Implications and Usefulness of Artificial Intelligence in Higher Education Institutions: A Case of Pakistan

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Abstract

Artificial intelligence (AI) in higher education is enhancing the potential of the teaching and learning process, fostering academic achievement, and bringing innovation. Studies on AI have yet to discuss widely the quantitative implications in educational institutions. Thus, the present study aims to analyze the implications and perceived usefulness of AI in higher education institutions of a developing country like Pakistan. The study uses data from 256 teaching staff in higher education from private and public sector higher education institutes. Our results show that more than 95% of faculties are familiar with AI technology, and two-thirds of the majority areusing it in the working environment. Most of the faculty respondents perceived that AI improves cognitive skills, enhances the personalized learning experience, saves time, reduces workload, improves the quality of education, and helps students in better learning outcomes. The present research suggests that AI technology is an impactful and credible source of information and is essential for achieving learning goals.

Keywords: Artificial intelligence, higher education, academic achievement, skills, learning

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Introduction

The term 'AI' was first introduced in 1955 by J McCarthy as he organized a research proposal for the Dartmouth Summer Research Conference (McCarthy et al., 2006). However, since then, there has yet to be a widely agreed-upon definition specifically regarding the application of Deep Learning. In a broader sense, AI can be understood as the integration of human intelligence into machines.Tredinnick (2017) describes AI as a collection of technologies and computational methodologies that emphasize the capability of computers to make adaptable and rational decisions when confronted with uncertain and ever-changing environmental circumstances. AI pertains to a domain within computer science that focuses on developing systems capable of performing tasks typically associated with human intelligence(Jakhar & Kaur, 2020). Berendt (2019) reveals that the primary outcome of AI is knowledge, which can be valuable and comprehensible to both humans and machines. This research intends to examine the use of AI tools for research and development, personalized learning experiences, and other educational purposes in Pakistan's educational environment.

Artificial intelligence has been playing a significant role in the education sector for twenty-five years (Roll & Wylie, 2016). It also defined the potential and development of information systems based on computer systems or other machines to complete tasks in a better way that usually requires human intelligence and logical deduction. Artificial intelligence is mostly helpful for faculty members, administrative staff, student counsellors, and teaching assistants. Artificial intelligence is creating fear for the fate of teachers and administrative departments. The AI covers a broad range of educational dimensions, such as intelligent tutors, expert systems, and chatbots. AI in education (AIED) refers to the application of AI technologies, such as intelligent tutoring systems, chatbots, robots, and the automated assessment of all modes of digitized artefacts that support and enhance education. AIED has enormous potential to improve learning, teaching, assessment, and educational administration by offering students more personalized and adaptive learning, fostering teachers' understanding of students' learning process, and providing anywhere, anytime machine-supported queries and immediate feedback (Chiu et al., 2023).

These tools and techniques can replace their jobs. On the other hand, AI is playing a crucial role in supporting higher-level education. AI provides effective and efficient information, acknowledgement, and fruitful information for higher-level students, teachers, and administration staff. In this modern era, everything is converting into an AI-based mechanism, such as information and acknowledgement through online procedures like chatbots and virtual assistants, and there are many tutorials to get

information for the research degree. AI provides these dimensions in many countries around the world, including Pakistan.

Gašević et al. (2023) have underscored the urgent research and policy challenges and opportunities that accompany the widespread integration of AI in education. Additionally, they underscore the importance of future research tackling ethical concerns, bias, and fairness in the implementation of AI in education. Challenges related to data sources and ownership, which serve as the primary catalyst and facilitator of contemporary AI development, are also highlighted. The studies emphasize the necessity of enhancing AI literacy and competencies among stakeholders who utilize and are affected by AI in education. Furthermore, they stress the importance of identifying effective learning and teaching practices when employing AI, along with the development of policies to enhance the responsiveness of education systems to the swift changes driven by AI.

It is crucial to comprehend the role of chatbots as tools that assist and facilitate the learning experience for both students and instructors. Chatbots prove to be advantageous devices, contributing to the facilitation, simplification, and support of the academic process. Nevertheless, academia needs to reassess and revise training, policies, and assessment methods for both students and teachers in writing courses. This is particularly important in addressing concerns related to academic integrity and originality, including issues such asplagiarism, assignments generated by AI, online or home-based exams, and challenges associated with auto-correction (Imran & Almusharraf, 2023).

