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RESEARCH PAPER

Moderating Effect of AI Learning Behavior on AI Awareness and AI Anxiety of Prospective Teachers in ODL Environment

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ABSTRACT

The rapid advancement of Artificial intelligence (AI) applications and tools across various domains has introduced many societal challenges in recent times. The fast prevalence of AI development and its practices in the teaching-learning domain demands that students be trained with AI-related skills and applications for improved learning outcomes. Despite AI's potential boom in the global economy and productivity, many scholars have shown concern that AI technologies have already disrupted and diffused the future workforce and societies. In this context, the present research aimed to explore the role of AI-learning behavior in moderating the AI-awareness and AI anxiety of prospective teachers in an Open and Distance Learning (ODL) environment. This study employed a correlational descriptive design to examine the role of AI-learning behavior in moderating the relationship between AI-awareness and AI anxiety. All students enrolled in the faculty of education in Fall 2023 were considered the study population. Data were collected from the prospective teachers using the AI Anxiety scale (AIA), AI awareness scale (AIA), and AI Learning Behavior questionnaire. The results revealed that AI-learning behavior moderated the relationship between AI anxiety and AI awareness by 16.37% in the Pakistani context.

***Keywords**:* Open and distance learning, AI awareness, AI anxiety and Learning behavior, moderation

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Introduction

Recently, all social systems, including education, health, politics, and the economy, have been affected by rapid development and innovations in Artificial Intelligence (AI) tools and applications (Kaya et al., 2022; Luan et al., 2020; Stephanidis et al., 2019). A 2017 report by the McKinsey Global Institute (MGI) projected that, depending on the pace of AI adoption, between

75 million to 375 million workers (representing 3–14% of the global workforce) may need to transition to new occupations or upgrade their skills by 2030 (Sander et al., 2021). Additionally, AI- technologies are expected to drive innovation and economic growth, potentially creating 133 million new jobs worldwide by 2022 (Dwivedi et al., 2021). Reinhart (2018) stated that 85% of the population around the globe is using at least one AI-based technology. However, many people remain unaware of the AI applications that interact with in their daily lives (Tai, 2020). Zhang and Dafoe (2019) explained that AI technology is widely useful in advancements in many sectors, including education, labor market, farming, health, and national security. Darko et al. (2020) highlighted AI as a key technology of the Fourth Industrial Revolution (Industry 4.0), offering numerous benefits across various domains. Its applications include enhancing students' educational experiences, diagnosing diseases, preserving environmental resources, predicting natural disasters, driving financial growth, preventing violence, and improving overall quality of life and psychological well-being (Cohen & Jones, 2020). Similarly, in certain sectors such as healthcare, researchers at Stanford successfully developed an AI-based system capable of diagnosing 14 types of medical conditions with greater accuracy than human experts within just one month (Rajpurkar et al., 2017). In education, AI is being utilized to monitor students' progress while also surpassing human capabilities in the job market (Tuomi, 2018. P.5). These advancements in AI are influencing individuals' psychological well-being, leading to increased anxiety about its widespread adoption and impact (Li, & Huang, 2020).

AI Adaption in Teacher Education

As Artificial Intelligence (AI) continues to transform education, teachers play a pivotal role in integrating AI technologies into the classroom effectively. Kaya et al. (2022) emphasized that many factors contribute to willingness and tendency to use AI technology in specific fields. According to Seo et al. (2021), AI-based teaching-learning processes are currently offering effective support to design personalized instructions, activities, and assessments for students and teachers alike. On a similar notion, Hwang et al. (2020) explained that AI provides students with tailored learning content and feedback based on students' learning styles and preferences. It further helped the teachers to organize their work and save ample time to engage in meaningful activities to improve their practices (Goel & Polepeddi, 2018). In fact, AI provides real-time data to teachers about students learning patterns and strategies to reshape their experiences (Fong et al., 2019). No doubt, the opportunities of AI are very promising and revolutionary in the educational context; however, its true potential for students is still vague and requires more empirical evidence. Zawacki-Richter et al. (2019) conducted a systematic review on AI in education (AIEd) using data from 2007 to 2018, and they found there is a lack of critical reflection on the ethical impact of AI-based systems on students and the learner–instructor interactions.

