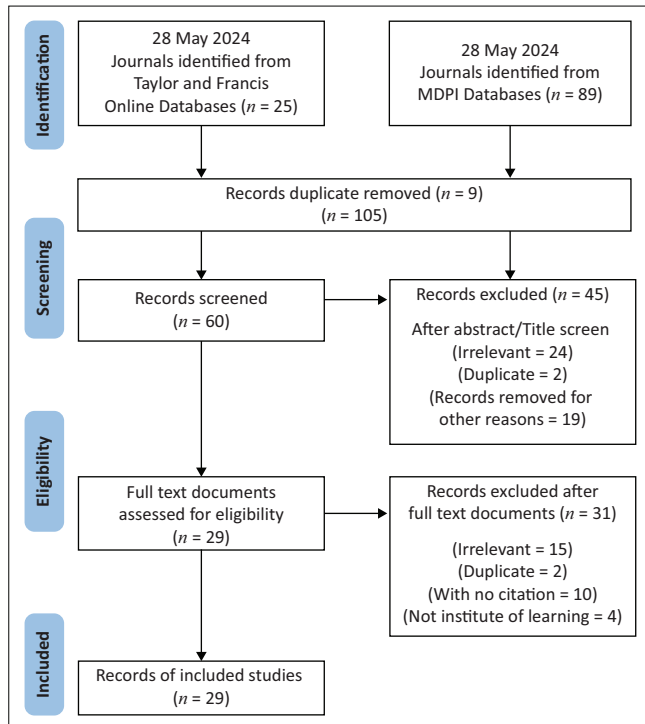
Source: Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D. et al., 2021, 'The Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 statement: An updated guideline for reporting systematic reviews', *BMJ* 372, n71
MDPI, Multidisciplinary Digital Publishing Institute.

FIGURE 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.

During the identification phase, reputable databases such as Taylor & Francis Online and MDPI were used to search for relevant studies. These databases cover a wide range of related AI topics; more additional databases may be considered for future work. Because of the time-consuming nature of systematic reviews and limited time for the project, only two large databases where most scholars in information also publish their work were considered for this paper. The selection of these databases was based on their extensive coverage of pertinent articles related to the research subject, hence minimising the risk of overlooking relevant studies (Sepasgozar et al. 2020). The search was conducted using Boolean operators AND/OR. Boolean operators included 'artificial intelligence' OR 'AI' and 'education' search phrases and 'learning institutions'.

As a follow-up criterion for the identification, open-source journals published between 2018 and 2024 were selected. The search was performed in May 2024 with only journal papers. Seminars and proceedings were excluded because they have low impact and quality (Bandara et al. 2015). See Table 1 for a summary of inclusion and exclusion criteria.

Only journals with citations of more than one were included to assess the publication's quality. Using the keywords specified, the databases yielded a total 114. To avoid duplicate publications during the screening process, the retrieved data was imported into EndNote, resulting in 105 studies after eliminating duplicates. The studies were

TABLE 1: Inclusion and exclusion criteria (researcher).

Inclusion criteria	Exclusion criteria
The title 'artificial intelligence' OR 'AI' and 'education' search phrases and 'learning institutions'	Not AI in education
Written in English language	Other languages
Published between 2018 and 2024	Published before 2018
Open-source journal papers	Seminars and proceedings
Google Scholar cited	No citation
MDPI and Taylor and Francis Online	Others

MDPI, Multidisciplinary Digital Publishing Institute; AI, artificial intelligence.

selected based on their titles, abstracts, and keywords. The findings were reduced to 60 after considering each study's criteria and records, such as the title, abstract, keyword, and publication year. However, 45 studies were rejected for the following reasons:

- A total of 24 papers were deemed 'irrelevant' because of their lack of comprehensive coverage of AI in the education settings.

- As many as 31 entries were omitted from the full-text document, as they did not give clear answers to the study's objectives.