Artificial intelligence has the potential to advance the technological capabilities of analytic learning. The aim of this research is also to provide educators with an overview of AI applications in higher education.The awareness of Artificial intelligence in Pakistan is negligible. According to the given scenario, the dynamic development in recent years, the growing interest of educators in this field, and a review of the literature on AI in higher education are warranted. AI influences online higher education, and it remains unclear whether to explore and fill these gaps and provide awareness to higher-level students; the current research suggests that AI technology is an impactful and credible source of information and is essential for achieving learning goals.

The present study aims to determine the teachers' perception of the application of artificial intelligence in the teaching-learning process and to evaluate the usage of AI and perceived learning experiences from AI in higher education institutions (HEI).The present research is based on the following research questions:

- Does Artificial intelligence (AI) help in academic achievement?
- Does AI help teachers to create and deliver more effective lessons?
- Does AI help to reduce the workload of teachers?
- Do you think that AI enhances cognitive skills?
- Can AI be effective in improving the quality of education?
- Does the use of AI in higher education lead to the creation of more engaging learning experiences?
- Does the use of AI in higher education lead to better student outcomes?
- Do you think that AI improves the efficiency of work?

The rest of the study is designed as follows: Section 2 includes a brief literature review on AI in education, section 3 discusses the data and method, section 4 is reserved for analysis, and research is concluded in Section 5.

Literature Review

Educational tools have enabled personalized learning experiences tailored to individual students' learning styles, preferences, and needs. Intelligent tutoring systems can provide real-time feedback, adapt content difficulty, and suggest resources, fostering active engagement and deeper understanding among students (Mathews et al., 2012; Woolf, 2010). Fadel et al. (2019) have illustrated that artificial intelligence is the most powerful machine and greatly affects the learning and teaching process. In tradition, the way of learning and teaching was "what" to teach and "how" to teach. Nowadays, the innovative process of AI takes the place of teaching and learning and transforms the level of thinking. AI provides software for the teachers to update assessments and feedback and facilitate the tutoring system. On the other hand, Al is enhancing the cognitive skills of the students and providing software to get acknowledgement and information regarding subjects.

Technological advancements such as Big Data, Machine Learning, and Artificial Intelligence (AI) have empowered contemporary technology to adapt to the unique characteristics of individuals. Smart machines and computers are designed to comprehend the specific needs of each person, paving the way for personalization in the education sector. This trend is evident in the rapid growth of Educational Technology (Bhutoria, 2022). In this modern era, Artificial intelligence is a significant innovation and prompt development of the internet. AI contains the future trends in education development. The best example isan internet application. Nowadays, the world is considered a global village due to the high enhancement of core values of AI. The internet offers a wide range of resources, making life easier for teachers and students and enabling them to explore various concepts such as religion, culture, norms, values, and

education. The development of education from academic education to knowledge education is an inevitable trend (Han, 2018).AI-driven learning analytics leverage data to monitor students' progress, predict their performance, and identify at-risk students. By analyzing patterns, educators can intervene early to provide necessary support, leading to improved retention rates and academic success (Daud et al., 2017). By examining the influence of artificial intelligence on education, Paek and Kim (2021) concluded that AI can enhance both teaching methods and student outcomes. They concluded that AI is a key element of revolutionary change in education through network analysis, global trends, and subject modelling. In addition to this, research by Shrivastava (2023) and Sanusi et al. (2022) underscores the crucial role of teamwork and the importance of human-tool collaboration in fostering artificial intelligence literacy within course content. The results highlight the necessity for students to engage in teamwork to effectively keep pace with the advancements in emerging technologies. Furthermore, the multigroup analysis indicates that no significant differences were observed across gender and school types. In conclusion, the study suggests implications based on these findings and proposes directions for future research.

Knowledge about practices on artificial intelligence tools would enable the students to utilize available tools to improve their standards. Students have access to a variety of tools and techniques, such as MOOCs (massive open online courses), which provide a platform for learning various subjects, fostering creativity without the need for in-person instruction and saving time (Bidarra et al., 2020). In addition to this, AI-powered feedback can offer more detailed insights into students' strengths and areas for improvement (Botelho et al., 2023; Koedinger et al., 2010). These technologies enable students to explore complex concepts, such as medical procedures or engineering designs, in a safe and immersive environment (Bacca Acosta et al., 2014; Wu et al., 2013). However, Malik et al. (2022) studied the perspectives on the fourth industrial revolution, characterized by digitalization; researchers said that AI helps to update the curriculum and course. Artificial intelligence has been playing a significant role in the clinical transformation and practices of radiology. AI covers the main part of the medical department of radiology, and the innovation of AI fulfilled the requirement of the radiological department of the students and provided the easiest way to practice (Gong et al., 2019).

