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A systematic review of research on artificial intelligence in higher education: Practice, gaps, and future directions in the GCC

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Abstract

Acknowledging its potential on diversifying economy and attaining sustainable development, the Gulf Cooperation Council (GCC) countries, comprising of Bahrain, Kuwait, Oman, Qatar, Kingdom of Saudi Arabia, and United Arab Emirates, have been investing heavily on digital transformation and keeping pace with technological advancements. In particular, over the last years, with the unified efforts on transitioning to a knowledge society and enhancing educational outcomes, GCC countries have been demonstrating a strong dedication on integrating artificial intelligence in education (AIED). This systematic review investigates characteristics of artificial intelligence (AI) research in the region, identifying advantages and disadvantages of AI utilization in higher education, and exploring main issues accompanied with possible directions for the future. In the Scopus database, 32 studies were analyzed, all open access documents affiliated to a GCC country, having artificial intelligence and higher education, or related terminologies as keywords. Results revealed that AI applications were beneficial for institutions to improve educational outcomes, assist in decision-making, and advance institutional systems. No study reported negativity resulting from AI practices. However, important barriers were identified that hinder the full deployment of AI in higher education, including poor technology skills, inadequate technology infrastructure, resistance in leveraging traditional approaches in education, and challenges related to structural complexity of Arabic language. Future directions are proposed, offering opportunities for practitioners and research potential for scholars.

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Introduction

The term AI was first introduced in 1956 by McCarthy and Turing followed up the work, describing AI as an existence of intelligent reasoning that could go into machines (Górriz et al., 2020). In line with advancements in AI capabilities, AI definition has been growing and changing significantly. With the recent AI technologies, such as chatbots, expert systems, machine learning, intelligent agents, personalized learning and virtual learning environments (Zhang & Aslan, 2021), nowadays AI is defined as a computing system that can engage in human-like processes, which include learning, adapting, summarizing, and self-correcting (Crompton & Burke, 2023).

While AI has been integrated into several fields, education sector has welcomed AI technologies for more than 30 years (Jantakun et al., 2021). AI in education offers various possibilities and opportunities, performing many tasks teachers and students need. Particularly, AI can transform traditional teaching methods, personalize learning experiences, streamline administrative tasks, and improve overall outcomes in education (Hashim, Tlemsani, & Matthews, 2021). For example, by utilizing AI, institutions can increase student engagement, provide individualized learning experiences, and optimize administrative processes for greater efficiency and efficacy (Daghestani et al., 2020). Students can access learning from any location without access to physical classrooms in the natural environment (Shorey et al., 2019). AI could also be a professional facilitator or moderator by conducting monitoring and student collaboration activities and providing targeted support (Holmes et al., 2023). A study by Ansari and Khan (2020) shows that using information and communication technology in education, such as web-based applications and social networking, significantly increases students' interactivity with teachers and peers, improving knowledge-sharing behaviour as well as student engagement and academic performance.

Evidently, using AI in education can profoundly transform instruction and learning. However, it also presents a number of obstacles and drawbacks that must be carefully considered. Specifically, ethical considerations, data privacy concerns, bias and errors, as well as digital divide and resistance to change are among the complex issues to be addressed (Dignum, 2021). For instance, AI models are fallible and can make errors, resulting in incorrect outcomes and recommendations (Borenstein and Howard, 2021). This can have significant repercussions, particularly in educational decisions and sensitive student support. In addition, collecting and analysing large quantities of student data can raise concerns about privacy, consent, and protection. Here, protecting sensitive information and assuring data security are highly crucial to prevent data breaches and unauthorized access (Sharma et al., 2019). Furthermore, regarding transparency and interpretability, AI models such as deep learning neural networks, can be highly complex and challenging to comprehend. A study by Kim et al. (2022) reveals that teachers are not able to apply the AI tools due to facing difficulty in interpreting the information provided.

To ensure that AI functions as a tool for empowerment rather than a replacement for human, it is necessary to balance leveraging AI's capabilities and maintaining human-centric educational approaches (Chiu et al., 2023). AI tools cannot completely capture the complexities of human emotions, motivations, and individual learning styles, thereby limiting the richness of educational experiences and personalized student support. Understanding and addressing these obstacles is crucial for maximizing the benefits of AI in education while mitigating potential harm (Borenstein

and Howard, 2021). By acknowledging and proactively addressing these challenges, educational institutions can navigate the complex landscape of AI integration, ensuring that all students have access to equitable educational opportunities.

Evidently, establishing AI and its integration into education system requires abundant resources and robust funding (Ziad, 2021). In wealthy Arabic countries, such as the Gulf Cooperation Council (GCC) countries including Bahrain, Kuwait, Oman, Qatar, Kingdom of Saudi Arabia (KSA), and United Arab Emirates (UAE), governments have taken bold steps to foster technology and innovation in education, investing substantially in teaching and learning (Aldosari, 2020). As a game changer on the global stage, incorporating AI in education has been a central component of these investments (Khan et al., 2022). Indeed, over the last decades, with the common goal of diversifying economy from dependence on oil and gas industry to sustainability and a knowledge-based economy (Alzahrani, 2022), GCC countries have been actively working on highly ambitious long-term plans, such as the Saudi Arabia Vision 2030, UAE Vision 2021, Qatar Vision 2030, Kuwait Vision 2035, and Bahrain Vision 2030. Specifically, as part of Saudi Arabia Vision 2030, KSA created the Saudi Data and AI Authority in 2019, with a stated ambition to transform its workforce with a steady supply of data and AI-empowered talents (Elhajji et al., 2020). Similarly, UAE launched the UAE Artificial Intelligence Strategy 2031 to establish the nation as a global AI centre (Hanafi, Kshetri, & Sharma, 2021). Next, Qatar established the Qatar Computing Research Institute (QCRI) as a regional leader in AI research (Elmagarmid, & Saoudi, 2021). Likewise, Bahrain introduced the National Artificial Intelligence Strategy to promote AI adoption in various industries. Overall, these initiatives demonstrate the region's dedication to utilizing AI for diversification and modernization (Hassan et al., 2022).