Various countries are releasing a growing number of publications on AI in education because of the increasing popularity of AI in our daily lives (Chen et al. 2022). The review of these publications revealed crucial components of AI in the learning institution, including AI teaching programmes, assessment outcomes of the AI teaching programmes, pedagogical approach, and impact of existing AI teaching programmes, both good and bad, on students' involvement and motivation (Grájeda et al. 2024). Additionally, the reviews examined the current utilisation of AI in education.

Table 2 displays the journals selected and reviewed for this paper. The study used Google Scholar citations to assess the influence of published papers to determine the papers' impact. Since more significant research is likely to be mentioned more frequently, this approach was used to gauge the index papers' 'importance' in the scientific community (Martín-Martín et al. 2021). Google Scholar is a free resource that gives users access to an extensive and interdisciplinary citation index (Martín-Martín et al. 2021). Others, such as Elsevier's Scopus, are subscription-based databases that employ selective methods to document indexing, in contrast to Web of Science (Martín-Martín et al. 2021). Google Scholar was, therefore, a viable method for indexing citations.

Journals with no citation were excluded during the eligibility stage flow to gather publications that widely influenced the scientific community.

Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects.

TABLE 2: List of journals selected for this study (Researcher).

#	Articles	Google Scholar citation
1.	Pedagogical design of K-12 artificial intelligence (AI) education: A systematic review. (Yue, Jong & Dai 2022)	*84*
2.	Evolutionary game analysis of artificial intelligence (AI) such as the generative pre-trained transformer (CHATGPT) in future education. (You et al. 2023)	03
3.	Exploring the potential impact of artificial intelligence (AI) on international students in higher education: Generative AI, chatbots, analytics, and international student success. (Wang et al. 2023)	317
4.	Power to the teachers: An exploratory review on artificial intelligence (AI) in education. (Lameras & Arnab 2022)	202
5.	Exploring opportunities and challenges of artificial intelligence and machine learning in higher education institutions. (Bucea-Manea-Țoniş et al. 2022)	401
6.	Generative artificial intelligence: Implications and considerations for higher education practice. (Farrelly & Baker 2023)	224
7.	Sustainable curriculum planning for artificial intelligence education: A self-determination theory perspective. (Chiu & Chai 2020)	331
8.	Artificial intelligence potential in higher education institutions enhanced learning environment in romania and serbia. (Bucea-Manea-Țoniş et al. 2022)	110
9.	Prospers and obstacles in using artificial intelligence (AI) in Saudi Arabia higher education institutions. The potential of AI-based learning outcomes. (Alotaibi & Alshehri 2023)	96
10.	Artificial intelligence and reflections from educational landscape: A review of AI studies in half a century. (Bozkurt et al. 2021)	323
11.	Comparative study of the attitudes and perceptions of university students in business administration and management and in education toward artificial intelligence. (Almaraz-López, Almaraz-Menéndez & López-Esteban 2023)	96
12.	Artificial intelligence and its role in education. (Ahmad et al. 2021)	250
13.	Artificial intelligence empowers postgraduate education ecologically sustainable development model construction. (Zhu & Zhang 2023)	03
14.	Artificial intelligence and learning analytics in teacher education: A systematic review. (Salas-Pilco, Xiao & Hu 2023)	205
15.	Empowering education with generative artificial intelligence tools: Approach with an instructional design matrix. (Ruiz-Rojas et al. 2023)	221
16.	Implementing artificial intelligence in higher education: Pros and cons from the perspectives of academics. (Pisica et al. 2023)	128
17.	Artificial Intelligence (AI) in higher education: A predictive model for academic performance. (Pacheco-Mendoza et al. 2023)	31
18.	Artificial intelligence in higher education: An analysis of existing bibliometrics. (López-Chila et al. 2024)	27
19.	Exploring Artificial Intelligence (AI) in smart education: Real time classroom behavior analysis with embedded devices. (Li et al. 2023)	17
20.	Literacy in artificial intelligence as a challenge for teaching in higher education: A case study at portalegre polytechnic university. (Lérias, Guerra & Ferreira 2024)	21
21.	New era of artificial intelligence in education: Towards a sustainable multifaceted revolution. (Kamalov, Santandreu Calonge & Gurrib 2023)	552
22.	Higher education students' task motivation in the generative artificial intelligence (AI) context: The case of ChatGPT. (Hmoud et al. 2024)	55
23.	Managing the strategic transformation of higher education through artificial intelligence. (George & Wooden 2023)	271
24.	Artificial intelligence bringing improvements to adaptive learning in education: A case study (Demartini et al. 2024)	29
25.	Artificial intelligence alone will not democratise education: On educational inequality, techno-solutionism and inclusive tools (Bulathwela et al. 2024)	72
26.	Towards social generative Artificial Intelligence (AI) for education: theory, practices and ethics. (Sharples 2023)	115
27.	Artificial intelligence and the value co-creation process in higher education institutions. (Robayo-Pinzon et al. 2023)	12
28.	Artificial intelligence in higher education: A bibliometric analysis and topic modeling approach. (Maphosa & Maphosa 2023)	50
29.	Assessing student-perceived impact of using artificial intelligence tools: Construction of a synthetic index of application in higher education. (Grájeda et al. 2024)	93