Chatbots powered by natural language processing provide instant assistance to students and staff, enhancing communication and reducing workload (Akçayır & Akçayır, 2017; Popenici & Kerr, 2017). A SWOT analysis of the technology and the implementation of Artificial intelligence (AI) in Pakistani university libraries have been conducted. Artificial intelligence can be very useful in the education sector, especially in universities (Malik et al., 2022). The purpose of their study is to provide systemic base

libraries and identify the effectiveness and efficiency of technology for the higher level of students. Al can enhance the power of acknowledgement and information of students as well as teachers' strategies. Chatbots are important in providing genuine information within a short time and resolving students' queries immediately. Chatbots can reduce the workload of administrative staff. AI for staff and students through this platform can reduce the workload and avoid the use of highly risky material (Barrett et al., 2019).

According to Tao et al. (2019), artificial intelligence has been working all over the area of human life, and researchers have highlighted the challenges and disadvantages of artificial intelligence and bioethics. AI is working in place of teacher that is alarming for the teachers.

The integration of AI technologies requires institutional commitment, training, and resources. Resistance to change and lack of technical expertise can hinder successful implementation (Eynon, 2013; Jovanovic et al., 2018). Roll and Wylie (2016)argue that over the past 25 years, teaching and learning have been challenging for both teachers and students. However, the current situation has significantly changed due to revolutionary processes, collaboration, and technology diversification. AI, being a new field, has little literature available on the process of online learning for higher-level scholars and teachers. Nowadays, AI is providing great opportunities for students with easier ways to get acknowledgement, performance, and automatic assessment (Ouyang et al., 2022). Yang et al. (2021) determined the impact of artificial intelligence in education, greatly explored the impact of AI on human beings, and predicted that AI provides a flexible way of learning rather than traditional learning.

The literature review highlights the growing significance of AI in higher education, with applications ranging from personalized learning to administrative efficiency. While AI offers numerous benefits, ethical concerns, implementation challenges, and the need for pedagogical adaptation require careful attention. Continued research and collaboration among educators, researchers, and policymakers will shape the responsible integration of AI in higher education.

Data and Procedure

A quantitative methodology is used to assess the implications and perceived usefulness of AI in HE institutions in Pakistan(Zupic & Čater, 2015). For this purpose, a questionnaire was designed and requested to be filled in by faculty members of the HE institutions through emails, personal contacts, face-to-face questionnaire filling requests and through sharing Google links for easy and quick responses. We approached various public and private sector faculty members through emails and personal contacts to record their responses to record their responses. Despite a very slow and low response rate, we

gathered the data of 256 respondents by using a non-probability sampling approach. As this study was based on the data of faculty members of higher education institutions, therefore purposive sampling was the suitable approach to collect the data. The selection of the participants was based on willingness and availability to fill in the questionnaire. There may be a limitation of generalizability in the finding, but in order to overcome that, it has been considered to get the responses from the HEI faculty member, keeping in mind the equality of the responses from various institutes.

The questionnaire was divided into three parts: the first part includes the demographic and educational qualification, the second part includes the questions about personalized learning experience on five points Likert-scale ("1 = strongly agree" to "5= strongly disagree"), and third part includes the questions on the usage of AI, skills and efficiency on three points scaling ("1 = Yes", "2 = No" and "3 maybe"). To assess the implications of AI, results are presented for each research question asked by the respondents' faculties of higher education institutions. We plot pie charts and bar charts of each research question, which demonstrates the percentage against every response.

Results

Table 1 shows the summary statistics of sample faculty members from which data was collected. Out of the total sample, 87 (34%) of the respondents' faculty were females, and the remaining 169 (66%) were male faculty members. Among all respondents, our largest sample (n= 201, 8.5%) was from the faculty members who have completed eighteen years of education, and the remaining55 respondents (21.5%) have completed a PhD degree and are all full-time permanent faculty members. Moreover, 113 (44.14%) faculty respondents belong to public sector universities and higher education institutions, and the remaining 143 (55.86%) belong to private sector universities. The given information shows much familiarity with artificial intelligence as 66.80% are very familiar, 30.47% are somewhat familiar with artificial intelligence, and only 2.73% are not familiar. Based on the information, most of the respondents are deeply familiar with AI.

