



Investigating AI Literacy of Prospective Teachers and its Impact on their Academic Achievement in Pakistan

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ARTICLE INFO	ABSTRACT
Submission: August 11, 2026 Revised: August 22, 2026 Accepted: September 13, 2026 Available Online: September 28, 2026 Keywords: Prospective teachers; AI literacy; awareness; attitude; ethics; academic achievement. Corresponding author: Aqsa Zahid Email: aqsii7857@gmail.com	In an era of rapid globalization and technological advancement, artificial intelligence (AI) is transforming educational practices, learner interactions, and cognitive processes, highlighting the urgent need for all nations to develop AI-driven systems to promote sustainable and progressive growth in education. Teachers can play a crucial part in influencing and promoting the integration of AI in teaching-learning environments for a sustainable future, particularly in developing countries. The present study investigated prospective teachers' AI literacy and its impact on their academic achievement in the context of Pakistan. The study is descriptive in nature, and the survey method was used. A random sampling technique was used to collect the data. The sample consists of 615 prospective teachers (494 females and 121 males). A questionnaire was used to measure the AI literacy of prospective teachers across four key indicators: teachers' knowledge and awareness, attitude, use and apply and ethics. Validity and reliability of the questionnaire were ensured through expert opinion and Cronbach's alpha reliability. Data were analysed using descriptive and inferential statistics in SPSS 26. The study found that prospective teachers have a moderate level of knowledge and awareness of AI, they have a moderately positive attitude towards using AI, and they often use AI in their academics. Moreover, they reported moderate knowledge of AI ethics. However, the present study found no significant impact of using AI on prospective teachers' academic achievement. The study suggested that future research should employ multiple methods to assess teachers' AI literacy, thereby controlling bias. Additionally, prospective teachers should undergo formal training in utilizing AI to enhance the teaching-learning process and promote students' learning experiences. Based on the findings, it is recommended that artificial intelligence be integrated into teacher education, emphasizing practical applications to better prepare future educators for technology-driven classrooms.

Introduction

The current development in globalization, as well as the fast acceptance of innovative methods to worldwide development, necessitates that all countries have strong ICT and artificial intelligence (AI) systems (Sanusi et al., 2022a; Korinek & Stiglitz, 2021). The ability of AI systems to perform tasks efficiently and to handle increasingly complex and delicate tasks without interruption has led to widespread support for the application of AI concepts in addressing global challenges in the modern world (Chhaya et al., 2020). AI has been a key element of growth in many nations, depending on necessity and applicability. However, this is especially noticeable in industrialized nations where AI applications are the primary driver of economic growth. The development of AI has advanced significantly in wealthy nations since it is now incorporated into nearly every element of daily life, including infrastructure, communication, health care, and education (Vazhayil et al., 2019; Popkova & Sergi, 2020). Therefore, it is safe to say that growing technological developments will drive the future.

A collection of ideas, methods, and information aimed at imitating human cognitive capacities in robots is known as artificial intelligence. Recent developments, for example, are intended to allow computers to execute intricate jobs that were previously completed by humans (Council of Europe 2021). Based on human-established goals, artificial intelligence systems are machine-based technologies that can forecast, suggest, or decide on actions that affect real or virtual surroundings. These systems often give the impression of operating on their own, adapting their actions according to the surrounding context, and interacting with humans and their environment in both direct and indirect ways (UNICEF 2021). It is crucial to comprehend and interact with AI technologies as they increasingly impact our social, political, economic, and cultural lives. An informed populace is necessary for a thriving AI-embracing society.

Education has always been the cornerstone of progress and development, shaping individuals' knowledge, skills, and attitudes to navigate and contribute to society. However, we are now at a pivotal moment in the evolution of education. With the rapid advancement of technology, especially AI, the landscape of learning and teaching is shifting dramatically. Schools and universities around the world are starting to explore how AI can be used to facilitate personalized learning, and enhance the overall quality of education. AI has the potential to revolutionize how we teach, how we learn, and how we prepare students for a future dominated by technology. AI's introduction in education is more than a trend, it's a paradigm shift that demands students' and prospective teachers' to be prepared to understand and integrate AI effectively.