Note: Please see the full reference list of this article, Mogoale, P.D., Pretorius, A., Mogase, R.C. & Segooa, M.A., 2025, 'Integrating artificial intelligence within South African higher learning institutions', *South African Journal of Information Management* 27(1), a1939. https://doi.org/10.4102/sajim.v27i1.1939, for more information.

Findings and discussions

The analysis of literature-reviewed papers is centred on aggregating, discussing, organising, comparing, and critiquing selected literature (Okoli 2015). Coding and concept-centric analysis are the other two alternative approaches to analysing the literature review. Coding identifies new areas of study; it is concept-centric and identifies the findings of a literature review based on themes different from the authors. Literature reviews should create propositions and provide a mechanism for evaluating these statements. This paper explored the literature review to gain a better understanding of the existing knowledge on integrating AI in higher learning institutes to establish a strong basis for institutions. Scholars acknowledged that some of the literature review studies might add to the body of knowledge by synthesising the literature without creating a theory. In this paper, discussions were conducted for the literature review, and then a firm foundation based on the advantages and difficulties of AI integration discussion was formulated. Advancing knowledge is recommended as a strategy for integrating AI in the SA institutions of higher learning.

Benefits of integrating artificial intelligence

The review of selected studies offered valuable knowledge on the possible advantages and difficulties of this topic of study. To explore the possible uses of AI in learning institutions, it is crucial to have a comprehensive grasp of how AI impacts educational paradigms. By conducting this study, various practical advantages can benefit both teachers and pupils. The results of the literature analysis offer significant insights into the potential benefits of AI-driven learning environments. A systematic review study examined 29 current empirical research papers on AI teaching programmes and gave an in-depth review of AI teaching and learning (Yue et al. 2022). The findings of the study indicated that teaching units integrating AI positively influenced students' attitudes towards learning and their interest in the subject of AI (Bucea-Manea-Țoniş et al. 2022). The results revealed that these AI-based teaching units had a beneficial impact on students' engagement and enthusiasm for learning with AI. This can be achieved by overseeing the integration of AI in education, fostering student engagement through active involvement, and enhancing students' learning attitudes. This demonstrates the importance of teacher-student collaboration in the integration of AI.

Artificial intelligence technologies like chatbots utilise machine learning (ML) algorithms to independently gather knowledge from data and generate well-written content after being trained on a vast collection of text (Biswas 2023). Such technology can

assist students in completing assignments quicker, allowing them to focus on being imaginative in their thinking. AI may provide personalised and tailored learning materials to international students, which are customised and available in several languages via AI translation services. This makes learning more accessible to individuals with language barriers (Wang et al. 2023) intelligent tutoring systems, like Deep and Auto Tutor, are AI technologies that tailor educational content to suit the individual abilities and requirements of pupils (Paladines & Ramirez 2020). These tutoring systems are meant to meet each student's specific needs. Then, it delivers information based on the student's behaviour, knowledge, and characteristics. It also offers immediate feedback on the quality of students' responses and provides suggestions on how they can be enhanced. Additionally, AI chatbots can generate hints, explanations, and other informative guides (Wang et al. 2023).