As literature shows, the current state of knowledge regarding the application of AI within the GCC region is marked by a scattered and incomplete understanding (Al-Zyoud, 2020). Uncertainties persist in many aspects, such as effectiveness, implementation strategies, and potential impact of AI interventions (Sharfi, 2021). There are a number of studies in the region showing positive impact of AI interventions in higher education, such as making it easy for instructors to grade students (Al-Hashimi and Hamdan, 2021) and improving students' understanding on how to incorporate technology into the existing business process (Johnson et al., 2022). However, a number of studies reflect significant obstacles and issues, such as inadequate training of faculty members (Aldossary et al., 2020), failure to follow up and monitor challenges for adopting AI (Albasalah et al., 2021), stress and pressure among teachers due to feeling AI is challenging their position (Khan et al., 2022), as well as the scarcity of resources, lack of investment in AI, poor interest in college administration, lack of knowledge, and a limited number of studies that are associated with the AI applications (Mohammad et al., 2021). Alzahrani (2022) states that AI will continue to assist humans in the future when more research, funding, and resources are needed from the perspective of Arabic countries in successfully implementing AI systems in education.

The necessity of this review arises from the fact that studies conducted so far lack a GCC focus, failing to address the unique challenges, cultural considerations, and regional context specific to GCC countries (Ashfaq and Ayub, 2021; Yanes et al., 2020). This study aims to analyse and synthesize the current state of knowledge on AI in higher education in the GCC region, providing evidence-based directions for practice, policy, and research. Specifically, this study addresses the following research questions:

(1) What are the advantages and disadvantages of using artificial intelligence in higher education?

(2) What are the main gaps and issues highlighted in artificial intelligence research in higher education across the GCC countries? What are the corresponding directions for future research in the region?

Method

This study presents a systematic review of research on artificial intelligence in education at the college level. Mainly, it focuses on the literature in the GCC region, analysing published studies' reports systematically, transparently, and replicable (Møller & Myles, 2016). The study answers the targeted research questions with explicit criteria to "extract, analyze, and synthesize data" from the relevant studies (Xiao & Watson, 2019, p.102). The review is conducted in concurrence with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the four-phase flow diagram (Moher et al., 2009; Page et al., 2021) and reported according to the article writing standards of the American Psychological Association (APA; APA Publications and Communications Board Working Group on Journal Article Reporting Standards, 2008).

Eligibility criteria

As Harden and Gough (2012) suggest, reviews should include "only the most appropriate, trustworthy, and relevant studies" (p. 154). Given the scope of this review, the eligible studies were all the open access documents that self-identify themselves with the keywords "artificial intelligence" and "higher education" and related terminologies. In addition, as the review focuses explicitly on the GCC region, studies affiliated with the six GCC countries, namely Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates, were included. No exclusion was done regarding the year of publication, subject area, document type, source title, source type, and language, as well as author name, affiliation, and funding sponsor. Table 1 summarizes the inclusion and exclusion criteria for the review.

Table 1.

Inclusion and exclusion criteria for the systematic review

	Inclusion criteria	Exclusion criteria
1.	Theme: artificial intelligence (or machine intelligence, chatbot, machine learning, AI, deep learning)	Any study not having artificial intelligence or related terms in keywords
2.	Theme: higher education (or university, undergrad, college, tertiary, post-secondary education)	Any study not having higher education or related terms in keywords
3.	Accessibility: open access	Any study not available access
4.	Publication stage: final	Any study in press
5.	Region: GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates)	Any study not related to the GCC region

Information sources

On May 14, 2023, studies were identified by searching the Scopus database, which is the largest (Schotten et al., 2017), global, and multidisciplinary abstract and citation database (Baas et al., 2020), consisting of a wide range of peer-reviewed scholarly content, indexed over an expanded spectrum of journals with a high competence for citation analysis (Falagas et al., 2008). So far, the record coverage of Scopus includes over 90 million documents from seven thousand publishers, with the oldest record dating back to 1788 (Elsevier, 2023).

Search strategy and selection process

Boolean operators were applied to identify the most relevant records using search terms and limiters, as described in Table 2. First, a keyword search was done for the words "artificial intelligence", "machine intelligence", "chatbot", “machine learning" and "deep learning", yielding an initial number of 911,377 records. Next, within the results, a keyword search was done for the terms "higher education", "university", "undergrad", "college", "tertiary" and "post-secondary education", bringing about 7,178 records. Then, the gathered results were restricted to final documents, excluding the ones in press in the publication stage, reducing the number to 7,118 records. After that, the results were restricted to open-access documents to have free and full access to the papers for the data analysis, resulting in 2,644 records. Lastly, given the scope of the review, the search was refined to documents belonging to the GCC countries, leaving 77 records.

