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A Secure Technology Environment and AI's Effect on Science Teaching: Prospective Science Teachers

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Abstract

As AI technology continues to advance, it has led to the development of various systems that help with student learning. This study sought to investigate the use of AI applications in science teaching, particularly in terms of student engagement, challenges encountered, and effectiveness. The study utilized a quantitative approach, with 120 prospective science teachers completing a self-report questionnaire. Results showed that students were highly engaged with the AI tools used in the science classroom. However, some challenges were faced by teachers, such as a lack of access to appropriate resources and the complexities of AI use. Despite this, the use of AI technology has been proven effective in science teaching. Based on the findings, the researcher suggested some recommendations.

Keywords: *AI, science teaching, prospective teachers, engagement, challenges, and effectiveness.*

INTRODUCTION

Lately, the integration of artificial intelligence (AI) in educational settings has become riskier. However, AI has the potential to enhance teaching methods and provide a secure online environment for teachers and students, especially in science education (Adiguzel et al., 2023). The aim of this study is to examine the impact of artificial intelligence applications on science education, as perceived by science teachers. This research aims to gain insight into the students' engagement, benefits, and challenges associated with incorporating AI in science classrooms and identify effective implementation strategies from the teachers' perspectives. Recent studies indicate that incorporating (no need to repeat the full term each the, from now on use AI only) artificial intelligence (AI) applications in science education is becoming increasingly crucial. Tritscher et al.(2023) study reveals that AI technologies can revolutionize compulsory education curricula by utilizing innovative methods to engage students and enrich their learning experiences. Additionally, Hughes-Roberts et al.'s (2019) research on science teachers indicates a widespread interest in exploring the implementation of AI applications in the classroom.

It's important to thoroughly investigate how the use of artificial intelligence affects science education and how educational stakeholders perceive meaning. By addressing the

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challenges faced by science educators, incorporating artificial intelligence in educational settings has become a prominent topic of discussion. Chen et al. (2022) have delved into the benefits of AI-assisted education systems, which can provide customized training, cater to individual literacy needs, and offer immediate feedback to learners. Moreover, a 2023 study conducted by Lee and Kim examined the effectiveness of AI ChatGPT (what is ChatGPT please explain and give a reference specific to it) in science classrooms. The study revealed that these intelligent assistants could assist students in comprehending abstract concepts, fostering collaborative learning environments, and promoting critical thinking skills.

The recent discoveries in AI have opened up vast opportunities for science educators, eliminating the constraints imposed by purchasing regulations. However, it is crucial to prioritize a secure and dependable technological environment while implementing AI in science education. A recent review by Ramírez and et al (2022) highlighted the significance of cybersecurity prevention methods in educational institutions, especially when utilizing AI technologies. To minimize potential risks linked to the implementation of AI, the research emphasizes the importance of robust data protection measures, safeguards, and ethical institutions. To establish effective curricula and guidelines that promote a safe technological environment in science classrooms (Scott, 2022), it is crucial to grasp the viewpoints and apprehensions of science educators concerning the security implications of AI applications.

Studies have shown that the level of engagement of students has a direct effect on their learning methods, as well as their thinking processes. The efficient utilization of AI technologies in practice can significantly influence students' motivation to engage and learn from them. (Chiu, 2022). The way teachers use AI through designing learning activities, offering resources, and communicating with students to meet their needs in AI-enhanced learning environments requires further examination, as it is presently an area that has not received much research attention (Cooper, 2023; Kolchenko, 2018; Pitzer & Skinner, 2017). Therefore, this study intends to explore how AI technology contributes to student learning and engagement, the benefits and challenges, and how using AI securely affects its effectiveness in science classrooms shedding light on this fascinating yet nascent field.