Syed et al. (2023) stated that AI is anticipated to play a significant part in education and the skilled workforce; therefore, it's useful to have relevant skills in AI and machine learning (ML). He further gave the example of the healthcare field, which, due to a lack of awareness about how to choose the right AI tools and incorporate them for patient care, may result in worse patient outcomes. On a similar notion, it is crucial to train teachers with the latest AI tools and mentor students for meaningful and engaging teaching-learning experiences using AI.

Ayanwale et al. (2022) described that teachers are being trained to use AI-based instructions

through professional development programs at the university and class levels. For this, many researchers have prepared instructional resources like AI-based tools, curricula, and approaches for teachers that support the teaching-learning process using AI concepts (Chiu, 2021). Tang et al. (2021) highlighted that academia is concerned about the absence of educational theories and models for AI-enabled e-learning for students. Similarly, it is important to know the student-teacher perceptions regarding their AI learning behavior and how AI learning behavior would affect AI awareness and AI anxiety in an online environment. This understanding would help researchers and teachers plan and implement AI-based instructional pedagogy efficiently.

Theoretical framework

The current study is based on Leont'ev (1978) cultural-historical theory of activity, which posits that human learning behavior is not a singular phenomenon but rather a structured process composed of three hierarchically interconnected levels. This theory provides a framework for understanding learning within its broader cultural-historical context. Vygotsky and Luria (1992) emphasized the influence of social and cultural factors in shaping learning behaviors. Meanwhile, critical pedagogies, i.e., Freire (1972) and Engestrom (1987), highlighted the role of learning behavior in transforming educational practices. The learning behavior of individuals in the context of AI is further explained by a model proposed by (Tuomi, 2018). In this context, behavior is viewed as a socially meaningful activity driven by social, cultural, and cognitive motives. It can be further explained that activity, when properly understood, necessitates social and intergenerational learning (p.8). This theory explores the fundamental questions of why, what, and how learning behavior occurs. In the AI context, learning AI is an activity shaped by socially, culturally, and historically significant questions, i.e., why it should be learned, and, at a more operational level, how it is applied within concrete settings.

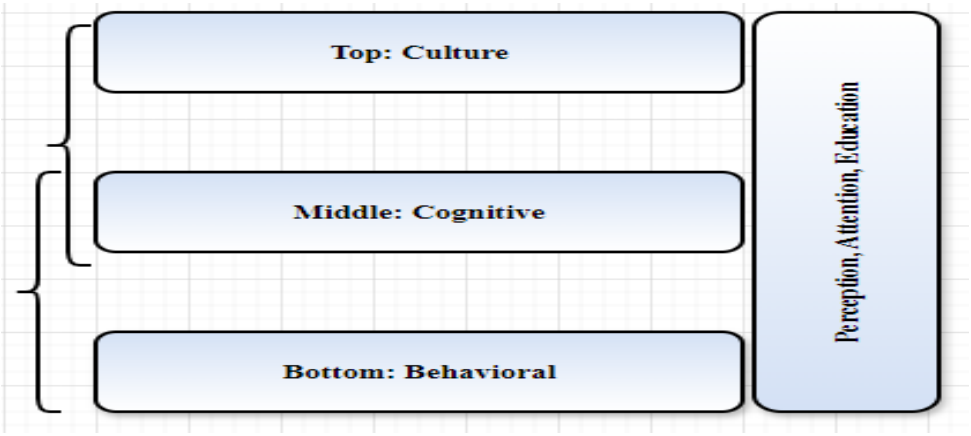

Fig. *1 Three-level model of learning behavior (Tuomi, 2018)*

The three-level model serves as a very valuable framework for understanding artificial intelligence and its impact on various domains of human life. However, it is evident that different types of AI, along with their awareness and learning behaviors in machine learning systems, function at distinct layers within this hierarchy (Tuomi, 2018. p.10). This layered structure forms the foundation for the motivation to learn and advance AI capabilities.