Table 2.

Search terms and limiters used in the database search

Search Terms	Search Limiters	Database	Hits
"artificial intelligence" OR "machine intelligence" OR "chatbot" OR "machine learning" OR "AI" OR "deep learning" AND "higher education" OR "university" OR "undergrad" OR "college" OR "tertiary" OR "post-secondary education"	Open Access Final documents in the publication stage Country- Saudi Arabia, United Arab Emirates, Oman, Qatar, Kuwait, Bahrain	Scopus	77

After the initial search strategy, one researcher downloaded the identified papers to prepare for the selection process. Then, the researchers screened the records for keywords, titles, and abstracts to select the eligible studies. 32 papers were retained as the final dataset based on all the inclusion and exclusion criteria.

Data collection process and data items

Before data extraction, the researchers created an Excel spreadsheet as a template for data collection. The research questions informed all the variables for which data were sought, and those variables were used as the column headings of the spreadsheet. Both researchers reviewed and extracted the data individually. Then, the information was compared, and disagreements were resolved through discussion.

The researchers used inductive coding method to collect data. It involved extracting data from the studies by examining them and identifying important text that addresses the intended information rather than fitting it into pre-existing categories (Schreiber & Cramer, 2022). In particular, this required deep and inferential comprehension of how the selected studies report on the advantages and disadvantages of using AI in higher education, gaps and issues related to AI research, and possible directions for future studies.

Study selection

The flow of the study selection process, including identification, screening, eligibility, and included studies, is illustrated in Figure 1. Briefly, the initial search strategy generated 77 records from the Scopus database. The third inclusion criteria excluded three records from the review because they were not open-access documents. In addition, one record was excluded because the publisher removed the document due to incomplete authorization.

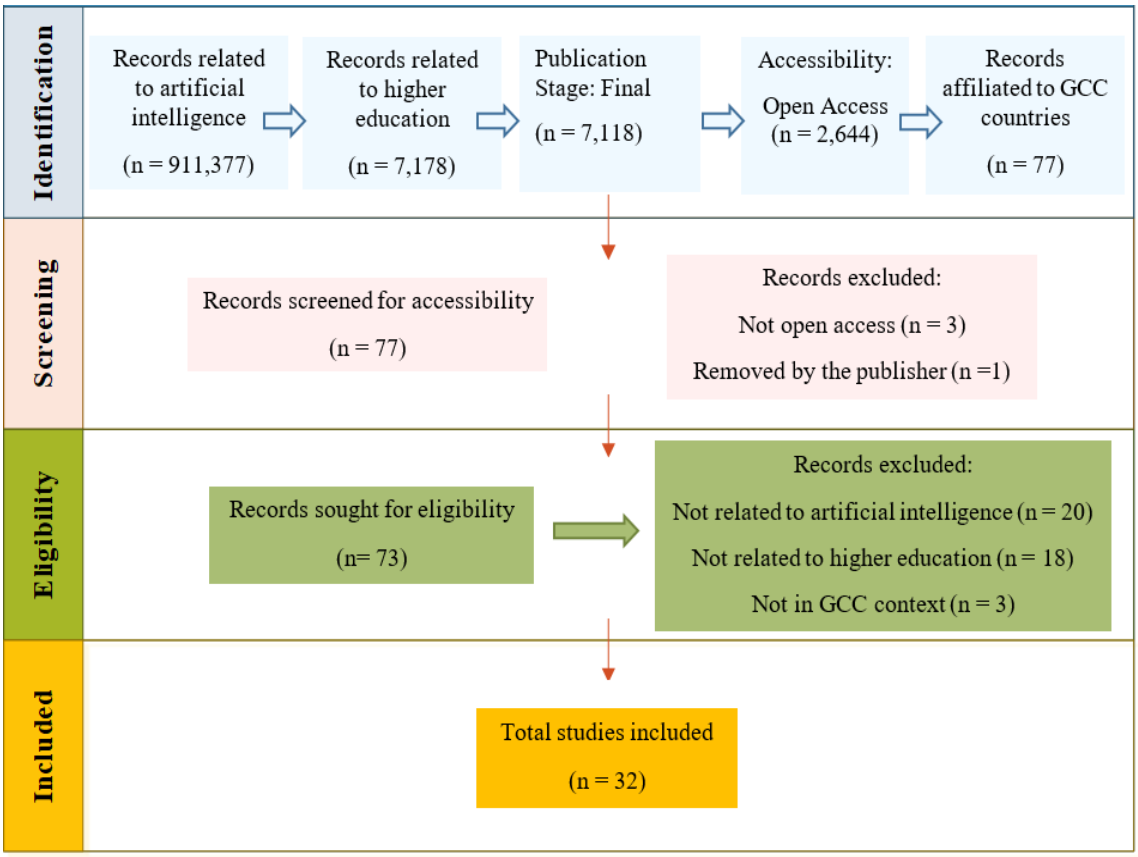

Figure 1.
PRISMA Diagram of Election Process Based on Scopus Database

Afterward, the records' keywords, titles, and abstracts were analysed for the eligible studies. Based on the first inclusion criteria, 20 documents were excluded from the review because they did not contain any keyword related to the artificial intelligence theme or similar terms such as machine intelligence, chatbot, machine learning, AI, and deep learning. The researchers also screened the titles and abstracts of those papers, yet they were unrelated to artificial intelligence. In addition, 13 studies did not include any keyword or a keyword related to artificial intelligence. Yet, the researchers kept them for review because five studies had machine learning, four had artificial intelligence, three had AI, and one had deep learning, either in their title or abstract.