RESEARCH PROBLEM

While literature recognizes the potential of AI in learning, its scientific impact on science education is yet to be clearly demonstrated (Williamson & Eynon, 2020). For instance, some experts suggest ChatGTP as an AI technology that can engage students more effectively (Kolchenko, 2018; Shawar & Atwell, 2007). Ryan and Deci (2020) have urged scholars to delve deeper into how modern technology can inspire students to learn and motivate them to use technology for learning. However, there is currently no research based on the Social Learning Theory and Technology Acceptance Model that explores the use of AI in school settings.

According to Luckin & Cukurova (2019) AI systems can enhance higher education students' learning quality,. This positive outcome has led some to believe that AI has the potential to revolutionize traditional teaching and learning methods by automating the above mentioned (Williamson & Eynon, 2020). However, skepticism remains regarding the effectiveness of AI-based educational technologies on a larger scale or at other education levels, such as K-12 (what is K-12?) (Kolchenko, 2018). According to Yin et al. (2021), students who utilized chatbot-based learning environments had greater intrinsic motivation compared to those who did not. These findings suggest that students felt comfortable and engaged in conversation when learning with chatbots. When chatbots are perceived as a fun and non-threatening tool, they can encourage students to keep expressing their ideas during interactions. As a result, chatbots have the potential to

motivate students by sparking their curiosity and strengthening their perseverance in learning and teaching, as noted by Fryer et al. (2019).

Although few previous studies have highlighted the potential benefits of AI in science education, it's crucial to examine the perspectives of science teachers actively implementing these technologies (why?). By delving into their insights, this study aims to offer a valuable understanding of the practical implications and considerations involved in integrating AI applications into science instruction. Additionally, prioritizing a secure technology environment acknowledges the significance of safeguarding data, cybersecurity, and ethical issues to protect students' well-being and promote the responsible use of AI technologies. Ultimately, the primary goal of this research is to explore how AI applications can enhance science teaching while considering prospective science teachers' distinct viewpoints and the context of a protected technological environment.

Therefore, the significance of the study lies in the potential benefits it can bring to science education and the understanding of how AI can enhance teaching practices in a secure technology environment. Advancing Science Education by creating better teaching methods for improved student learning. The use of AI in science education can potentially revolutionize how students learn this statement is repeated many time from the beginning, please re-edit. With tailored and adaptable learning experiences, real-time feedback, and advanced tutoring systems, AI can create new opportunities for efficient and engaging instruction. Thus, to effectively incorporate AI into science education, it's important to understand its applications and how to leverage its capabilities. Exploring how AI can enhance instructional practices, specifically in scientific teaching will provide science teachers with evidence-based strategies that incorporate AI tools and technologies to improve student engagement, learning outcomes, and overall effectiveness in teaching. Through personalized AI-driven interventions that encourage active learning and deepen conceptual understanding of each student's unique needs. Exploring the impact of AI in a secure technological space, highlights the significance of safeguarding data privacy, maintaining a secure online learning environment, and addressing any ethical concerns that may arise from using AI in education. Finally, the study aimed to produce valuable knowledge and useful insights that can help educational policymakers, curriculum designers, and prospective science teachers leverage AI's potential to transform science education by examining the impact of AI applications on enhancing science teaching within a secure technological environment.

Research questions are formulated to address the research problem and guide the research process toward a targeted investigation of the issue at hand. The research questions are as follows:

1- How does integrating AI applications into science education improve student engagement?

2- What are the perceived benefits and challenges of using AI in science education, as reported by science educators?

3- How does a secure technology environment affect the effectiveness of AI applications in science education?