AI- Learning Behavior in relation to AI- Awareness

Learning behavior in this study is defined in terms of motivation to learn AI (Wang et al., 2022), and it is further explained by the individual engagement in a particular direction to sustain this learning. Additionally, motivation theorists suggest that behavior is influenced by intention, which is shaped by both intrinsic and extrinsic motivation (Teo et al.,1999). In the context of AI, learning behavior requires awareness and comprehension of various advanced and complex computational processes, often causing anxiety among students. The process of learning behavior is closely linked to motivation (Vallerand et al.,1992), which is a key predictor of students' academic performance (Donnermannet al.,2021; Law et al., 2019). A study by Almaiah et al. (2022) found that students' intention to engage with e-learning was negatively correlated with computer phobia, highlighting the impact of technological anxiety on learning adoption.

According to Wang et al. (2022), when people have this fear that AI will replace their jobs and work, it will motivate them to learn and to gain more awareness regarding the potential applications of AI in their field. AI awareness encompasses individuals' knowledge and comprehension of AI concepts, capabilities, limitations, and potential societal impacts. It includes both general awareness and domain-specific knowledge related to AI applications. Factors affecting AI awareness include media exposure, educational resources, personal interest, and cultural context.

Law et al. (2019) emphasized that learning intention is the ability to achieve a specific task with the goal of improving or developing an ability in a specific subject area. Similarly, for current students, AI is expected to replace their jobs. Thus, it is indispensable for them to use resources and tools to increase their learning related to AI skills and knowledge to improve their competitiveness in the job market. Based on the theory mentioned above and the support of the studies, the researchers designed the first hypothesis.

H_1: AI Learning behavior moderates the AI Awareness of prospective teachers in ODL environment

AI-Awareness and its role in AI Anxiety

Almaiah et al. (2022) stated that AI is different from computers as it provides human-based features and personalized learning characteristics (Li et al., 2020). Syed et al. (2023) reported that there are several studies conducted internationally that show the positive impact of AI on their profession and their workflow (Reznick et al.,2020). Teng (2022) highlighted that students' attitudes, awareness, and anxiety regarding AI vary across disciplines and field of specialization. Even those initially indifferent to AI have come to recognize the importance of integrating fundamental Al knowledge into their curricula and learning practices. Neudert et al. (2020) further emphasized the ongoing debate surrounding AI's ethical, emotional, social, political and economic implications. Similarly, Green (2020) noted that AI presents significant challenges, including job displacement, privacy concerns, transparency issues, algorithmic biases, socio-economic inequalities, and the potential for unethical use of technology.

AI anxiety (AIA) is often compared with the term Technophobia (or computer phobia). However, these two terms are different in their context and usage (Ha et al., 2011). AIA is believed to evaluate learner's perceptions regarding the use of AI technology for various purposes. Any undesirable feelings related to AI technology and its application have a negative impact on the

successful development of AI tools and resources (Wang et al., 2022). Therefore, it is important to identify the perceived AI anxiety and minimize it to expand the use of AI for future users. AIA is being rigorously investigated in recent literature due to its widespread application across the globe. Kaya et al. (2022) define 'Artificial Intelligence Anxiety' as the fear associated with AI becoming uncontrollable, a concept previously discussed by Johnson and Verdicchio, (2017). Drawing from prior research on anxiety in the AI domain, AIA may be understood as an overall affective response characterized by anxiety or fear that hinders individuals from engaging with AI. Wang et al. (2022) further explain that this anxiety is often linked to individuals' lack of confidence in learning complex subjects, making AI particularly intimidating (p.3). The increased number of emerging AI tools makes it difficult for students to grasp all technologies, thus creating a gap between individual knowledge and skills, hence generating AI anxiety (Khasawneh, 2018). Another comprehensive study involving 154,192 participants from 142 countries, as reported by Neudert et al. (2020), found that many individuals are anxious about the potential risks of using AI, thus providing the base for the second hypothesis.