Similarly, based on the second inclusion criteria, 18 records were excluded from the review because they did not contain any keyword related to the higher education theme or similar terms such as university, undergrad, college, tertiary or post-secondary education. The researchers also screened the titles and abstracts of those papers, yet they were not related to higher education. In addition, 25 studies did not include any keyword or a keyword related to higher education. Yet, the researchers kept them for the review because ten studies had higher education, 13 had a university, and two had college, either in their title or abstract.

Regarding the fifth inclusion criterion, all the records had at least one author affiliated with a higher education institute in one of the GCC countries. However, the researchers dropped three studies

as the data were collected from students and faculty members not in the GCC region. In particular, one study had data from India and two from the United Kingdom, with results not belonging to the GCC context. Based on all the inclusion and exclusion criteria, 32 records were retained for the systematic review as the final dataset.

Study characteristics

Table 3 shows the information about the reviewed studies regarding publication year, publication type, affiliation, and country. The complete list of the studies is provided in the Appendix.

Table 3.

Information about the reviewed studies

#	Year	Publication Type	Affiliation	Country
1	2020	Conference	Global College of Engineering and Technology	Oman
2	2022	Article	King Abdulaziz University	KSA
3	2023	Article	Australian University	Kuwait
4	2022	Conference	Gulf College Sultan Qaboos University University of Hail	Oman KSA
5	2022	Article	Princess Nourah Bint Abdulrahman University	KSA
6	2020	Article	Prince Sattam Bin Abdulaziz University	KSA
7	2020	Conference	Imam Abdulrahman Bin Faisal university	KSA
8	2019	Article	King Abdulaziz University	KSA
9	2021	Article	University of Ha'il New Valley University Saudi Standards, Metrology, and Quality Organization	KSA
10	2022	Article	King Abdulaziz University	KSA
11	2023	Review	Jazan University	KSA
12	2021	Article	Jazan University	KSA
13	2023	Article	Community College of Qatar	Qatar
14	2016	Article	King Abdulaziz University	KSA
15	2022	Review	Northern Border University	KSA
16	2021	Article	King Abdulaziz University	KSA
17	2021	Article	Imam Abdulrahman Bin Faisal University	KSA
18	2020	Article	Khalifa University of Science and Technology	UAE
19	2022	Article	Najran University	KSA
20	2022	Article	Qatar University	Qatar

21	2022	Article	Saudi Electronic University	KSA
22	2021	Article	Canadian University Dubai American University of Sharjah	UAE
23	2017	Article	King Abdulaziz University Northern Border University	KSA
24	2019	Conference	Amity University	UAE
25	2020	Article	King Khalid University	KSA
26	2021	Article	King Saud University Prince Sattam Bin Abdulaziz University	KSA
27	2021	Article	Umm Al-Qura University	KSA
28	2023	Review	Prince Sultan University	KSA
29	2021	Article	King Saud University University of Jeddah	KSA
30	2022	Article	Umm al-Qura University	KSA
31	2020	Article	Prince Sultan University	KSA
32	2021	Article	Umm Al-Qura University	KSA

Results

Advantages and disadvantages of using AI

The first research question is about the possible advantages and disadvantages of using artificial intelligence in higher education, as reported in the GCC region. For the benefits, among the 32 studies analysed, 18 studies were used for answering the second research question since the other studies were either survey papers [4, 5, 6, 13, 17, 19] or review papers [9, 11, 15, 20, 24, 25, 28, 31], that have no utilization of artificial intelligence.

Table 4 summarizes the papers analysed, including information about the AI applied, who used the AI, and what main benefits it provided. In brief, the results revealed that the main advantages of AI applications in higher education were to improve educational outcomes [3, 7, 12, 16, 18, 22, 27, 29, 30, 32], to enhance institutional decision-making [1, 8, 14, 21, 26], and to advance institutional systems [2, 10, 23]. Moreover, the end users benefiting from the AI applications mainly were higher education institutions (n=11), instructors (n=9), and college students (n=6).

Table 4.

Advantages of using AI in higher education

#	What AI is used?	Who benefits?	What is it suitable for?
[1]	Machine learning algorithms	Higher education institutions	Predict no-detriment rate (for decision-making)
[2]	Search and rescue optimization technique	Higher education institutions	Provide biometric authentication for improving the cybersecurity system
[3]	An algorithm based on Convolutional Neural Networks (CNN)	College students	Enhance students' reading and comprehension skills
[7]	Neural network model based on machine learning	College counsellors	Predict students' level of anxiety
[8]	Deep learning model	Higher education institutions	Predict at-risk students and enforce student retention (for decision-making)
[10]	Automated outlier detection tool	Higher education institutions	Identify intrusions and attacks to enhance the cybersecurity system
[12]	Blackboard	Instructors and college students	Improve pedagogical approaches and academic outcomes
[14]	Algorithms based on Support Vector Machine and Naive Bayes	Higher education institutions	Examine tweets to assess learning experiences
[16]	Recommender system	College students, instructors, higher education institutions	Guide students in specialization selection
[18]	Deep learning technique	Instructors	Predict students' behaviour in online learning environments
[21]	Metaheuristics and machine learning-based method	Higher education institutions	Predict students' academic success (for decision-making)
[22]	Machine learning techniques	Instructors	Detect plagiarism
[23]	A personalized framework	College students, instructors,	Enhance the processes of information collection, development, and accessibility