Table 1
Summary Statistics of Respondents Faculty

Variables	Frequency	Percent
Gender		
Female	87	33.98
Male	169	66.02
Education		
Masters	201	78.52
PhD	55	21.48
Institution		
Public	113	44.14
Private	143	55.86
Familiar with AI		
Very Familiar	171	66.80
Somewhat Familiar	78	30.47
Not at all Familiar	7	2.73

RQ 2: Artificial intelligence helps in academic achievement.

The most fundamental element of AI is helping with academic achievement. The given results in Figure 1 show that 51.95% of faculty members strongly agree with the question that AI helps students in academic achievement, 39.45% Agree, 5.47% are neutral, 2.34% dis-agree and the rest of the respondents (0.78%) strongly disagree with the statement. To concise the results, AI plays a significant role in academic achievements, and it helps us to identify trends and patterns in a student's performance.

RQ3: Artificial Intelligence helps teachers to create and deliver more effective lessons.

How crucial is AI in the present day for instructors to design and deliver more effective lessons? Out of our sample respondents, 41.02% agree and 30.47%strongly agree with the research statement. Figure 1 demonstrates the significance of the education sector for both teachers and students, who believe that AI facilitates effective and efficient learning. The world is transitioning to digitalization, and AI is becoming a crucial part of our lives. AI-embedded tools can help educators and teachers to prepare lectures and lesson plans more efficiently and effectively. To deliver lectures to students from multiple regions, teachers can also make effective use of AI to translate the lesson into multiple languages.

RQ4: Artificial Intelligence helps to reduce the workload of teachers.

One of AI's most significant purposes is to lighten the load on teachers. Figure 1 demonstrates that 33.98% of respondents strongly agree with the statement that AI helps to reduce teachers' workload, while just 10.55% show a neutral response and only 11-12% oppose the research statement. This suggests that AI plays a significant role in the workload reduction brought on by technological advancement and robotic systems.
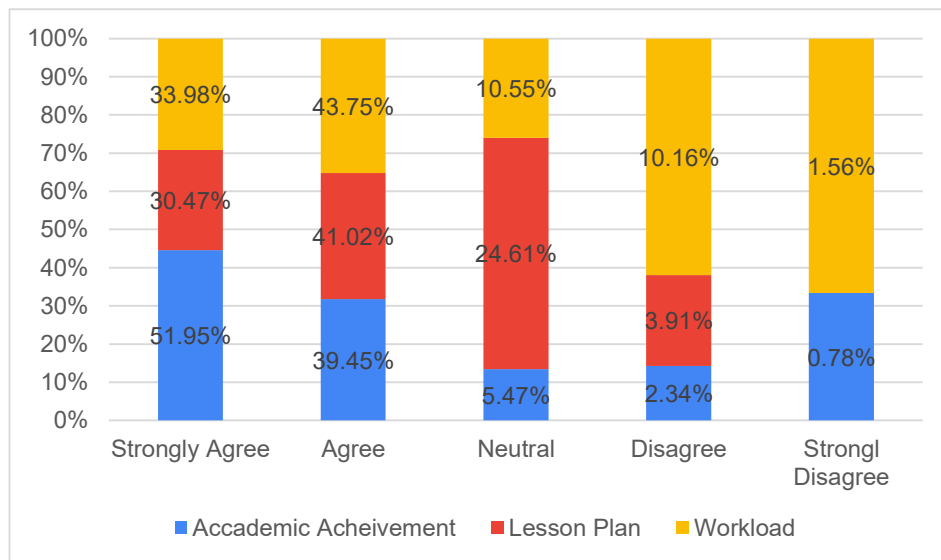

Figure 1. *AI and Academics*

RQ5: Do you think that AI enhances cognitive skills?

According to Figure 2, 62.89% responded 'Yes' thatAI enhances cognitive skills, and only 14% responded 'No'. Many respondents believe that AI improves pupils' cognitive talents and potential by utilizing various software programs, sophisticated robotic and autonomic systems, and quickly expanding digital technology. Although human beings cannot be replaced fully with the development of technology, AI is an important tool to enhance the existing advancement in HE institutions by improving cognitive skills and using them in teaching and learning.