H_2: AI Awareness helps in decreasing/minimizing the AI anxiety of prospective teachers in an ODL environment

AI Adaption in Pakistan

The use of AI in teaching-learning, particularly in Pakistan, is in its infancy. The education system of Pakistan is criticized for using traditional pedagogy, teacher-centered approaches, and paper-based assessment techniques. However, the infusion of technology with pedagogy has created new innovative approaches for teachers and students to create interactive learning experiences. Amjad et al. (2024) investigated the mediating role of ChatGPT on M-learning and students' performance in Pakistan context and found positive responses. Moreover, the widespread use of ChatGPT tools and its affiliated applications has created a buzz in the education community, particularly for students and teachers. Kalhoro (2024) stated that in May 2023, the Ministry of Information Technology and Telecommunication released the first draft of Pakistan's national Artificial Intelligence (AI) policy. Introduced under the Digitalize Pakistan initiative, this policy aims to enhance public awareness of AI, strengthen workforce development, invest in research and innovation, and establish regulatory frameworks and ethical guidelines across various disciplines. This study aimed to explore how prospective teachers' learning behaviors regarding artificial intelligence moderate AI awareness and AI anxiety in the Pakistani context, a topic that has been extensively researched.

Conceptual Framework

This theoretical framework aimed to explore how teachers' AI learning behavior moderates the relationship between AI-awareness and AI-anxiety.

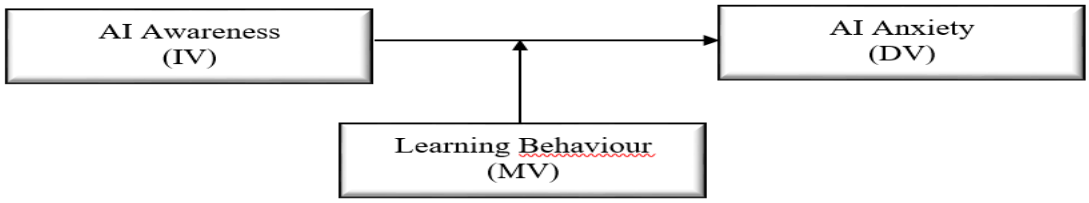

Figure 2. *Conceptual framework of variables*

Methodology

A cross-sectional correlational study was conducted to examine the moderating role of AI-learning behavior in the relationship between AI awareness and anxiety. Spector (2019) stated that a cross-sectional design is the best design for measuring status.

Study Participants

All the students enrolled in the Faculty of Education at an online university during Spring 2023 semester, from the first-year to the final-year, were invited to participate in the study. A total of n=1019 students participated in this study. Participants background information is provided below in Table 1.

Table 1. *Sample Distribution (1019)*

Variables	Category	F	%
Gender	Male	200	19.6
	Female	819	80.4
Education	Bachelor	443	43.5
	Masters	502	49.3
	MPhil	65	6.4
	PhD	9	0.9
Total	-	1019	100