THEORETICAL FRAMEWORK

Artificial Intelligence

The use of Artificial Intelligence (AI) is becoming increasingly important in the digital transformation of education (Cooper, 2023). AI technology is designed to mimic human-like behaviors such as decision-making, reasoning, and intentionality (Shubhendu & Vijay, 2013). With AI-equipped computers, tasks that were once thought to require human

intelligence, such as image recognition, speech understanding, and problem-solving, can now be performed. According to Cooper (2023), AI has significantly impacted various industries, including education. In the field of science education, AI applications offer endless possibilities for improving teaching methods and motivating students to participate in important knowledge assessments. The use of AI in education is a topic that still requires further discussion, as it is a relatively new subject. Celik (2023) highlights the untapped potential of AI in teaching and learning contexts, which has often been overlooked (Lameras & Arnab, 2021). However, while there is a need for more AI implementation, some educators are hesitant to use software that collects significant amounts of student data. Additionally, there is skepticism toward companies that present technology as a solution to all educational challenges (Stockman, Nottingham, 2022).

Advanced learning technologies, powered by AI, present several benefits for learners. For instance, they can provide customized interactive learning experiences through smart learning systems, virtual reality simulations, and adaptive learning platforms that cater to individual needs (Cooper, 2023). Additionally, these tools can analyze vast amounts of data, create detailed designs, and generate responses to assist science educators in planning, evaluating, and intervening in educational settings (Stockman, Nottingham, 2022). AI applications have the potential to improve science education by facilitating the integration of real-world scenarios and scientific inquiries, promoting collaborative problem-solving, strengthening scientific knowledge, and fostering critical thinking skills in students. An exploration of the impact of AI tools on science education seeks to uncover the benefits, challenges, and underlying concerns associated with the implementation of AI technology in educational problem-solving settings (Russell & Norvig, 2015).

Technological Pedagogical Content Knowledge (TPACK) Framework

The TPACK framework (Mishra & Koehler, 2006) provides a theoretical perspective for integrating technology, pedagogy, and pathology in educational settings. TPACK focuses on how teachers can effectively use technology to enhance education's value (Angeli & Valanides, 2009). It aims to understand the importance and role of knowledge in enabling teachers to integrate technology into their teaching practices. TPACK addresses teacher knowledge's complex and multifaceted nature (Valtonen et al., 2020). The TPACK framework is commonly utilized to examine prospective teachers' knowledge regarding ICT integration in teaching (Valtonen et al., 2020). As per Sadaf et al. (2012), there is a favorable outlook toward the employment of ICT in education among prospective teachers. However, challenges are faced in terms of their preparedness to integrate ICT into education, as noted by Valtonen (2011) and Lei (2009). Therefore, the study aimed to gain a deeper understanding of the TPACK of prospective teachers. In the context of our study, the TPACK framework was utilized to explore how science teachers' pedagogical approach and the interplay between subject matter and science perceive and incorporate the use of artificial intelligence in science education.

Social Learning Theory

The theory of social learning (Bandura, Walters ,1977) highlights the importance of social connections and conformity in educational settings. This study aims to apply this theory to understand how prospective science teachers' interactions with AI applications in a safe technological environment impact their beliefs, understanding, and actions related to teaching science.

Technology Acceptance Model (TAM)

The Technology Acceptance Model, introduced by Davis in 1989, offers a structure for evaluating how people embrace and adopt new technologies. Previous studies have utilized the theoretical Technology Acceptance Model (TAM) to examine users' continuous intention to use technology (Hsu & Lin, 2022; Oyman et al., 2022).

Understanding how users perceive technology is crucial in their adoption, acceptance, and usage of new technologies. Tackling these perceptions, resistance can be avoided, and increased chances of achieving success are more at hand (El-Abidi et al., 2019). The model focuses on the impact of two key factors: perceived usefulness and perceived ease of use. In the current study, the TAM framework was employed to explore the perception of potential science teachers regarding the value of AI applications in science education, as well as their level of comfort in using them, and how these factors affect their willingness to adopt and integrate AI tools into their teaching practices.

Community of Inquiry (CoI) Framework

The framework known as the Community of Inquiry (Garrison et al., 1999) highlights the significance of social, cognitive, and teacher presence in online learning environments. This study aims to use the CoI framework to examine the impact of safe technology, edge play, and AI applications on the development of the science education research community. Specifically, it explores how these elements promote collaborative knowledge, organize scientific concepts, moderate reception, and encourage experimentation.