RQ6: Do you think that AI can be effective in improving the quality of education?

The maximum number of participants agreed and emphasized that AI can be used to improve the quality of education. A total of 61.72% responded 'Yes', while 22.66% responded 'Maybe', and the rest of the participants (15.63%) responded that AI could not improve the quality of education. Through these tools and techniques, effective and efficient learning can be performed, and educational outcomes and experiences can be enhanced.

RQ7: Is Artificial Intelligence commonly used in higher education institutions?

AI is highly contributing to education institutions, and many countries are implementing it in HEIs. AI is commonly used in higher education institutions to boost credibility, authentic information, and personalized learning for both teachers and students. Figure 2 shows the perception of the usage of AI in HEIs of Pakistan. 51.56% of total sample respondents perceived that it is being used in HEIs while 22.27% perceived that it is still not commonly used.

RQ8: Does the use of Artificial Intelligence in higher education lead to the creation of more engaging learning experiences?

AI can help the personalized learning experience of teachers and students. Students may engage by providing relevant material, virtual tutors and resources related to course contents. Our data also depicts that 64.5% of teachers perceived that AI could lead to engaging students in more learning experiences, while only 11% responded with 'No'. However, it should be noted that students' learning through AI depends upon several factors, like how they are given training and strategies to use AI for their improvement in skills. However, this is possible only if ethics are involved in the usage of AI.

RQ9: Does the use of Artificial Intelligence in higher education lead to better student outcomes?

The use of AI in HEIs can contribute to better student learning outcomes, especially when used with ethics and no student has a disparity in using the advanced learning tools. Our data shows that 62.11% of teachers perceived that AI can lead to better student outcomes in education, while only 13.67%perceived that AI cannot lead to better learning outcomes for students in HEIs. It means that AI hasa highly positive impact on education, leading to better student outcomes and pure information. Furthermore, AI provides different software for the usage of students as well as for teachers, which will lead to better outcomes.

RQ10: Is it possible for Artificial Intelligence to adapt to changes in the educational curriculum?

AI can be programmed to design and make changes in course curriculum. As curricula continue to evolve, AI developers and educational experts need to collaborate closely. This collaboration ensures that AI tools are not only effective but also adaptable to the changing needs of learners. By working together, they can create AI tools that enhance the learning experience and help students thrive in a rapidly changing educational landscape. Results of our study reveal that 56% of teachers perceived that AI could be used to adapt changes in educational curriculum, and 34.7% responded that it might be used for changes in the curriculum, while only 9% said 'No' as they perceived that AI could not be used to adapt changes in curriculum.
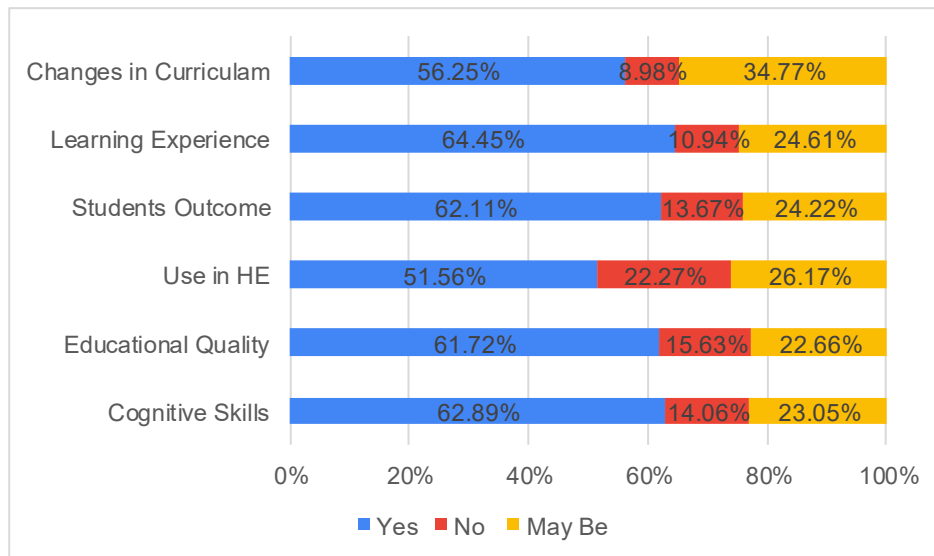
Figure 2. *Sills, Experiences and Quality through AI.*

RQ11: Have you ever used any AI-powered tools or software in your academic pursuits?