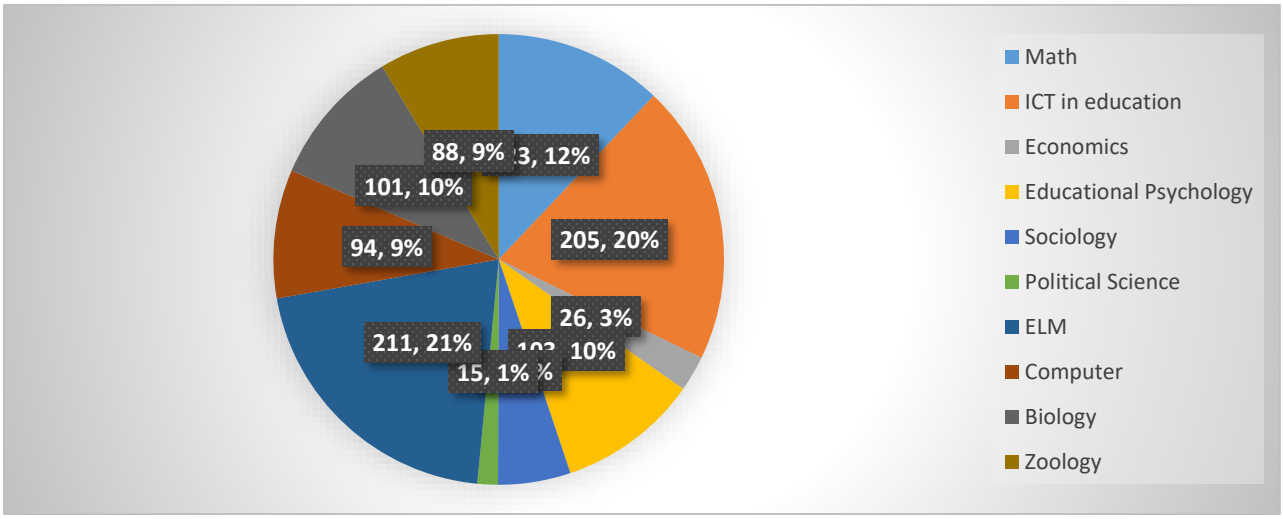

Fig 3. *Area of Specialization of prospective teachers (n=1019)*

Fig 4. *Distribution of male and female with respect to Area of Specialization of prospective teachers (n=1019)*

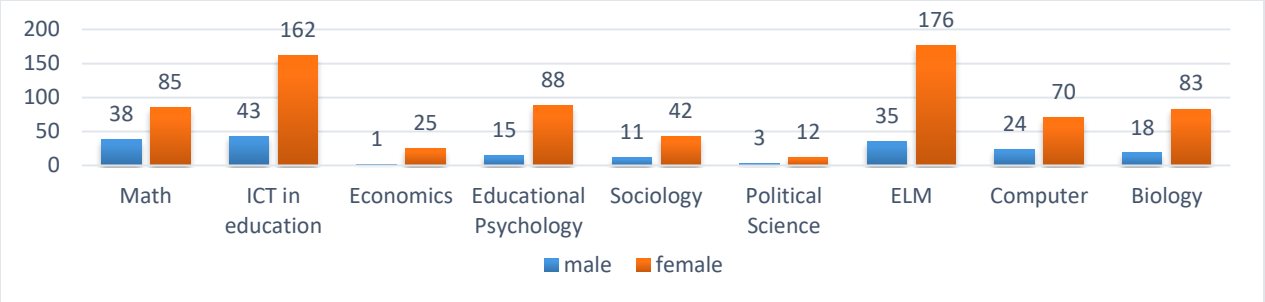

Table 2 reports the prospective teachers' perceptions regarding their AI awareness and their interaction in daily life. The majority (89%) of the respondents are aware of the AI term and consider it will replace their work/job (67%). Half of the respondents use the AI application (49.6%) or product, and most of the participants did not receive any formal qualification regarding AI(51%).

Table 2. *AI Awareness of prospective teachers (n=1019)*

Do you know the term Artificial Intelligence (AI)	f	%
Yes	905	88.8
No	111	10.9
Any comment	3	0.3
Do you think that AI may replace work content?		
Yes	690	67.7
No	329	28.9
Have you previously used an AI application or product?		
Yes	505	49.6
No	514	50.3
Have you previously developed AI products or applications?		
Yes	188	18.4
No	831	81.5
Have you previously interacted with Robots/ AI products?		
Yes	406	39.8
No	610	59.9
Any comments	3	0.3
Have you received any formal education about AI?		
yes	255	25
No	526	51.6
Through seminars and presentations	71	7
Received training through the internet	167	16.4
Total	1019	100

Instrumentation

To collect the data, standardized questionnaires were used in this research. The questionnaire was divided into four parts.