		higher education institutions	
[26]	An approach based on supervised machine learning	Higher education institutions	Improve educational decision-making processes, such as the admission process, curriculum, and learning activities
[27]	AI supported instructional infographic templates	Instructors	Enhance students' academic achievement, visual thinking skills, and willingness to learn
[29]	Online safety training modes	College students, instructors, higher education institutions	Enhance learners' knowledge retention, engagement, and attention
[30]	Cheating detection system	Instructors, higher education institutions	Detect cheating
[32]	AI enabled mobile application	College students, instructors	Enhance students' participation and communication between faculty members and students

Regarding decision-making, paper [1] used different machine learning algorithms to advance data analysis at a higher education institute in Oman. Data from 1020 students were utilized to examine whether academic performance could predict the no-detriment rate. The results revealed that the Random Forest algorithm, rather than Support Vector Machine, Decision Tree, and Naive Bayes, provided the highest performance for making decisions on no detriment policy. Next, the paper [8] generated a deep short-term memory model using students' online clickstream information to predict their academic performance. Data collected from 316 college students showed that leveraging deep learning models can assist in the early prediction of at-risk students, enforce student retention, and advance higher education decision-making. Similarly, paper [21] developed a metaheuristics and machine learning-based method to predict students' college achievement. After using three different machine learning classifiers and applying a relief algorithm, researchers developed a tool for making projections about students' academic success for long-term institutional decisions.

Paper [14] developed Support Vector Machine and Naive Bayes algorithms to examine college students' "tweets" on their learning experiences at a university located in the KSA. Opinion mining and sentiment analysis results showed that the developed framework could identify text sentiments and detect patterns in Arabic tweets. It showed promising results with students' comments and opinions about their learning experiences. Moreover, the paper [26] used supervised machine learning and developed an approach to enhance the correctness of decision rules. The proposed method improved decision-making, specifically for the admission process, curriculum, and learning activities.

Regarding improving institutional systems, paper [2] developed a search and rescue optimization technique for biometric authentication at a higher education institute in the KSA. Deep learning was utilized for median filtering, extraction of features, classification process, and fingerprint identification. Results showed that the approach was practical for biometric authentication and could improve the institute's cybersecurity system. Likewise, paper [10] developed an automated outlier detection technique to identify intrusions and attacks to the higher education institute's cyber security system. The method was effective for outlier detection, classifying data into the existence or absence of intrusions, and adjusting hyper parameters. Furthermore, the paper [23] developed a personalized framework utilizing the Internet of Things, big data, supercomputing, deep learning, mobile computing, and cloud computing techniques. The framework was used for enhancing the processes of information collection, development, and accessibility.

As for enhancing educational outcomes, paper [3] developed an AI algorithm based on Convolutional Neural Networks to enhance students' reading skills at an international higher education institute in Kuwait. The algorithm improved students' cognitive capabilities, such as reading, locating, and comprehending a text, presenting better outcomes than other reference models. Next, paper [7] developed a neural network model based on machine learning classifiers to predict students' level of anxiety. Data were collected from 917 college students at a university in the KSA. The proposed model could predict anxiety among the students and found gender, level of support from family and friends, and family income as the top three factors playing a role in the level of anxiety. In another study, paper [12], researchers examined the benefits of using Blackboard as a learning management system. Data were collected from 81 faculty members and 243 college students at a university in the KSA. Researchers explored faculty members' utilization of Blackboard in their online courses and its impact on student's academic success. Blackboard improved both faculty members' pedagogical approaches and students' educational outcomes.

In a paper [16], researchers developed a recommender system to guide preparatory year students in their specialization selection process. Data were collected on various tests and grades from 960 students. Using a collaborative filtering technique, the proposed AI system made practical recommendations for selecting an appropriate specialization. Next, paper [32] developed an AI-enabled mobile application and examined its impact on the quality of automatic services among college students at a university in the KSA. The application provided several advantages, including encouraging students to participate actively in the learning process and contributing to effective communication between faculty members and students, in addition to providing multiple methods of communication between students.

In a predictive study paper [18], researchers at a university in the UAE developed a deep learning technique to predict college students' behaviour in online learning environments. Data were collected from learning management systems from three countries (Portugal, UAE, and Greece) to forecast users' online learning engagement. The results revealed that the technique could provide educators with an evaluation path to content-related assessment and promote student motivation and participation in learning. Likewise, in a paper [22], researchers from two universities in the UAE used machine-learning techniques, including recurrent neural networks and anomaly detection algorithms, to develop a tool for detecting potential cases of cheating. Considering students' grades before the final exam, grades of the final exam, and overall class performance, the tool effectively caught plagiarism. In addition, the paper [30] developed a

cheating detection system using a Convolutional Neural Network. The system identifies I.P. addresses, records exam sessions, and prevents internet browsing during exams without a camera. The results showed that the system successfully minimized cheating cases, which could be helpful for higher education institutions, especially those operating online.