The role of teachers has always been central to the educational process, but in an era where technology is reshaping the way knowledge is delivered and consumed, teachers must evolve. AI is becoming increasingly embedded in education, with its influence expanding into various educational settings. Students are facing new opportunities and challenges. Education lies in the hands of educators, in a classroom where AI can adapt learning experiences, analyse student data and even automate routine tasks. Teachers are no longer the sole source of information; instead, they are facilitators, guiding students through the complexities of an AI-driven world. Therefore, it is crucial to ensure they have a solid understanding of AI first. Prospective teachers, in particular, must be prepared in teacher training programs to engage with these technologies to foster more personalised, inclusive, and efficient learning experiences for students to cope with the challenges of the 21st century. On the one hand, AI could be highly beneficial in promoting sustainable education; on the other hand, it could result in grave dangers. Therefore, people should know how to use AI ethically and responsibly. As AI becomes increasingly integrated into the educational system, teacher education plays a crucial role in equipping in-service and pre-service educators with the professional knowledge to use AI in their teaching deliberately and reflectively.

In a developing country like Pakistan, where AI and its systems are in an emerging phase and AI is not yet integrated in teacher education programs, it is significant to know about the current status of teachers' AI literacy level prior to teaching them AI training. Therefore, it is essential to understand the level of AI literacy among prospective teachers and their current standing. AI literacy encompasses AI awareness, attitude towards its use, application of AI in academic and personal contexts, and the ethics involved in its use. It is essential to examine three key dimensions of AI among prospective teachers: attitudes toward AI, awareness of AI technologies, and the extent to which they use and apply AI in academics. It is essential to measure these aspects to gain a comprehensive understanding of their preparedness to engage with emerging technologies in educational contexts. As future teachers, their ability to understand, utilise, and critically engage with AI tools will not only enhance their professional growth but also prepare them to educate students in a rapidly evolving, technology-driven world. Vazhayil et al. (2019) argued that without such literacy, they risk falling behind in a rapidly evolving educational landscape. Moreover, the growing importance of AI in education makes it a new concept in prospective teachers' training programs. AI has not been formally incorporated into teacher training programs. However, teachers are likely to have some informal knowledge of AI. If teachers were AI literate, they would be better equipped to prepare the next generation for an uncertain future, enabling them to contribute to economic growth. Many teacher training programs are not adequately addressing AI as part of their curriculum, leaving future educators underprepared in their teaching practices.

Several studies have examined teachers' knowledge and attitudes in various contexts, including science, mathematics, and the English language in Pakistan. However, few studies have explored prospective teachers' AI knowledge in this context. Furthermore, the economy of Pakistan is gradually shifting toward technology-based education, while urban areas in Pakistan are making strides in adopting digital technologies, rural and underserved regions face significant barriers to educational access and quality. AI can play a key role in this transformation and support teachers in instructional challenges. By making teachers AI-literate, the education system will be better positioned to equip students with the skills required for the future workforce. Moreover, an AI-literate teacher can better understand how to cope with the challenges related to variability among learners and plan teaching and learning

accordingly. Therefore, the present study aims to measure the AI literacy level of prospective teachers and to investigate the impact of AI literacy on their academic achievement.

Literature review

The term literacy describes basic knowledge of how to read and write. It is challenging to provide a clear and reliable definition of artificial intelligence (AI) given the wide range of informal interpretations. Nevertheless, the topic of artificial intelligence can be defined using previous definitions and examples. John McCarthy, a pioneer in the field of AI, was the first to define the term around 1955, describing it broadly as the effort to create machines capable of acting as if they possessed intelligence. According to McCarthy (2007), in 1956, Artificial intelligence (AI) refers to the discipline within science and engineering focused on designing systems capable of intelligent behaviour. As McCarthy (2007) described it, AI involves creating machines that can perform tasks requiring intelligence.

Over the past 60 years, as artificial intelligence has advanced alongside modern information technologies, it has brought about several clever strategies in every area of modern life. Artificial intelligence (AI) is having a profound impact across multiple sectors, including healthcare, psychology, scientific research, and governmental decision-making (Xu et al., 2021). The development of AI has made it possible to include intelligent systems in learning and instruction (Özden et al., 2025). Numerous scholars have emphasised AI's potential to assist educators by predicting student performance, personalising learning content, and streamlining the assessment process. Tools such as intelligent tutoring systems, chatbots, and recommendation algorithms are being used to improve the experience of education (Su et al., 2022; Mousavinasab et al., 2021; Liang et al., 2021; Zawacki-Richter et al., 2019). As AI technologies are becoming a bigger part of our daily lives, their application in professional fields like education continues to expand (Hwang et al., 2020; Chen et al., 2020). Prior to the rise of AI literacy, the concept of digital literacy was introduced to measure basic computer understanding starting from the 1970s, when computer applications began permeating various sectors. Competence in using computer systems relevant to one's job or task was essential. Digital literacy was also vital for technology users, as it opened up broader opportunities in social and economic spheres (Leahy & Dolan, 2010).