Artificial intelligence-powered interactive learning platforms, such as AI-assisted ACTIVE Math, MATHia, and Why2Atlas, are utilised to monitor learning progress, assess performance, improve instructional tools, and foster communication and feedback between educators and students across various levels and disciplines (Chassignol et al. 2018). Artificial intelligence has voice chatbots, and students can enhance their English communication skills by enhancing speech and increasing engagement (Bucea-Manea-Țoniş et al. 2022). Furthermore, chatbots improve students' enthusiasm, self-esteem, and interest in learning English.

Although AI voice chatbots have the potential to improve communication skills, AI-powered English learning applications have constraints in their capacity to engage in natural conversations with humans, accurately replicate the nuances of traditional and contextual language variations, generate novel phrasing, and identify potential errors or flaws in language usage (Ruan et al. 2019). While AI has the potential to offer advantages, it is important to recognise that technology cannot substitute the knowledge and supervision provided by human instructors.

Challenges and barriers of integrating artificial intelligence

Most university students, particularly those in developing countries, are not fully utilising AI technologies because technology is in its infancy, and a lack of knowledge on how technology usage plays a critical role (Bucea-Manea-Țoniş et al. 2022). As a result, significant training is necessary in integrating AI. Scholars have proposed a model that integrates AI competencies with the Revised Bloom's Taxonomy, a widely recognised framework for classifying educational objectives. This framework includes a perspective of cultural competence in relation to AI. This may assist instructors to utilise these technologies in an ethical manner within their teaching practices (Farrelly & Baker 2023). In addition, there is an uncertain legal and ethical challenge related to AI. However, a recommended method to use the technologies is to become acquainted with topics such as 'transparency of algorithms, ownership of data, privacy

concerns, concealed labour, inherent bias, and undisclosed plagiarism' (Wang et al. 2023).

Artificial intelligence technologies may lack critical knowledge, be unable to recognise significant facts or distinguish between trustworthy and uncertain sources (You et al. 2023). This means AI may not always be accurate, and the additional time and effort required to teach and learn to create meaningful material will be challenging for untrained users. The inaccuracy of AI is indicative of a deficiency in the AI's practice environment, an incapacity to discern crucial details, or an inability to differentiate credible sources from unreliable sources (You et al. 2023). As much as AI can provide individual students with personalised learning materials in several languages through AI translation services, the translation services are not precise and are missing the majority of foreign languages, notably SA languages. This means the diversity of learners from various ethnic, cultural, and economic backgrounds may not be accommodated. Institutions of higher learning in developing countries may seek to stay ahead through this transformation of the educational environment; however, a lack of resources may hinder the integration of AI technology into educational contexts (Grájeda et al. 2024).

Factors that impact on teaching and learning

Higher learning institutions are facing multiple factors that influence the integration of AI into their teaching and learning. Thus, factors are assessing the potential risks and benefits of AI and deciding on the most effective ways to meet the demands of learners and teachers (Chen et al. 2022). Learning institutions can optimise the utilisation of AI by clearly defining the purpose and use for both teaching and learning (Pagano & Marengo 2021). An in-depth understanding of how AI impacts educational paradigms is necessary. Implementing AI in education is a major priority in order to fulfil the demands and expectations of instructors and students.

Higher learning institutions can optimise the utilisation of AI by clearly defining the purpose and use for both teaching and learning (Pagano & Marengo 2021). An in-depth understanding of how AI impacts educational paradigms is necessary. Implementing AI in education is a major priority in order to fulfil the demands and expectations of instructors and students.

One of the studies that examined AI in the context of education argues that to effectively integrate AI in education, research should explore integrating pedagogy, curriculum, and instructional and/or learning design with technological processes (Dogan, Goru Dogan & Bozkurt 2023). Technological processes such as the Flipped Classroom Model and Gamified Learning Environments become important.