In an experimental study, paper [27], designed a double-template educational program. It developed two AI-supported instructional infographic templates (static and animated), to examine their impact on academic achievement, visual thinking skills, and willingness to learn among a sample of students at a university in KSA. The results showed that both infographic templates had a favourable impact on all the aspects studied, whereas animated infographics had a more significant effect than static ones. Likewise, paper [29] developed two online training modes (slide-based and virtual world) and examined their impact on learners' knowledge retention, engagement, and attention. Data collected from 143 participants revealed that the virtual training platform, which used deep learning, allowed more interactive and engaging learning.

As a final point, regarding disadvantages, none of the studies reported any disadvantages, weaknesses, or negativity resulting from implementing the proposed artificial intelligence techniques. This implies that the application of artificial intelligence in higher education was beneficial from all aspects in the GCC region.

Gaps and issues identified in AI research

The second research question is about gaps and issues identified in AI research in higher education and the corresponding research directions for the future. As the paper [6] states, “In the Arab environment, the subject of artificial intelligence is still a relatively recent topic” (p.146). There are numerous research gaps and issues in the GCC region, and the researchers recommend many possible research directions. To start with, research shows that Arab universities are likely to “follow a traditional approach to education with the variation of these universities in infrastructure, so there are no applied research or studies or even theory on the topics of artificial intelligence” (paper 6, p.146). Paper [17] also highlights that “there is not enough general knowledge of AI”, in Saudi Arabia, “and the consequences of not implementing it” (p.375). This brings a call for research to examine Arab universities’ willingness to implement artificial intelligence projects and understand their potential in accomplishing educational goals. Likewise, the paper [27] emphasizes, “the majority of faculty members at different universities are still persistent in relying on using traditional teaching methods” (p.2). The researchers suggest more studies to explore the impact of AI emerging tools and technologies in improving the educational process, for instance, how using AI-supported infographics can enhance students’ learning and interest in different academic content.

In the contemporary world today, the real question is not anymore whether to include AI in education or not; instead, it is which AI technologies to adopt for addressing “the changing learning needs that instructors are tackling in the classroom while taking into account circumstances and prospects” (paper 31, p.10). In this point, the paper [28] shows that students and instructors lack skills in using emerging technological tools in the GCC region. Even studies reveal a lack of use or limitation in the use of AI technologies, “due to the novelty of these systems and their compatibility with the beliefs and values of the local community” (paper 13, p.702). Paper [4] also pays attention to the lack of understanding of personalized learning and the importance

of AI technologies. The study spotlights the need for more research on factors, such as learners' participation and motivation, which influence a successful integration of AI in higher education settings.

In the paper [31], the researchers recommend conducting more systematic studies to examine AI usage and how it can contribute to educational success. Similarly, the research paper [28] calls for more frequent reviews on examining the relationship between IT self-efficacy and the use of information management. Moreover, paper [31] notes that "education policy implementation for AI is still in its adolescence" (p.9), and there is a need for "community engagement and peer networking to build an AI education "aurora" to look at AI projects in communication and advise on national and international AI policy proposals" (p.11).

Regarding gaps, issues, and research directions about machine learning, paper [1] shows that most of the machine learning research concentrates on students and instructors, disregarding the needs of administrators to handle complex decision-making for coming up with effective policies, strategies, and actions to improve quality of education. Researchers suggest more studies use machine-learning algorithms to help in decision-making at the tertiary level. Likewise, paper [26] reports that higher education institutions can record large amounts of student data with modern software technologies. However, data storage itself does not facilitate administrators to make adequate decisions. Hence, the researchers propose utilizing machine learning and algorithms with formal verification techniques to avoid bias and mislabelling.

Moreover, the paper [24] stresses that higher education institutes need to continuously bring innovative changes in their curriculum and delivery, which should be based on institutional data collected on various parameters. However, institutions' lack of information and communications technology (ICT) tools is one of the challenges in quality assurance in higher education (p.1024). The researchers propose future research to use ICT tools and apply data analytics for enhancing operational decision-making and quality assurance. Further, the paper [15] underlines the importance of students' academic performance for the success of higher education institutions. It points out that despite the large volume of educational data, there is a lack of systematic and comprehensive methodology to predict academic performance. Researchers suggest using machine-learning algorithms to accurately predict academic performance, using robust and extensive datasets from multiple institutions. As with, paper [21] reports current research on predicting student achievement. While the researchers acknowledge the existence of various predictive analytics, they suggest implementing machine learning and metaheuristics to make accurate projections about student performance for identifying potential issues and improving decision-making.

Another study on machine learning [22] focuses on online education and academic misconduct in higher education. Researchers point out that while higher education institutions try to combat student cheating by using remote proctoring, software monitoring, webcams, and plagiarism software, it is still relatively easy for students to receive third-party assistance during online exams. Researchers propose using machine-learning techniques by applying recurrent neural networks and anomaly detection algorithms to identify potential cases of cheating. The researchers also suggest using linear regression and anomaly detection combinations to minimize academic dishonesty. Moreover, paper [7] notes that few studies have explored the efficacy of AI in predicting anxiety among college students, suggesting future research to utilize

machine learning classifiers to examine the factors that predict mental health among college students. Furthermore, the paper [14] emphasizes the challenges related to Arabic language text analysis due to its structural complexity and use of informal language with ambiguous meanings. Researchers propose establishing semantic schema by applying opinion-mining techniques and sentiment analysis.