A widely recognised definition of AI literacy comes from Long and Magerko (2020), who defined it as a collection of skills that enable people to thoughtfully evaluate AI technologies, interact and work alongside AI systems, and utilise them effectively across various contexts, including the workplace, home, and digital environments (Long & Magerko, 2020). In an era where knowledge and technology dominate, AI literacy has become a crucial 21st-century skill. Individuals are considered AI literate when they use AI inventions appropriately and competently (Wang et al., 2023). The acceptance and perception of artificial intelligence significantly influence the widespread adoption of these technologies.

AI technology is growing in numerous areas, including education. AI's development has brought substantial changes to the way learning occurs, notably in STEM-related fields. Moreover, AI is poised to reshape education as a whole. Recently, AI has gained significant attention as a technology that facilitates numerous work activities, particularly within educational contexts. It enables instructors and lecturers to understand their students' needs better (Fitria, 2021b). Over 80% of French educators incorporate technology in their classrooms (PROFETIC, 2018), while 43% of German teachers report using technology during lessons (Sailer et al., 2021). Applying AI technologies in the classroom fosters greater student engagement. Although educational technologies are broadly accepted (Williams, 2015; PROFETIC, 2018), the introduction of AI necessitates considering teachers' perceptions, especially those directly affected by these tools.

The relationship between AI and humans is expected to be a defining feature of the Fourth Industrial Revolution (ETRI, 2019). Consequently, AI education is rapidly advancing, with numerous countries such as China, the United States of America, Korea, Singapore, Australia, and European Union members actively seeking methods to ensure AI education is successfully included in their K–12 curricula (Kim & Park, 2019; Chiu, 2021; Heintz, 2021; Steinbauer et al., 2021). A primary concern among scholars is determining the appropriate content for AI education (Ali et al., 2019; Touretzky et al., 2019; Lee, 2020). With growing interest in AI education, several empirical studies have aimed to improve it. Nevertheless, research on teacher professional development, particularly in preparing future educators for AI, is limited. The following studies offer insight into previous efforts to prepare teachers for AI classroom use (Frimpong, 2022). For instance, Sanusi et al. (2022) investigated 12 in-service teachers from Africa to add to the AI education literature, concentrating on teachers' preconceptions about teaching machine learning in K–12 classrooms. Their results suggest that in-service teachers need training to utilise current technologies when introducing machine learning effectively. Teacher education arguably represents the most critical and often underemphasised element of successful technology integration in education. Jamieson-Proctor, Finger, and Albion (2010) argued that teacher competence is one of the most influential factors on student achievement. The robust education system of Finland, which has attracted global attention due to

PISA results in the 2000s, provides a notable example of how high-quality teacher education underpins educational success (Sahlberg, 2010).

Prospective teachers, often referred to as pre-service teachers, are individuals who are actively engaged in formal preparation programs such as bachelor's or master's degrees in education, teacher certification courses, or postgraduate diplomas prior to full-time professional practice in K-12 classrooms. These candidates are typically enrolled in university-based teacher education programs or alternative certification pathways and participate in a blend of coursework, pedagogical seminars, and supervised classroom practicums. Throughout this period, they develop foundational knowledge in subject matter content, pedagogical theory, and classroom management, while gradually assuming greater instructional responsibilities under the mentorship of experienced teachers and university supervisors (Darling-Hammond & Bransford, 2005; Zeichner & Conklin, 2005). According to Tondeur et al. (2012), teacher education programs must integrate ICT-related competencies into their curriculum to bridge the gap between training and practical implementation in schools. The term also highlights the transitional stage of these individuals, which makes them a critical focus for research into emerging pedagogical trends. Their attitudes, beliefs, and competencies, particularly about technology, are still forming, making this an ideal period to introduce advanced literacies like AI.