Integrating artificial intelligence in Saudi Arabian learning institutes

The South African National Artificial Intelligence Policy Framework recommends integrating AI technologies for

economic growth and the benefit of society (Department of Communications and Digital Technologies 2023). This includes integrating AI in HE institutions because HE institutions are the proponents of this vision. Integrating AI in learning institutions encompasses many AI technologies, some of which are listed in Table 3. These are technologies reviewed from the selected study. Many AI technologies integrated into the institute's learning may be available in other publications.

The South African National Artificial Intelligence Policy Framework places emphasis on sectoral interventions for AI ethical development, capacity building, and developing regulations for making AI applications secure, ethical, and in the public interest (Department of Communications and Digital Technologies 2023). However, integrating AI into the SA learning institutions requires a strategy that ensures technology will improve teaching, streamline administrative procedures, and be consistent with the institution's aims, values, rules, and regulations. This could be an important discussion among lecturers, students, and technology experts in the institution. This discussion may include student privacy, data security, and the potential loss of human touch in education. From the reviewed studies and considering the advantages and difficulties, this study proposes a strategy as follows (Figure 2):

• Planning: Artificial intelligence has the potential to improve security and efficiency in a number of areas, including the enrolment process and institutional overall operations (Pisica et al. 2023). This includes students, faculty, and curriculum (Chen et al. 2022). Some developed universities have already used chatbots for marketing purposes to offer students individualised support and guidance, cutting down on tedious tasks like creating lesson plans or administering tests (Bhutoria 2022). This means higher learning institutions in SA need to plan and identify specific educational opportunities where AI can make an impact such that this technology can be fit for purpose (Segooa, Modiba & Motjolopane 2025). Assess the current technological infrastructure and determine the upgrade needed to support AI integration, including cost implications.

• Goal: Artificial intelligence has the potential to improve education and provide a more individualised approach for both instructors and pupils (Pisica et al. 2023). Some of the AI-provided technologies, such as voice assistants and virtual and augmented reality, have gained popularity in more developed universities and high schools because of their effectiveness (Holmes et al. 2022). Artificial intelligence curriculum aligns institutions to achieve their learning objectives at a rate that aligns with the dynamic needs of the 21st century. Artificial intelligence may give students access to a variety of resources, including chatbots, voice assistants, translation tools, virtual reality and gamification, individualised study plans and tutoring, immediate evaluation, feedback, and many more (Ruan et al. 2019). Therefore, it is imperative for learning institutions to define clear, measurable goals for AI integration in their institutions,
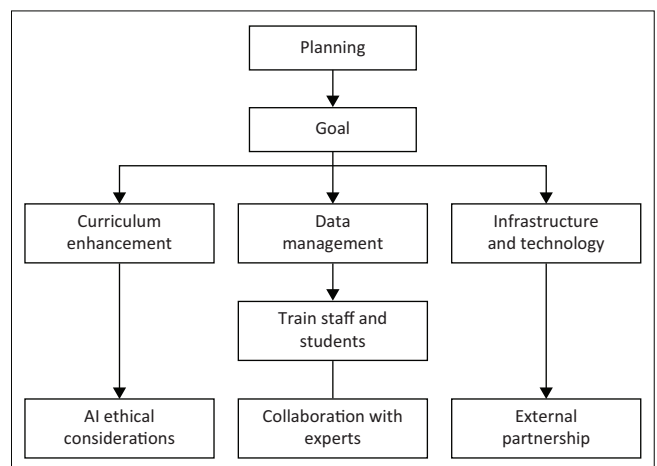
AI, artificial intelligence.

FIGURE 2: Strategy to integrate AI into the South African higher learning institutions (researcher).

TABLE 3: AI technologies in the learning institutes (Researcher).