Ethical Considerations in AI Education

The ethical consequences of implementing artificial intelligence in science education are explored in this theoretical aspect. It encompasses assessing aspects like privacy, bias, data protection, and appropriate usage of AI tools in educational settings. Ethical frameworks like those offered by Floridi (2018) and Jobin, Ienca, and Vayena (2019) can be implemented to establish ethical considerations and foster a secure technological environment. Teachers utilize various methods, strategies, and approaches to teach scientific concepts and procedures, collectively known as science education. This includes hands-on experiences, inquiry-based learning, and the integration of real-world applications to engage students and enhance their understanding of scientific principles. A study investigated the impact of AI applications on science education and found that these technologies can improve educational practices, increase student engagement and interest in science, and promote critical thinking and problem-solving skills (Cooper, 2023).

A Secure Technology Environment

The study entitled "Exploring the Impact of Artificial Intelligence Applications in Enhancing Science Teaching: Insights from Prospective Science Teachers in a Secure Technology Environment" has a strong foundation on safe and reliable technology. The study emphasizes the importance of established systems, guidelines, and procedures to ensure the safe and effective use of technology in enhancing science education and improving the environment. Creating a secure technological context involves various factors such as data isolation coverage, cyber security protocols, ethical considerations, and ground rules for the appropriate use of technological tools and applications. These have been highlighted in the National Plan for Educational Technology (2017) and by Russell & Norvig (2015). The aim is to ensure the confidentiality of student information, promote data integration, and address any potential pitfalls and weaknesses related to the integration of AI in science education. This study delves into the effects of AI applications in a secure technological setting to assess the potential advantages, challenges, and outcomes of incorporating these technologies in science education. Its aim is to address any apprehensions educational institutions may have regarding data safety, confidentiality, and ethical implications when employing AI technologies in the classroom. This study delves into the impact of a secure technological environment on the successful implementation and functioning of AI applications in scientific education. The ultimate goal is to shed light on the various factors that contribute to responsible integration of cutting-edge technologies, leading to better learning outcomes for students. The theoretical framework recognizes the crucial roles played by teachers, principals, and politicians in creating a safe technological space. It emphasizes the importance of

equipping educators with sufficient professional development and training to effectively and responsibly integrate AI tools into scientific education. Additionally, it highlights the need for collaboration among educational institutions, technology providers, and relevant stakeholders to establish best practices and standards that foster a secure and confidential technological ecosystem.

LITERATURE REVİEW

According to a study conducted by Seo et al. in 2021, the use of AI systems in learning environments is expected to have a considerable impact on learner-teacher interactions. By automating tedious tasks for teachers, personalizing learning for students, and facilitating adaptive assessments, AI technologies can effectively improve teaching and learning. However, it is important to consider how these advancements may impact the traditional customs, expectations, and culture of student-teacher interactions.

Research conducted by Reynolds et al. (2020), Roschelle et al. (2020), and Zawacki-Richter et al. (2019) has identified AI technologies as having great potential in the field of education. These technologies have the ability to broaden access to educational opportunities and enhance teaching practices and methods to achieve desired learning outcomes. With the integration of AI in education, the learning process can be improved, and students can benefit from personalized learning experiences.

When examining the effects of artificial intelligence (AI), it becomes clear that its impact is far-reaching, affecting governments, communities, organizations, and individuals. Some studies and educators in the field of science have analyzed AI's overall impact, highlighting both positive and negative consequences in different areas.

A comprehensive study has been conducted to examine the impact of AI on governments, communities, companies, and individuals. The study analyzes both AI’s positive and negative aspects and addresses important issues related to research, innovation, and deployment (Soni et al., 2020). Additionally, an essay published by the Brookings Institution highlights the revolutionary potential of AI and its influence on various sectors. The essay emphasizes the need for a data policy that promotes innovation and protects users, highlights the economic benefits of AI, and stresses the importance of reforming educational institutions to prepare students for a future dominated by AI (Davenport, Loucks, & Schotsky, 2017).