Research on deep learning, as a type of machine learning, also points out various gaps and issues. For instance, paper [2] emphasizes the weakness of higher education institutes' information technology infrastructures and the increased risks of cyberattacks. The researchers recommend exploring deep learning-based biometric authentication techniques and fusion-based deep learning models for enhancing cybersecurity in higher education institutions. Likewise, paper [10] suggests future research to integrate different methods, such as "signature generation algorithm, honeypots, intrusion detection systems, analysis, and tracking," to detect attacks more effectively (p. 3386).

Another study on deep learning [8] stresses the limited number of studies on adopting deep learning approaches for predicting student outcomes, especially for early intervention of at-risk students. The researchers suggest that future research examine deep advanced learning and natural language processing techniques to assist in educational decision-making. Next, the paper [25] underlines the importance of deep learning techniques in enhancing e-learning applications. Researchers propose exploring the impact of automatic classifiers on indexing and reusability of educational content in multiple formats and on various platforms. Then, they suggest investigating virtual and intelligent tutoring techniques with innovative deep learning environments to help learners acquire, process, and organize information best suited to their needs.

As for big data analytics, the paper [9] emphasizes the lack of systematic studies about big data algorithms based on machine and deep learning techniques. In particular, paper [19] calls for researchers to collect data from several higher education institutions in different countries to utilize big data analytics to explore the role of metacognition in promoting students' deep learning in online learning settings, specifically in Massive Open Online Courses. Moreover, the paper [23] underlines the importance of eLearning and distance learning in the future of higher education, and suggests utilizing the Internet of Things (IoT), big data, supercomputing, and deep learning in the e-Teaching and e-Learning systems to serve the needs of next-generation learners better. Next, a study specifically on IoT, paper [11], states that research on IoT is still in its early phases, and more efforts are needed to explore augmented reality and learning analytics and their effects on learning outcomes. The researchers also highlight the need to work on security and privacy issues for adopting IoT in education.

As a final point, the paper [20] reports that research on teaching AI ethics is a relatively recent endeavour in the GCC and merely based on human-driven approaches, having limited disciplinary scope and geographical coverage, indeed being biased towards Western cultures. For future research, it is suggested to utilize automated data-driven approaches based on topic modelling, "which includes the analysis of content combining the algorithmic extraction of coherent and recurrent patterns" (p.935) with huge scales, including data from under-represented regions such as Africa, South America, and Asia, "to connect the various communities within a shared understanding of the value of AI ethics" (p.956).

Discussion

This study presents a systematic review of artificial intelligence research in higher education across the GCC countries, addressing advantages and disadvantages of using AI in higher education, and issues highlighted in the region with the corresponding future research directions. The studies were identified by searching the Scopus database, based on five criteria: artificial intelligence or related terminologies as a keyword, higher education or associated terminologies as a keyword, open access, documents in the final stage, and documents affiliated to a GCC country. Accordingly, the final dataset consisted of 32 studies, from which inductive coding methods extracted data.

As for the advantages of using AI in higher education, this review showed that the most striking benefits are improving educational outcomes, enhancing institutional decision-making, and advancing institutional systems. In particular, regarding educational outcomes, the results showed that AI was implemented in the region for various academic purposes, including enhancing students' reading skills, measuring anxiety levels, promoting class participation, motivation, and knowledge retention, and detecting cheating. Next, for decision-making, the findings indicated that AI was implemented for several institutional purposes, such as making predictions for at-risk students, no-detriment rate, and student academic success, to assist in the long-term institutional decision on the admission process, curriculum, and learning. Then, for advancing institutional systems, the results highlighted that AI was implemented for developing biometric authentication system and creating an outlier detection system to enhance institutes' cybersecurity system, and for developing g personalised framework to enhance institutes processes of information collection, development, and accessibility. Overall, the results showed that the end users benefiting from the AI applications mainly were higher education institutions, followed by instructors and college students. Overall, these findings have confirmed some results from the broader AI literature. Notably, AI has the potential to transform traditional teaching methods, personalize learning experiences, streamline administrative tasks (Hashim et al., 2021) and improve overall educational outcomes in education (Eager & Brunton, 2023). Students can access education without access to physical classrooms (Shorey et al., 2019). Moreover, by utilizing AI tools and technologies, institutions can increase student engagement (Daghestani, Ibrahim, Al-Towirgi & Salman, 2020), collaboration (Ansari & Khan, 2020; Lodge, de Barba & Broadbent, 2023), and provide individualized learning experiences (Holmes et al., 2023) with higher level of self-regulation (Lodge, de Barba & Broadbent, 2023).

Regarding disadvantages, no study reported any disadvantage, weakness, or negativity from leveraging AI in higher education. This could imply that the application of artificial intelligence in higher education was found to be beneficial from all aspects of the GCC region. Nonetheless, in the literature, there have been various notes on some of the drawbacks of using artificial intelligence in education, such as ethical issues (Dignum, 2021; Eager & Brunton, 2023; Lodge, de Barba & Broadbent, 2023), increase in unemployment (Chiu, Xia, Zhou, Chai & Cheng, 2023), difficulty of understanding the algorithms (Kim et al., 2022), interpretation of data (Sharma et al., 2019) and poor quality, biased or incorrect output (Crawford et al., 2023. Yet, the studies analysed in this review do not seem to have these issues on their radar. There is still much to learn about what works and does not work regarding applying artificial intelligence in higher education. Research can inform and guide future educational practitioners, researchers, and policy makers

by carefully investigating the disadvantages, drawbacks, and obstacles associated with leveraging AI tools and technologies. Indeed, identifying the potential issues will not only provide a comprehensive view of AI's impact on higher education but also inform the stakeholders to establish frameworks and policies for addressing those issues and ensuring the integration of AI keeps being beneficial for education and aligns with the best global practices.