Both pre-service and in-service teacher training institutes are available at colleges and universities in Pakistan. Higher Education Commission Pakistan has developed the National Accreditation Council for Teacher Education (NACTE), which is responsible for determining the quality of teacher education programs. However, teacher education in Pakistan is not in good shape and is facing numerous challenges mainly because of its structure, lack of expertise of teacher educators, and financial resources (Bibi & Hanif, 2023). Generally, teacher education programs lack integration of technology in classrooms due to insufficient resources. Therefore, prospective teachers are not formally trained to integrate technology in classrooms. Hence, it would be interesting to examine prospective teachers' AI literacy level.

Researchers emphasise that academic achievement is often linked with self-regulatory behaviours, motivation, and learning strategies. Meanwhile, past studies highlight that technological skills and digital confidence also correlate with academic success in teacher training programs. In today's digitised educational environment, the ability to effectively engage with artificial intelligence tools for learning, assessment, and lesson planning may serve as a significant predictor of a prospective teacher's academic outcomes (York & Gibson et al., 2015). Moreover, academic achievement is not a static construct; it must be understood in context. For instance, students with high AI literacy may outperform their peers academically, not because of intelligence alone but due to enhanced problem-solving skills, resourcefulness, and engagement with modern learning technologies. Therefore, it is particularly relevant to explore how AI literacy can contribute to improving academic achievement among prospective teachers (Richardson et al., 2012).

Theoretical framework

The ability to be literate in AI involves understanding, using, evaluating, and ethically navigating AI (Long & Megerko, 2020; Laupichler et al., 2022). Ng et al. (2021) present four key competencies of AI literacy: know and understand AI, use and apply AI, evaluate and create AI and ethics to use AI. Furthermore, the University of Florida uses the model by Ng et al (2021) as a foundation of their work as the UF AI literacy model in (2023). The UF AI literacy model is based on the four aforementioned key areas. The authors use three key areas of AI literacy model by Ng et al. (2021) as a foundation of their study. Knowing and understanding AI encompasses fundamental knowledge of what AI is and how it functions, including familiarity with machine learning algorithms, training data, and the potential limitations and biases in AI systems. Using and applying AI involves the practical use of AI tools and systems to carry out tasks and solve problems, often requiring coding abilities and data management skills. Evaluating and creating AI, involves the ability to assess the trustworthiness of AI systems and to develop responsible AI solutions, requiring both technical skills and an understanding of ethical and societal impacts. AI ethics encompasses the moral and ethical concerns surrounding AI, including issues of fairness, transparency, accountability, and societal impact, as well as the need for informed decision-making.

The direct application of the model may not fully support the technological and pedagogical realities of developing countries like Pakistan, particularly for prospective teachers. Therefore, the authors did not adopt this model in its original form; instead, they adapted the model to fit the needs of the teacher education system in the context of Pakistan. The integration of AI among prospective teachers in Pakistan is still at a nascent stage. It is essential to contextualise the framework according to the context of Pakistan, so that prospective teachers' AI literacy can be assessed accurately. Among the factors of Ng et al.'s (2021) model, the present study excluded the factor of evaluating and creating because this dimension is relatively advanced for the knowledge level of common prospective teachers, who are not knowledgeable enough to evaluate AI and create with it, to propose solutions that require advanced technology. Therefore, the present study examined AI literacy of prospective teachers through three dimensions

of AI from NG et al. (2021) model. These include: to know and understand (to examine their awareness about AI), use and apply (how often they use AI), and AI ethics (about using AI ethically and responsibly). In addition to these factors, the authors added prospective teachers' attitudes towards using AI in learning and instruction. An individual's attitude toward the use of AI represents their positive or negative perception of its applications (Ayanwale et al., 2022).

Know and understand AI (Awareness): AI literacy involves understanding how artificial intelligence generally functions and learning to interact with AI applications. It includes teaching students basic concepts, skills, knowledge, and attitudes related to AI, without requiring any prior expertise. Beyond simply being users of AI programs, students should also comprehend the underlying technologies. According to Burgsteiner et al. (2016) and Kandlhofer et al. (2016), AI literacy is also described as the power to know basic AI techniques and concepts and how they are utilised across different products and services. Further, according to some researchers, AI literacy is associated with perceived ability, self-assurance, and a desire to learn about AI. Druga et al. (2019) and Lin et al. (2021) have created curricula and activities designed to foster AI literacy by highlighting the way learners acquire AI concepts in K-12 classrooms.