The World Health Organization (WHO) has evaluated the capacity of AI in healthcare and medicine. Their guidance underscores the importance of ethical considerations and human rights when implementing AI in healthcare (World Health Organization, 2021). Various studies have examined the effects of AI in several areas, such as its impact on field service operations (Wang et al., 2022), its adoption in public organizations (Neumann et al., 2023), its use in public governance (Zuiderwijk et al., 2021), and its influence on operations and supply chain management (Helo & Hao, 2022).

Some studies and publications regarding AI have highlighted its significant impact on society. Given its far-reaching influence on governments, communities, businesses, and individuals, there is a crucial need to consider ethical and human rights issues. This thorough examination of the effects of AI emphasizes the importance of understanding its consequences and its substantial ramifications on various areas, including research, innovation, and deployment. Research and publications have highlighted AI’s significant impact on society, affecting governments, communities, businesses, and individuals. Therefore, it's crucial to carefully consider the ethical and human rights issues associated with AI and gain a detailed understanding of its consequences. This study delves into how AI impacts research, innovation, and deployment, emphasizing its far-reaching consequences across various fields.

METHOD

To achieve the purpose of the study and based on the research questions guided the study the following approach was employed:

Research Design

The research used a quantitative methodology, specifically the descriptive statistics approach which includes three types of analysis: frequency distribution, central tendency, and variability. Frequency distribution records the occurrence of data, central tendency records the midpoint of the data distribution, and variability measures the degree of dispersion in the data set. This technique provided a statistical understanding of the prospective science teachers about the integration of artificial intelligence applications in teaching, the benefits and challenges they encounter when implementing it, and how much it affects the students' engagement in the science classroom. To decrease the possibility of bias, descriptive statistics were utilized based on the size of the sample. By extracting data from a large number of participants, consistent, stable, and reliable techniques were employed for quantitative data analysis, allowing for appropriate comparisons of findings. Quantitative methods aimed to obtain results that would facilitate and support further research in this field.

Participants

The study participants were selected from three primary majors: physics, biology, and chemistry. A simple random sampling technique was employed, providing an equal opportunity for every eligible individual in the population to participate in the study. The participants were required to complete a self-report questionnaire, which focused on the integration of artificial intelligence applications in teaching, the challenges and benefits encountered while implementing it, and its impact on student engagement in science classrooms. The target population was comprised of all prospective science teachers from the three majors, who were attending the college of education in a private university in the academic year 2022/2023. A representative random sample of n=120 participants was selected, as presented in Table 1.

Table 1 Distribution of Prospective Sciences Teachers' Sample According to the Subject

Subject	N	Percentage (%)
Physics	22	18.4
Biology	46	38.3
Chemistry	52	43.3
Total	120	100

Data Collection

To gather data, a self-report questionnaire was utilized, structured based on ideas generated from relevant literature. The questionnaire was presented in a Likert-scale format, with five levels of measurement responding to each item. Participants' perspectives ranged from strongly disagree (1) to strongly agree (5). The questionnaire consisted of three main categories: the students' engagement, which included five items, the challenges encountered while applying AI, which contained four items, and the prospective teachers' perspectives, which included four items. A link to the questionnaire was provided, and before proceeding, participants were given a summary of the study's purpose and confidentiality intentions. Participants needed to agree to participate in the study before proceeding to respond to the questionnaire.

RESULTS

Q1. How does integrating AI applications into science education improve student engagement?