The first part was about the socio-demographic characteristics of the respondents. The second part was regarding the AI awareness of prospective teachers. For this purpose, Syed et al. (2023)

Al-Awareness Questionnaire was adapted and modified to align the objectives and requirements of the study, incorporating 16 items specifically related to AI-awareness. Nine items were based on a five-point Likert scale (Strongly disagree to strongly agree), while six items were dichotomous (Yes, No). However, 1 item related to training has four options.

The third part of the questionnaire, adapted from Wang and Wang (2019) and Trezi, (2020), was used to measure individuals' anxiety about AI. This 21- items scale comprises four sub-factors: AI Learning Anxiety (8 items), Job Replacement Anxiety (6 items), Sociotechnical Blindness (4 items), and AI Configuration Anxiety (3 items).

The fourth part of the questionnaire measured AI Learning Behavior. It is adapted from Wang et al. (2022), consisted of two sub-factors: AI-Learning Intension (3 items) and AI- Learning Behavior (14 items).

Reliability and validity of Instrument

After finalizing the questionnaire, it was sent to three experts (PhD in AI) and subjected to content and face validity. The feedback on a few items was taken into consideration, and the items were revised. Initially, it was a 50-item scale, which was reduced to 47. For reliability, a questionnaire was pilot-tested, and the coefficient of Cronbach alpha for internal consistency of items was measured (Martin, 2020), which is acceptable in quantitative studies and presented in Table 3.

Table 3. *Reliability of the Scale*

Variables	Reliability value	Number of Items
Artificial Intelligence Awareness (AIAwareness)	0.823	9
Artificial Intelligence Anxiety (AIAnxiety)	0.939	21
Artificial Intelligence Learning Behaviour (LB)	0.964	17
Scale	0.931	47

Data Collection

A digital version of the questionnaire was created and distributed online to facilitate data collection. The questionnaire was circulated from July to September 2023, and multiple reminders were sent to students to get the maximum participation. Ethical concerns regarding consent and anonymity were considered, and students were assured to keep using their information for research purposes only.

Data Analysis

The dataset was screened for missing values and outliers and assessed for normality distribution and collinearity (Field, 2013). The data was found to be normal, and no missing items were found. After viewing the graphs resulting from normality tests, the data were analyzed further.

Descriptive Analysis

Descriptive analysis was applied to measure mean scores, standard deviations, and frequencies.

The mean score on each item was above 3.0, which meant that the responses agreed with the variables and these values are presented in Table 4.

Table 4. *Variables Means and SD*

Variables	*M*	*SD*
Artificial Intelligence Awareness (AIA)	3.83	0.58
Artificial Intelligence Anxiety (AI anxiety)	3.23	0.72
Factor-I- Learning	3.12	0.82
Factor-II-Job Replacement	3.56	0.90
Factor-III-socio-technical blindness	3.53	0.90
Factor-IV- AI configuration	3.24	0.93
Learning Behavior (LB)		
Factor1-Learning Intention	3.64	.87
Factor 1-Learning Behavior	3.34	.72

Hypotheses Testing

The coefficient of moderation was applied to find out the role of moderating variable (AI Learning Behaviour) on the AI awareness and AI anxiety

Table 5. *Summary of Model*

R	R-sq	MSE	F	df1	df2	p
0.4046	0.1637	0.4940	66.2343	3.0000	1015.0000	.0000

The model was analyzed using regression in SPSS (version 23.0). The results, presented in Table 5, indicate that the model explains 16.37% of variance ($R^2 = .1637$), demonstrating that, Artificial Intelligence Learning Behavior significantly moderates the relationship between artificial intelligence awareness (AIA) and artificial intelligence anxiety (AIA). This moderation effect is statistically significant ($p < 0.001$).