Keeping in view the ethical considerations, AI can be used by instructors and learners for research enhancement, personalized learning experiences, and improving cognitive skills and effectiveness in the education system. To conclude this, we have asked respondents of HE teachers whether they are using AI or not. Almost 81% of teachers responded with 'Yes' while the remaining 19% responded that they are not using AI for their personal academic use (Figure 3).
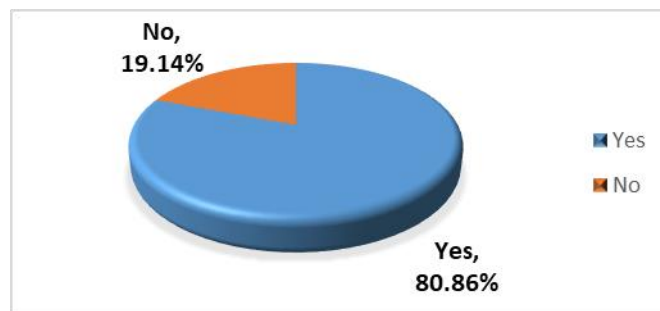

Figure 3. *Use of AI-powered tool.*

RQ12: Do you think that AI improves work efficiency?

Al helps effectively and efficiently with academic achievement, assessments and immediate feedback, information, and guidance on their work, and it is much better than the traditional way of learning. Results presented in Figure 4 also show that 67% of total respondents perceived that AI improves efficiency in work, and only 8.24% responded with 'No'. According to the given results, most of the respondents think that AI improves work effectively and efficiently.
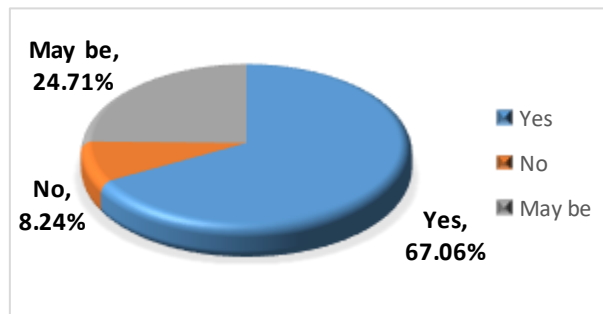

Figure 4. *Work Efficiency*

Discussion

The implications of artificial intelligence (AI) have brought new challenges and opportunities to improve the learning process and development in higher education. Although there is limited literature on the implications of AI in higher education (HE), it is essential to understand its functions and implications. The outcomes of this study confirmed the revolutionary potential of ChatGPT in education while also providing new insights. It also indicated serious issues like ethics in education that needed to be addressed. More research is needed on ChatGPT's application in higher education due to its novelty and projected nature.

Previous studies have reported the positive impacts of AI on learning, cognitive skills, workload, and efficiency in HEIs for both instructors and learners. With the innovation of AI technology, traditional learning techniques in HEIs are transforming from teachers to AI-enabled and other modes of online tools (Ouyang et al., 2022). Based on the previous literature, the present study proposes the practical implications of AI in Pakistan's HEIs. Previous studies have discussed the theoretical implications of AI in education. However, this study is different in that it analyzes the practical implications of AI and its assessment in the HEIs of Pakistan by using data from 256 teachers from public and private sector colleges and universities offering minimum undergraduate programs.

The present study uses quantitative tools to assess the awareness and implications of AI in HEI. Results of this study show that more than two-thirds of teachers are familiar with AI, and they are using HEIs. They perceived that AI could be helpful in academic achievements, finalizing lesson plans, improving cognitive skills, enhance the quality of education and personalized learning experience. AI is also helpful for teachers in preparing course curricula according to advancements in technologies and increasing efficiency and effectiveness in work. Many respondents also perceived that AI reduces the workload of teachers. However, human beings can never be replaced with artificial advancement to retain reliability and sustainability, especially in HEIs. Many students can misuse AI technology in the learning process without following any ethics, so educators need to train them regarding the advancement in AI with ethics.