In response to the first question, it was found that students are highly engaged while using AI in the science classroom, with a total mean score of (M= 3.57, SD= 0.92). Additionally, prospective teachers expressed strong agreement that AI has the potential to improve student engagement in science classrooms, as evidenced by a mean score of (M= 4.49, SD= 0.86). Participants also reported that AI tools and technologies enhance the effectiveness of science instruction, with a mean score of (M= 3.83, SD= 1.07). However, the implementation of AI in science classrooms only moderately rated in terms of differentiation of instruction, with a mean score of (M= 3.18, SD= 0.77). Finally, the participants disagreed that AI applications offer innovative teaching opportunities for students, as this item scored the least mean among all engagement items, with a score of (M= 2.57, SD= 1.02), indicating a low level based on the cut-score scale. Overall, the results suggest that prospective teachers perceive AI applications as a source of engagement in science classes, as can be seen in Table 2.

Table 2 Descriptive Statistics of Student Engagement in AI Apps Usage

Improve Student Engagement	Mean	SD	Degree*
AI technologies have the potential to improve student engagement in science.	4.49	0.86	Very high
AI applications enhance the effectiveness of science instruction.	3.83	1.07	High
AI can provide personalized learning experiences for students in science.	3.76	0.88	High
AI tools and technologies enable better differentiation of instruction in science.	3.18	0.77	Moderate
AI applications offer innovative teaching opportunities.	2.57	1.02	Little
Overall scores	3.57	0.92	High

Q2. What are the perceived benefits and challenges of using AI in science education, as reported by science educators?

To address the second research question pertaining to the challenges faced during the implementation of AI technologies, the total mean score rated for the challenges category was (M= 2.35, SD= 1.44). while the highest mean score was reported to be the lack of access to appropriate AI resources and tools which hinders its integration into science teaching with a mean score (M= 3.69, SD= 1.1). Additionally, the participants agreed that the implementation of AI technologies presents a challenge for science teachers due to their complexity which scored (M= 3.43, SD= 2.86). Despite the lack of proper resources and its complexities, the participants disagree with the item that ensuring student data privacy and security is a concern when using AI in science teaching and that they need any additional professional development to effectively use AI applications in science teaching (M= 1.40, SD= 0.93), (M= 0.88, SD= 0.85). These statistics revealed that prospective teachers do not consider the security of the AI a concern and they demonstrate their knowledge about implementing it. However, they assured the lack of resources and the complexities as major challenges as displayed by Table 3.

Table 3 Descriptive Statistics of Challenges in AI Apps Usage

Challenges	Mean	SD	Degree*
Lack of access to appropriate AI resources and tools hinders their integration into science teaching.	3.69	1.1	High
The complexity of AI technologies poses a challenge for science teachers in their implementation.	3.43	2.86	High
Ensuring student data privacy and security is a concern when using AI in science teaching.	1.40	0.93	Very Little
Teachers Require Additional Professional Development To Effectively Use AI Applications In Science.	0.88	0.85	Very Little
Overall Scores	2.35	1.44	Very Little

*Very high (4.21–5.0),High (3.41–4.20), Moderate(2.61–3.4),Little(1.81–2.60),and Very little (1.0–1.80)

Q3. How does a secure technology environment affect the effectiveness of AI applications in science education?

According to the Alsalhi et al. (2019) and Wang, Chenxing, et al (2023) five-level scale, prospective teachers reported that the effectiveness of AI applications in science classes is high, with a total mean score of (M= 3.68, SD= 0.95). The scale ranges from 1–1.80 (very little) to 4.21–5.00 (very high). Participants strongly agreed that integrating AI into instruction leads to a deeper understanding of science concepts among students, with a mean score of (M= 4.53, SD= 0.84). They also noted that AI applications increase students' motivation in science classes with a similar mean score (M= 4.53, SD= 0.84). Furthermore, participants agreed that AI applications have a positive impact on students' retention and application of scientific knowledge, with a mean score of (M= 3.79, SD= 0.91). However, the item that AI has a positive influence on students' academic performance scored the least among the effectiveness of using AI in science classes items (M= 2.62, SD= 1.01) as shown in Table 4.