Table 6. *Coefficient of moderation*

Model	coeff	SE	*T*	*p*	LLCI	ULCI
constant	5.9563	.5623	10.5925	.0000	4.8528	7.0597
S_F1to4	-1.1091	.1726	-6.4268	.0000	-1.4478	-.7705
S_AIA	-.7462	.1336	-5.5834	.0000	-1.0085	-.4839
Int_1	.3348	.0411	8.1393	.0000	.2541	.4155

SE= Standard Error, LCL = Lower Confidence Limit, UCL = Upper Confidence Limit

Table 6 reflects that the moderator variable, artificial intelligence learning behavior, significantly moderates the correlation between artificial intelligence awareness and anxiety. The table also shows that as the moderator increases, the moderating effect also increases. The coefficient value increases from -1=1091 to -.7462 and then to a positive .3348 value. The t values also change from -1.4478 to -1.0085 and then to a positive .2541, respectively. All these values are significant at p<

0.001.

Discussion

Artificial Intelligence (AI) has become an essential component of modern society, shaping and influencing various aspects of human life. As AI technologies continue to advance, understanding the interplay between AI learning behavior, AI awareness, and AI anxiety becomes increasingly important. To the best of our knowledge, this is first kind of study in Pakistan that aimed to explore the awareness, anxiety, and role of AI learning behavior in moderating their relationship. As there is no evidence of similar studies in the education sector, the findings are compared with the other domains to consolidate the findings.

Prospective teachers demonstrate a high self-perceived AI awareness (M = 3.83), which is associated with lower AI anxiety. This finding aligns with Caporusso's (2023) study, which introduces the concept of "Creative Displacement Anxiety"—a fear that individuals may be outperformed by AI across various aspects of life. Stănescu and Romașcanu (2024) found that higher levels of AI anxiety negatively correlate with positive attitudes toward AI, suggesting that anxiety can impede effective learning and engagement with AI technologies. Similarly, Chen et al. (2024) asserted that awareness of AI capabilities helps mitigate anxiety, ultimately enhancing students' learning outcomes. These findings align with the results of the present study. IIKKA (2018) explained that a systemic level, AI is set to transform education system profoundly. This shift is not o soley due to AI' intrinsic characteristics but rather because AI represents broader digital transformation).

Implications

Findings from this study indicate that AI learning behavior significant moderates the relationship between artificial intelligence awareness and artificial intelligence anxiety, and guided application of AI is required at all levels. It requires the need for guided AI integration at all levels of education to ensure its effective adoption and utilization. However, data collection was limited to a particular online university, which may impact the generalizability of findings. Further studies with larger and diverse sample may indicate different results. Cross-tabulation with different faculties might provide further insights into AI-related attitudes and behaviors across disciplines.

The increasing penetration of information technology (IT) in Pakistan and other developing countries is gradually paving the way for greater acceptability and readiness for AI-driven innovations and education. As technology continues to advance, it is only a matter of time before AI becomes an integral part of the Pakistan education sector or beyond.

Limitations

Although this study provides valuable insights into the role of AI learning behavior in the relationship between AI awareness and AI anxiety, it has certain limitations. Firstly, it relies on self-perceived awareness and anxiety level of prospective teachers only in ODL. Secondly, studies could benefit from incorporating a qualitative viewpoint and including other stakeholders. Lastly, the generalizability of the study is possible for Pakistan; further studies may be repeated, including student-teachers from other countries and even with different variables.

Conclusion and recommendations

The study reveals that learning behavior significantly moderates the correlation between artificial intelligence and artificial awareness. The more the trend of online education increases, the more the learning behaviors will develop. Once the learning behavior is developed, the artificial intelligence anxiety will start decreasing gradually. The scope of this study was totally quantitative; it is recommended to add semi-structured interviews of a few learners to identify the learning behaviors and patterns. The more awareness is spread; the more anxiety levels will be reduced. The researchers recommend a longitudinal study to examine the real effect of learning behaviors on awareness and anxiety related to artificial intelligence. The sooner education institutions shift towards artificial intelligence; the sooner it will help them improve the learning outcomes of their students.

Conflict of interest

The authors have not reported any financial or personal relationships with individuals or organizations that could influence the research.

Data availability statement

The data is available upon reasonable request to the corresponding author.

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