Use and apply AI: Utilising AI principles, knowledge, and applications across various contexts has been a focus in education. Researchers emphasise teaching students to apply AI tools in everyday situations. AI training programs are offered, with a central focus on developing AI thinking. This approach teaches learners to structure logical procedures, enabling them to apply knowledge effectively, interpret meaning, and handle complex or unstructured information. (Vazhayil et al., 2019). How and Hung (2019) explored new insights gained from machine-learned detection of hidden data patterns and applied AI reasoning to computational data analytics.

Attitude: An individual's attitude toward AI reflects how positively or negatively they perceive its applications (Ayanwale et al., 2022). No matter what education they receive, students with no positive learning attitude towards professional skills are less likely to master them (Ajzen, 1991; Fredrickson, 2001). Attitude is a psychological tendency expressed by evaluating a specific entity with a certain degree of favour or disfavour (Eagly & Chaiken, 1993). Williams (2015) found that in the United States of America, prospective teachers generally hold positive attitudes toward educational technology. It is important to distinguish between acceptance and acceptability, concepts closely related to attitude and referring to the degree of support for using a system (Schuitema et al., 2010; Sindermann et al., 2021). Acceptability is the judgment made prior to system use, while acceptance is the judgment after experience with the system (Martin et al., 2016; Schuitema et al., 2010). Interestingly, the term "AI" itself can influence attitudes toward AI-powered systems. Ragot et al. (2020) found that paintings labelled as AI-generated were rated less favourably than those described as human-painted. Hence, measuring and knowing students' attitudes toward AI is crucial for effective AI education.

AI ethics: Artificial intelligence (AI) positively influences many aspects of daily life; however, it also raises significant ethical and privacy concerns. Often, the benefits of AI are overshadowed by these considerations (Özden et al., 2025). They further stated that it is essential to address privacy and ethical issues throughout the design, development, and deployment of AI systems (Özden et al., 2025). As AI's usage has expanded, concerns have grown regarding how AI systems collect, analyse, and manage data. Rodríguez-García et al. (2020) evaluated acquiring knowledge of machine learning aimed at promoting public awareness of the ethical dilemmas about using AI and its extended societal effects. Significantly, almost half of the studies reviewed focused on ethics and human-centred design topics, highlighting the significance of employing AI in socially responsible ways. Over 100 AI ethics guidelines have been issued by NGOs, academic institutions, corporations, and governments to promote responsible AI development and use. Hickok (2021) analysed those guidelines and revealed they have shared values and priorities. Jobin et al. (2019) analysed 84 publicly accessible AI ethics guidelines and discovered that more than half highlight the importance of transparency, fairness, non-maleficence, responsibility, and privacy. All these aspects of AI ethics are considered while measuring AI ethics in the present study.

Research Questions

RQ1: What is the level of AI literacy of prospective teachers in Pakistan? AI literacy is measured through four dimensions: knowledge and understanding, use and application, attitude towards AI and AI ethics.

RQ2: What is the impact of AI literacy of prospective teachers on their academic achievement?

Limitation

The present study examined AI literacy through a self-report questionnaire.

Rationale of the Study

The utilisation of AI is emerging rapidly in various sectors, including science, healthcare, business, and different disciplines of education. In today's digitally connected world, artificial intelligence literacy is crucial, especially in teacher education. In the contemporary era, to meet the evolving demands of education, teachers should be AI literate. Therefore, prospective teachers need to be well-informed about AI. Prospective teachers are assets for the future generations. So, the teachers who are well-versed in AI can better prepare students for a technology-driven world by fostering problem-solving skills, critical thinking and digital literacy in their classrooms.

Even highly educated individuals working as researchers in Pakistan, according to Nauman (2017), have inadequate critical thinking abilities in AI. The researcher examined the research output of Pakistani scholars, arguing that there is a lack of work on the AI literacy of prospective teachers and that the contributions of these researchers have not yielded valuable insights. One must complete teacher training at a teacher training institute in order to work as a teacher in Pakistani public schools. These teacher training institutions are often universities where prospective teachers are trained by university faculty, including professors, assistant professors, associate professors, and lecturers. Prospective teachers may not understand, implement, or employ AI in their professional teaching in an ethical manner if they do not receive sufficient knowledge on the subject.