Previous research indicates that by offering comprehensive insights into students' areas of strength and growth, AI can enhance teaching strategies and student outcomes (Paek and Kim, 2021and Botelho et al., 2023).To ensure effective learning, the AI anticipates student learning abilities, analyzes learning scenarios, and continuously modifies and improves the subsequent stage lesson using continuously updated data and deep learning algorithms (Meng & Sumettikoon, 2022).AI helps teachers create content, use automatic grading systems, prepare lectures, and use virtual assistants to respond to students' queries, which significantly reduces their workload. Natural language processing chatbots enhance communication, reduce workload, and prevent high-risk material use, providing instant assistance to students and staff (Popenici & Kerr, 2017 and Barrett et al., 2019).The goal of AI education is to teach about the fundamentals of AI, its history of development, projected trends, applications in everyday learning, comprehension of the AI development process, and an unbiased assessment of its effects on life which enhances the cognitive skills of students (Huang & Qiao, 2024).

Perminova et al. (2022) argue that AI learning tools are helpful in fastening the learning process, making it more accessible and feasible to enhance quality education for those who have less cognitive skills, and offering more versatility in educational dimensions. Pokrivcakova (2019) emphasizes that by using machine learning algorithms to provide content that is specific to each student's requirements and skills, the combination of AI and chatbots improves the educational experience for students. As a result, learning resources are tailored to each student's particular requirements and skills. By improving curriculum development, content creation, and instructions through the use of technologies such as virtual reality, web-based platforms, robotics, video conferencing, audiovisual files, and 3-D technology, artificial intelligence (AI) has greatly improved education. This has led to more effective teaching and a richer educational experience for students (Chen et al., 2020).Practices for adapting curricula differ by subject and get better with work experience. Instructors may improve their content by using AI,

especially ChatGPT, to remove irrelevant material, add pertinent stuff, and edit or replace content to better suit the requirements of their students, but it needs professional development programs designed specifically for teachers (Karataş et al., 2024).

The development of AI-based technologies like ChatGPT raises the chance that human-based educational experiences will be replaced by low-cost chatbot encounters. Adopting AI-based technologies, such as ChatGPT, can assist HEIs and teachers by improving student services and teaching or research activities, but this potential may lead to biassed teaching and learning experiences with less human connections and assistance(Dempere et al., 2023).

AI has greatly increased the efficacy and efficiency of teachers, which has raised the quality of education. Enabling the personalization of learning materials to suit specific requirements has also improved the educational experiences of teachers and students. The use of AI has demonstrated its impact on education sector administration, instruction, and learning domains. However, there are many complexities and challenges to extending the AI tools and applications in HEIs. For example, all students and teachers need equitable access to AI tools, and in some rural and low-income areas, they also need access to the internet and technology. Many teachers do not have the technical skills and advancements in training to use AI databases and tools in their teaching philosophy.

Moreover, they are also reluctant to use AI because of a fear that AI can replace their roles in future, which also leads to poor implementation of AI tools. AI can also reduce the face-to-face interaction between teachers and students during the learning process, which can threaten the originality of human-based work and higher the risk of loss of mentorship and societal development. Therefore, all these challenges and limitations should be addressed carefully to ensure equitable access to technology within the ethical dilemma.

Conclusion

In conclusion, AI can help institutions streamline processes, increase efficiency through the proper allocation of resources, and reduce costs. Furthermore, AI-embedded tools can accelerate the academic process and innovation in HEIs. However, with the benefits of AI, there are multiple challenges regarding ethical concerns and biasedness in shaping the contents of educational curricula. Therefore, it is the need of the hour to collaborate educators with industry and policymakers to ensure the educational quality and equity embedded with AI. Based on the results of this study,the theoretical and practical implications of AI in HEIs ensure ethical usage in research and development, teaching purposes and academic tasks. Faculty members should be trained to integrate AI effectively into their teaching and learning process and ensure accountability policies are embedded with AI policies and guidelines.

Overall, the impact of AI on higher education is broad and complicated, embracing both benefits and obstacles. To completely realize the possible benefits of AI while addressing its allied risks, higher education stakeholders, including educators, researchers, and policymakers, must engage in thoughtful dialogue, collaboration, and continuous evaluation of AI-driven initiatives. This research is unique in various aspects as compared to past studies. The present research not only discusses the systematic review but also analyzes the implications of AI technology in HEIs. Moreover, the present study also analyzes the perceived usefulness and effectiveness of AI on instructor work. The present research is limited to faculty of higher education institutions, and the sample size is small due to the restricted population. However, more empirical work is needed to design the role of AI in an education system and how it is being used among students and faculty members in research and what are the outcomes of AI in HEIs?

Declaration of Conflict of Interest

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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