As a final point, regarding gaps, issues, and future directions, the findings showed that though there is an established research base on AI research in higher education, this topic is still in its infancy in the GCC region. The most evident gaps are a lack of knowledge about AI, poor technology skills of faculty and students, and inadequate technology infrastructure at the institutes. Besides, the prominent issues are resistance to leveraging traditional approaches in education and hindering beliefs and values of the local community that wrangle over AI enactments. As a recent study by Kelly, Sullivan and Strampel (2023) shows, students still have limited understanding about artificial intelligence and how to use it. Higher education institutions need to teach explicitly how to use AI technologies and tools, and embed experiential implications into their curricula (Kelly, Sullivan and Strampel, 2023). Respectively, researchers suggest that more investigation is needed to understand better universities' willingness to implement projects and research in artificial intelligence, the factors that influence a successful integration of AI in higher education settings, and the impact of AI tools and technologies in improving educational success and decision-making. Moreover, researchers emphasized the challenges related to the structural complexity of the Arabic language and called for more research to tackle Arabic sentiment analysis. Just as importantly, researchers highlighted the security and privacy issues in AI applications and called for more exploration on ensuring a safe AI adoption in education.

Limitations

While this review aims to provide a comprehensive, rigorous, and systematic synthesis of the existing literature, it includes several limitations. The main restriction is associated with using Scopus as the only database. It is an essential shortcoming because a single database cannot cover all scholarly work (Falagas et al., 2008). Future research can benefit from expanding its systematic methodology to a broader corpus by utilizing more databases. In addition, the search could be developed by not limiting to chosen keywords or to open access documents. Next, as the review focuses explicitly on the GCC region, the search was refined to studies only affiliated with one of the GCC countries. This may have caused not fully capturing the prevalence of international studies conducted out of the region, but still related to GCC. Furthermore, in this systematic review, only studies published in the English language were analysed. This may have caused not fully capturing the prevalence of regional studies, primarily written in the local language. Future research should strive to include Arabic publications to record more on potential insights and advancements made in the local context.

Another limitation is that the results and conclusions of this review are drawn based on the information provided in the included studies. Therefore, the validity and generalizability of the findings rest on the quality and heterogeneity of the set of studies included. Moreover, this review examines AI studies, particularly at the higher education level. While AI research in education is still in its infancy, further studies can be conducted to gather a more nuanced understanding of how to integrate AI techniques in education, including all the levels. Finally, this review focused

on elucidating AI research in the GCC region. To offer more excellent empirical evidence to support the verdicts, further reviews can be conducted by including data from the different areas and characteristics.

Implications

Without a doubt, forthcoming explorations in AI are “inexorably linked to the future of higher education” (Contact North, 2018, p. 5), and this systematic review suggests a range of implications for practice, policy, and research. As for practice, it is evident that administrators can improve institutional quality by making informed decisions using AI-supported systems that turn large datasets into practical recommendations. They can improve educational quality by providing the latest AI-driven educational technologies to practitioners, students, and staff and offer training to strengthen their AI literacy and technology competencies (Chu, Hwang, Tu & Yang, 2022). In addition, education practitioners can enhance student learning and engagement by utilizing AI-assisted tools that improve personalized experiences based on student data and needs. In particular, practitioners can implement AI for e-teaching and learning purposes, creating a supportive and positive educational environment where AI tools provide personalized learning for students to progress at their own pace, adjusting the difficulty level based on their needs and giving real-time feedback. Furthermore, with immersive learning technologies, using Virtual Reality and Augmented Reality, practitioners can simulate authentic scenarios, offering students practical and hands-on learning experiences in virtual settings.

Regarding policies, as AI practices still present ethical issues regarding personal data privacy and protection (Zawacki-Richter et al., 2019), institutions can develop policies to guard against these issues for responsible deployment of AI technologies in higher education. Moreover, higher education institutions must become involved in creating institutional collaborations and public–private collaborations with educational stakeholders to build guidelines, protocols, and policies for the collective good (Salas-Pilco & Yang, 2022).

For future research, with an increasing number of studies on AI in education, researchers “should keep a close eye on AI development and include both content analysis and in-depth quantitative analysis of relevant studies” (Salas-Pilco & Yang, 2022, p.16). More reviews are needed to synthesize how AI technologies can be applied in higher education to promote quality teaching and learning (Chu, Hwang, Tu & Yang, 2022), how to improve users’ confidence in using AI technology-assisted tools, and how to ensure safety, robustness, and prevention against cyberattacks. In addition, to address the plans related to the enhancement of technological infrastructure, future studies can examine how budgets are allocated towards hardware and software upgrades in the GCC universities and the measures in place to ensure these investments translate into effective AI implementation within the education sector. Furthermore, researchers must be involved in collaborative studies and projects to set research priorities, address current gaps and challenges, and expand AI implications to a broader level to benefit the society.

Conflict of Interest

The author(s) disclose that they have no actual or perceived conflicts of interest. The authors disclose that they have not received any funding for this manuscript beyond resourcing for academic time at their respective university.

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Appendix

Studies included in the systematic review:

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