Furthermore, after knowing the current level of prospective teachers' AI literacy, the results of the study will assist in updating teacher education curriculum to incorporate particular artificial intelligence modules that address important topics like the principles of AI, its applications in education, ethical issues, and AI-assisted teaching techniques. Additionally, incorporating AI across different subject domains enables prospective teachers to understand how AI impacts various disciplines. Practical exercises during learning will aid in bridging the gap between real-world and AI theory educational applications. As AI increasingly influences the educational landscape, it is necessary to ensure that prospective teachers are equipped with the knowledge and skills to harness its potential. By equipping prospective teachers with AI literacy, this study aims to create a ripple effect, ensuring that future teachers are well-prepared to thrive in an AI-dominated workforce and society.

Teacher education in Pakistan is mainly comprised of a 4-year Bachelor's degree called B Ed Honors. During this four-year degree program, prospective teachers are taught to teach subject-matter knowledge and pedagogical knowledge in multiple domains, including a course or two in instructional and communicational technology (ICT). However, no course is taught about AI in the teaching and learning process presently, nor is it focused on in the course outlines of ICT courses. Therefore, prospective teachers are not expected to have AI literacy based on their scheme of studies. Prospective teachers would have taught it due to their interest in it.

Methodology

The present study applied a quantitative research design and is descriptive in nature. A survey method was used, and data were collected through a questionnaire. The sample was drawn from the B. Ed Honors degree, which is a four-year teacher training program comprised of eight semesters. The prospective teachers were studying in the 6th or 8th semester at the time of data collection. The sample was drawn from 7 universities offering teacher training programs in the Punjab province. The total sample consists of 615 prospective teachers, among whom 494 were females and 121 were males. The majority of the sample was female, as females typically prefer teaching as a career in Pakistan.

Research instrument

After an extensive review of the literature on measuring AI literacy, the authors partially adopted Ng et al.'s model, taking into account the context of Pakistan and the teacher training program model for measuring AI literacy. Then, the authors developed the AI literacy scale and got it validated through expert opinion. The final scale comprises 37 items about AI literacy and uses a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree). The first section of the scale measured prospective teachers' demographic information, including gender, age, semester, and CGPA. Prospective teachers' academic achievement was measured through their CGPA earned so far in their B Ed. Honors degree. The second section assessed four key factors of AI literacy: knowledge and understanding (measured through 11 items), attitude towards AI (measured through 12 items), the ability to use and apply AI (measured through 11 items), and the ethics of AI use (measured through 3 items). The pilot testing was done on 100 prospective teachers to ensure reliability of the tool. Reliability was measured through Cronbach's

alpha, and the scale showed a high reliability of Cronbach's alpha. .88. The factor-level reliability of the instrument is given in Table 1.

Table 1

Reliability Coefficient, the Number of items and the Sample of Items of AI Literacy Scale and its Factors

Scale/subscale	Number of items	Reliability	Sample item
Awareness	11	.76	I am aware of how AI works
Attitude	12	.82	I think AI should be integrated into teacher training programs.
Use and apply	11	.86	Use of AI tools help me to be more efficient in my academic work
AI ethics	03	.62	I can analyse AI based applications for their ethical implications in education
AI literacy (overall scale)	37	.88	---

Data collection

Participants were selected through simple random sampling technique from B. ED Honors students (prospective teachers) from the department of education. The institutional permission was taken, and ethical considerations were ensured. Informed consent was provided to all participants, ensuring that they clearly understood the study's purpose, their role, and their right to withdraw without facing any consequences. Confidentiality and anonymity will be upheld by coding data and protecting participants' identities, ensuring that personal information will not be disclosed. These considerations will support ethical integrity and protect participants' rights throughout the study.

Results

The data were analysed in SPSS 26, and descriptive and inferential statistics were applied to analyse the data. The first research question aimed to examine prospective teachers' level of AI literacy by measuring their knowledge, understanding, attitude, and application of AI ethics. The results are shown in table 2. The study found that prospective teachers have a moderate level of knowledge and understanding ($M = 3.69$, $SD .55$), and the majority of prospective teachers agreed that they are aware of artificial intelligence. Similarly, the study found that prospective teachers have a positive attitude towards using AI for their academic activities ($M = 3.62$, $SD .60$) and they are willing to learn more about AI. The Mean value suggests that the majority of the prospective teachers have a positive mindset towards AI.