AI Technologies	Explanations	Education categories
BookBuddy chatbot (Similar English learning technologies: ProWritingAid, Quillbot, Ginger, ELIZA, and ALICE)	Turn reading materials into interactive, conversational English learning activities (Ruan et al. 2019).	Virtual assistant interactive learning
Exploratory learning environments	Automated open-task-dependent adaptive feedback assists students in building their own learning by recognising errors, tackling complicated issues, and accepting uncertainty (Lameras & Arnab 2022).	Virtual assistant intelligent tutoring systems
Betty's brain	The learning and teaching approach serves as a self-regulation technique, motivating students to explore a scientific topic to enhance their understanding through a collaborative representation utilised in problem-solving strategies (Biswas 2023).	Interactive learning
Open essayist	An AI-powered, web-based feedback mechanism for summative assessment tasks. The technology offered students comments to help them improve their writing before submitting them by grouping keywords and phrases (Johnson 2023).	Automated grading and assessment tools
BELLA	A learning-by-teaching approach, where students take on the role of tutors, is employed for the study of mathematics and is grounded in the students' comprehension of symbolic models (Lenat & Durlach 2014).	Virtual assistant interactive learning
ACTIVE Math, MATHia, and Why2Atlas	Manage learning outcomes, track performance, develop teaching tools, and facilitate communication and feedback between instructors and foreign learners at various levels and disciplines (Chassignol et al. 2018).	Learning management systems
ChatGPT, Perplexity, BLOOM, ChatSonic, Claude, Bard, Whisper, and Jasper Chat	Deep learning algorithms have been modified to understand and create natural language. A large language model is an machine learning (ML) interactive algorithm that can autonomously acquire knowledge from data and generate coherent written content after being trained on an extensive text corpus (Farrelly & Baker 2023; Shen et al. 2023).	Virtual assistant learning

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that is clearly defined goals to yield the benefits. Institutions of higher learning should actively participate in determining the use and goal of AI in education.

- External partnership: Through the use of intelligent tutoring systems, intelligent agents, and intelligent collaborative learning systems in education, supports and improves learning environments (Salas-Pilco et al. 2023). Computer science, image processing, linguistics, psychology, neurology, and many other disciplines should be integrated using an interdisciplinary approach. In 2018, the United States and China Ministry of Education launched significant AI education programmes (Hrastinski et al. 2019). The 'AI Innovation Action Plan for Institutions of HE' was unveiled by China's Ministry of Education in an effort to assist and encourage youth to engage in AI-related activities and to educate students about AI (Chiu & Chai 2020). In response, a joint working group was established by the Computer Science Teachers Association (CSTA) and the Association for the Advancement of Artificial Intelligence (AAAI) to create national guidelines for teaching AI to K-12 students (Hrastinski et al. 2019). The goal of these initiatives was to aid in the creation of curriculum in schools that deal with AI. One significant international strategic endeavour to educate the future generation is the inclusion of AI subjects in school curricula. In addition to assisting students in understanding the nature and operation of AI technology, AI education in institutions may serve as an inspiration for the next software engineers, ethical designers, and AI researchers. Establishing external partnerships to formulate initiatives as a catalyst to prepare students for a future where AI is extensively used is recommended.
- Infrastructure and technologies: There are numerous branches and sub-branches of AI in education, including ML, which uses algorithms to identify patterns in educational data through successive training; deep learning, which simulates and predicts educational outcomes using large datasets; and natural language processing (NLP), which uses language recognition algorithms to extract and analyse textual meaning (Salas-Pilco et al. 2023). Although the technologies differ in certain aspects, deep learning, ML, and AI algorithms are linked to one another. Artificial intelligence is programmed to have certain abilities, such as learning, planning, recommending, problem-solving, and most importantly reasoning. Additionally, AI has already been used to predict student performance (Koçoğlu, Emre & Erol 2017), identify students at risk early (Bozkurt et al. 2021), identify the key factors influencing students' performance, conduct performance evaluation, provide descriptive information about students, and aid in the teaching process; develop adaptable, effective learning resources; and apply adaptive learning strategies (Bozkurt et al. 2021). These are some of the advantages that AI technologies bring to the learning institutions.