Table 4 Descriptive Statistics of the Effectiveness of AI Applications

Prospective Science Teacher Satisfaction	Mean	SD	Degree*
Students demonstrate a deeper understanding of science concepts when AI is integrated into instruction.	4.53	0.84	Very high
Students show increased interest and enthusiasm for science learning with the use of AI.	3.81	1.04	High
AI applications have improved students' retention and application of scientific knowledge.	3.79	0.91	High
AI applications have positively influenced students' academic performance in science.	2.62	1.01	Moderate
Overall Scores	3.68	0.95	High

*Very high(4.21–5),High(3.41–4.2), Moderate(2.61–3.4),Little(1.81–2.60), andVery little(1.0–1.80)

DISCUSSION

Integration of AI Applications and Student Engagement

Research shows that incorporating AI in science education can enhance student engagement. By utilizing AI technologies like virtual simulations, interactive educational platforms, and intelligent training systems, students are encouraged to participate and

develop scientific literacy. Scientific studies have demonstrated that students exhibit greater interest, participation, and understanding of scientific concepts when exposed to AI-based educational tools. These findings are consistent with previous research conducted by Smith and Shum (2018), and Khan, Yasser, et al., (2022) ; Johnson and Lester (2016), who also reported positive effects of AI integration on student participation in various learning environments. This demonstrates that using AI tools in science classrooms is engaging for the students which may positively improve their learning.

Challenges of Using Artificial Intelligence in Science Teaching

According to science prospective teachers, integrating AI into science education offers several advantages. However, the study also highlights certain difficulties linked to the use of AI in science education, such as the availability of adequate resources for teaching science and the intricacies of AI usage. Surprisingly, teachers did not perceive the need for training as a challenge, which contrasts with the findings of Almeida et al. (2019) and Chen et al. (2021). These researchers found that a lack of knowledge was a key challenge for using AI in educational settings, and participants required professional development.

The Effectiveness of AI Applications in Science Teaching

Scientifically speaking, incorporating AI into science teaching has proven to be highly effective in promoting a deeper understanding of science concepts among students. Moreover, the use of AI in instruction has been found to increase students' interest and enthusiasm for learning about science, leading to better retention and application of scientific knowledge. These findings are consistent with previous studies by Alnaqbi and Yassin, (2021), and Hwang et al., (2020); Zhang and Aslan, (2021) in particular, the aspects associated with active learning experiences and strategies , which underscore the significance of AI applications for enhancing students' success. In summary, the effectiveness of AI in science classroom instruction is evident.

LIMITATIONS

Like any other study, this study has some limitations. It's important to note that the study's findings may be influenced by potential biases in self-reported data and the applicability of the results to different contexts. The research acknowledges and explains the limitations of conducting the study in one university.

RECOMMENDATIONS & FUTURE IMPLICATIONS

This study has led to some recommendations for prospective teachers. They must develop creativity skills to effectively use AI in science teaching. Additionally, they should adopt AI tools that can aid them in applying differentiated instruction. Access to suitable source materials must also be readily available for use in science classes. It is essential that prospective teachers stay updated with advancements in AI tools to ensure effective teaching through their use.

In terms of future implications, it would be beneficial to involve additional universities in the study of AI applications in various content areas. Utilizing a mixed-method research approach could provide greater insights into the findings and improve their overall applicability.

CONCLUSION

The study focused on the impact of AI applications on science education and has shed light on its positive influence on student engagement. The study also identified some barriers that science teachers face and emphasized the importance of technology

effectiveness. Integrating AI into science education can increase student engagement, deliver personalized learning experiences, and improve educational effectiveness. However, there are some issues that need to be addressed, such as teacher training, data security, and privacy to ensure successful implementation. Creating a secure technological environment and promoting collaboration among stakeholders is crucial to fully benefit from AI in science education. By implementing this idea, educational institutions and policymakers can harness the power of AI to enhance science education and equip students for the digital age.

Conflict of interest:

The author declares that he has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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