Furthermore, the study found that prospective teachers often use and apply AI for academic purposes ($M = 3.73$, $SD = .660$). The mean indicates that their usage of AI is slightly higher than their knowledge, awareness, and attitude. The Mean value indicates that the majority of prospective teachers agreed that they are familiar with using and applying AI in academics.

Regarding knowledge and awareness about AI ethics, the present study has similar findings. The results showed that prospective teachers reported being moderately aware of the ethics of using AI ($M = 3.64$, $SD = 0.744$); however, the deviation in their responses is slightly higher than that of other AI-related factors. The study found that prospective teachers know the ethical concerns involved in using AI, and they use and practice AI accordingly. Conclusively, the present study found that prospective teachers have a moderate level of AI literacy.

Table 2

Mean and Standard Deviation of Prospective Teachers' AI Literacy Level at the Factor Level (Number of Prospective teachers = 615)

Factors	Mean	Std. Deviation
Know and understand	3.69	.554
Attitude	3.62	.606
Use and apply	3.73	.660
AI Ethics	3.64	.744

Table 3 shows intercorrelations among factors of AI literacy. Pearson correlation was calculated to find the relationship among factors. The study found that knowledge and awareness about AI and use and apply of AI have a significantly strong positive relationship (.63**) with each other. Similarly, knowledge and awareness have a strong, significant positive relationship with the use and apply of AI (.62**). The study further found that knowledge and awareness have a moderately significant positive relationship with AI ethics (.44*). The use and apply of AI have a significantly high and positive relationship with attitude toward using AI (.80**). AI ethics and attitude towards using AI have a strong, significant positive relationship (.61**). Furthermore, the study found that the use and application of AI have a significantly strong positive relationship with AI ethics (.60**).

Table 3

Intercorrelations Among Factor Awareness, Attitude, Use and Apply, Ethics, Academic Achievement and AI Literacy (Number of prospective teachers = 615)

	Awareness	Attitude	Use &Apply	Ethics	AI literacy	Academic achievement
Awareness	1					
Attitude	.63**	1				
Use & Apply	.62**	.80**	1			
Ethics	.44**	.61**	.60**	1		
AI literacy	.81**	.92**	.91**	.69**	1	
Academic Achievement	.10	.00	.04	.01	.05	1

The study further revealed that all factors of AI literacy: knowledge and awareness, attitude, use and application, and ethics of using AI, have a significant positive relationship with the sum score of the overall AI literacy scale, with correlation values of .81**, .92**, .91** and .69**, respectively.

The second research question aimed to investigate the impact of AI literacy on academic achievement, specifically whether frequent use of AI for academic purposes affects academic achievement. Table 3 shows that all factors of AI literacy have no significant relationship with academic achievement. Linear regression was applied to investigate the impact of AI literacy on the academic achievement of prospective teachers, and the results are shown in Table 4. The study found that AI literacy has no significant impact on the academic achievement of prospective teachers ($\beta = .05$). This indicates that despite having moderate awareness, knowledge, and a positive attitude towards AI, and frequently using it for academic purposes, AI does not significantly impact their academic achievement.

Table 4

Linear Regression Analysis Predicting Prospective Teachers' Academic Achievement from AI Literacy (Number of prospective teachers = 615)

	β	SE	Sig
AI literacy	.050	.002	.39
R ²	.002		
Adjusted R ²	.000		
*p < 0.05			

Conclusion

Based on the findings of the present study, it is concluded that prospective teachers have moderate awareness about artificial intelligence. As a prospective teacher, they are aware of the fundamentals of AI, its potential, and its challenges. They believed it would inspire them to use AI in their pedagogy, as they are aware that artificial intelligence facilitates individualised and efficient teaching and learning. Furthermore, findings concluded that prospective teachers generally showed positive attitudes towards the integration of AI in education. AI has several advantages for education, such as enhanced academic achievement, trustworthy information sources, and assistance with lesson design. Despite potential obstacles, they are willing and motivated to include AI in their future teaching and favour its inclusion in teacher training programs.

Moreover, findings revealed that most prospective teachers have knowledge about using and applying artificial intelligence for academic purposes, and AI has the advantage of saving time and increasing efficiency in the instructional process. The study further found that the majority of the sample of prospective teachers are aware of the ethical concerns related to the usage of AI. Lastly, the study found that AI literacy has no significant impact on the academic performance of prospective teachers.