- Data management: Artificial intelligence combines computer power, data, and algorithms to create deep learning models that can identify patterns in data (Sova et al. 2024). It is capable of faster and more effective decision-making, data analysis, and trend and pattern recognition (Sova et al. 2024). As a result, one of the benefits that comes with the integration of this technology is that it can enable learning that is tailored to each student's needs.
- Curriculum enhancement: Suppose an institution invests in curriculum enhancement to provide students with fundamental knowledge of AI. Artificial intelligence can create specialised AI courses and programmes that will educate students. This improves curricular content creation as well as teaching and learning procedures, including assignment review, grading, and feedback. Platforms for interactive learning environments, like MATHia, Why2Atlas, and AI-assisted ACTIVE Math, have been used to monitor performance, manage learning outcomes, enhance instructional resources, and facilitate feedback and communication between teachers and students in various subjects and levels (Chassignol et al. 2018). Among other administrative features that can help students, AI-powered programmes like Grammarly, Ecree, and PaperRater provide plagiarism detection, grading, and writing enhancement (Johnson 2023).
- Train faculty and staff: To encourage and facilitate the use of these technologies in the classroom, it is essential that staff and students receive the necessary training. In order to improve comprehension and practical application of the material, this training should cover more than just the technical usage of the tools; it should also cover how to incorporate what is learnt in class and other academic pursuits (Grájeda et al. 2024). Rapid training as technology advances and more upgraded versions get introduced.
- Collaboration with experts: Concerns about student data privacy and copyright infringement are among the issues surrounding the application of AI in education (Bucea-Manea-Țoniș et al. 2022). These issues show how important it is for educational institutions, educators, and tech companies to work together to create clear policies and teach students how to use these technologies responsibly (Grájeda et al. 2024). Collaborate with AI specialists and institutes to get external knowledge and perspectives and provide support for both students and staff.
- Artificial intelligence ethical considerations: The human-AI system as a whole must be set up to operate responsibly and dependably; it is not enough for any one interaction or AI to do so. Designing AI tools based on global human rights concepts is an effective place to start (Sharples 2023).

Create and implement ethical regulations for AI usage at the institute to ensure openness, accountability, and fairness as recommended by the SA National Policy Framework (Department of Communications and Digital Technologies 2023).

Recommendations

Future research can consider the delicate nature of AI integration strategy based on each institute's learning culture

and environment. The Institute of Learning may do empirical studies, be it interviews or a quantitative analysis approach, to provide educators, administrators, and students with more precise findings that can be utilised to enhance student performance in the classroom. It is imperative to acknowledge the limits of AI technologies and utilise them in collaboration with conventional teaching methodologies to guarantee a well-rounded strategy that prioritises human communication and comprehension.

Limitations

This study was limited to journals published between 2018 and 2024 in the MDPI and Taylor and Francis Online databases. Future studies may tackle other databases, which might influence diverse findings. The analysis took into account the AI technologies reviewed in the selected papers. Other scholars may be able to provide more AI technologies integrated into education.

Conclusions

Developed countries present the benefits of AI in their learning institutions, while in developing countries, like SA, the countries are on the verge of grasping the opportunity. As developed countries increasingly integrate AI tools in their institutions, it is vital to recognise that AI is not universally applicable and should be customised to meet the explicit needs and cultural differences of students, especially considering the unique circumstances of each country. Therefore, what works in other countries might not work as anticipated in another country like SA. Hence, strategies that are effective in one country may not provide the expected results when implemented in a different country. Research advocated for a collaborative initiative involving policymakers, academics, educators, and technology specialists for the implementation of AI technologies within educational settings. It is recommended that integrating AI technologies into the classroom will equip students for a future where AI will be prevalent in the workforce. Additionally, there is a need to initiate discussions on the integration of AI to enhance student learning and bridge the digital gap. Integrating AI is linked to a wide range of advantages and challenges. A deficiency in pedagogical AI techniques, concerns over privacy, transparency, biases, and misinterpretation of the human-centred AI concept are lacking.

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Authors' contributions

The main author, P.D.M., contributed to conceptualisation, methodology, formal analysis, and the drafting of the article. A.P., the second author, supervised the entire research. The third author, R.C.M., contributed to the article's data analysis and writing. The fourth author, M.A.S., contributed to selecting the approach and developing the methodology utilised.

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Data availability

The data that supports the findings of this study are available from the corresponding author, P.D.M., upon reasonable request.

Disclaimer

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