Discussion

The findings of the current study revealed that prospective teachers in Pakistan have a moderate level of awareness about AI. They have a moderately positive attitude towards integrating AI in the instructional process, often use and apply AI for academic purposes, and are well aware of AI ethics. The findings of the present study align with those of Zhao et al. (2022), who analysed 1013 surveys and found that teachers' application of AI is significantly associated with other aspects of AI, including knowledge and understanding, evaluation of AI applications, and AI ethics. However, Alimi's (2021) study found that university students (the present study sample is prospective teachers studying at university) demonstrated low AI awareness, likely due to limited exposure to digital technology. Alimi further highlighted that systemic barriers exist in AI literacy in developing countries, which cause a lack of knowledge and awareness about AI. It suggests that prospective teachers in Pakistan have better access to AI, leading to improved knowledge of AI that they apply in their academic life. Ding et al. (2024) enhanced teacher AI literacy during a professional development program and found that both case-based discussions and direct instruction can improve teachers' AI literacy. Therefore, these methods can be implemented in professional development training to foster a technology-centric future for future generations.

The findings of the current study showed a positive attitude of prospective teachers towards artificial intelligence in Pakistan. The past research conducted by Özden (2025) investigated the link between AI literacy and general attitudes among pre-service teachers. The study found a weak but positive relationship, with gender, age, and academic level influencing attitudes. Male and high-achieving students showed higher AI literacy and a positive attitude. It indicates that prospective teachers are generally willing to integrate AI in the classroom; therefore, systematic and in-depth integration of AI in teacher education is a step towards digitalisation in education.

The present study found that prospective teachers have a moderate level of awareness about AI ethics. Ahmad et al. (2020) reviewed studies to examine students' knowledge of AI ethics. They found that students lack sufficient ethical knowledge about using AI, and citizens should be educated about it to ensure fair practices of using AI. Gong et al (2020) found that students do not focus on ethical aspects of using AI, like bias in AI, intellectual property and legal responsibility. Therefore, educators should be professionally trained in AI ethics and then educate students about it to act ethically and responsibly while using AI. According to Ng et al. (2021),

teachers should educate students about the applications and benefits of AI, as well as the ethical implementation of AI technologies, to build a future inclusive society.

The study further investigated the impact of AI literacy on the academic achievement of prospective teachers and found that AI literacy has no significant impact on their academic achievement. The findings are similar to those of a study conducted by Abbas et al. (2019), who found no significant relationship between digital literacy and academic performance among Pakistani students. These similar results suggest that neither digital literacy nor AI literacy significantly impacts academic achievement. It shows that students' academic achievement is not always positively impacted by their level of AI literacy. Sperling et al. (2024) reviewed the concept of AI literacy in teacher education. They suggested that educational scientists should define AI literacy in multiple contexts of education. Teachers should be actively involved in developing AI content and teaching methods of AI literacy for teacher education programs. Moreover, they suggested that educationist needs to conduct in-situ studies and develop practical and ethical knowledge. These developments in AI literacy in teacher education would be more relevant and, therefore, might help in improving prospective teachers' academic achievement.

Implications for research and practice

In the present study, prospective teachers reported moderate to high levels of AI literacy. However, the present study used a self-report questionnaire to examine AI literacy. Although the instrument was reliable, future research can employ more effective methods to assess teachers' AI literacy, reducing the bias of social desirability and enabling a more accurate evaluation of their literacy. Moreover, future research should investigate prospective teachers' AI literacy, particularly in the instructional process. The present study found that prospective teachers are inclined towards integrating AI in teaching to improve the instructional process and believe it can improve teaching effectiveness. However, AI is not currently included in teacher training programs to train teachers on implementing AI in academics. Teacher training programs should integrate AI into their training to better prepare teachers to address the challenges of the 21st century and equip them to utilise AI tools in their teaching practices proficiently. Moreover, teachers' competence in using AI to enhance teaching and learning can help address local education challenges in Pakistan, such as high drop-out rates and a shortage of teachers and schools. The study further found that although prospective teachers are literate about AI, they are unable to use AI to improve their academic achievement. Therefore, they might not be able to integrate AI into their teaching practices effectively. Hence, the present teacher education system should train teachers to effectively integrate AI to prioritise real-world applications and to promote students' learning experiences.

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