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The mediating effect of self-efficacy on the relationship between digital literacy and artificial intelligence anxiety in nursing students

Gamze Akay^{1*} , Uğur Saruhan² , Yeşim Saruhan² , Elif Simay Koç³ and Hatice Oğuzhan²

Abstract

Objective The integration of digital technologies and artificial intelligence (AI) into healthcare has transformed nursing education, while also raising concerns about AI-related anxiety among students. This study aimed to examine the mediating role of self-efficacy in the relationship between digital literacy and AI anxiety among nursing students.

Methods This correlational study was conducted with 319 undergraduate nursing students enrolled at two universities in Türkiye. Data were collected using the Artificial Intelligence Anxiety Scale, Digital Literacy Scale, and Student Self-Efficacy Scale. Pearson correlation analysis and regression-based mediation analysis were performed using PROCESS macro (Model 4) with 5000 bootstrap samples.

Results Digital literacy was negatively associated with AI anxiety ($r = -.20, p < .01$) and positively associated with self-efficacy ($r = .54, p < .01$). Self-efficacy was also negatively related to AI anxiety ($r = -.23, p < .01$). Mediation analysis revealed that self-efficacy fully mediated the relationship between digital literacy and AI anxiety. While the total effect of digital literacy on AI anxiety was significant ($B = -0.40, p < .001$), the direct effect became nonsignificant after controlling for self-efficacy, whereas the indirect effect through self-efficacy remained significant ($B = -0.19, 95\% \text{ CI } [-0.35, -0.05]$).

Conclusions Self-efficacy plays a critical mediating role in the relationship between digital literacy and AI anxiety among nursing students. Interventions aimed at enhancing both digital literacy and self-efficacy may be effective in reducing AI-related anxiety and supporting nursing students' psychological adaptation to emerging technologies.

Keywords Artificial intelligence, Anxiety, E-literacy, Self-efficacy, Nursing students

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Introduction

Today, healthcare services are undergoing a process of change in which digital transformation is accelerating and technological innovations are reshaping care processes [1]. This transformation directly affects the nursing profession, one of the fundamental components of healthcare delivery, and is redefining the professional roles of nurses [2]. The increasing integration of artificial intelligence (AI)-based technologies into clinical practice not only requires nurses to work with new tools but also affects their perceptions of these technologies, their assessments of their competence, and their adaptation processes to change [3]. In this respect, the increasing visibility of digital transformation and artificial intelligence in the nursing profession can be considered a multidimensional phenomenon that influences not only clinical practice but also individuals' psychological and cognitive adaptation processes. Indeed, the limited level of knowledge regarding artificial intelligence among nurses working in Türkiye, along with ongoing concerns related to adherence to ethical principles and data privacy [4], suggests that this transformation may also affect individuals' cognitive appraisals and psychological responses.

As AI-based applications become increasingly prominent in clinical settings and working with these systems introduces new learning and adaptation demands, they may contribute to heightened perceptions of uncertainty, particularly among nursing students with limited professional experience. This context may therefore provide an important framework for understanding the experience of anxiety related to artificial intelligence [5].

AI anxiety is defined as a multidimensional psychological response stemming from feelings of uncertainty, loss of control, and inadequacy experienced by individuals when interacting with AI-based technologies [6]. This response may include concerns about the transformation of professional roles, the devaluation of human labor, and the potential reduction of autonomy in decision-making processes, in addition to the cognitively demanding nature of the technology [7]. For nursing students, this anxiety may become more pronounced as artificial intelligence this document. becomes increasingly integrated into clinical practice during a period when their professional identity is still developing. This is because AI-supported applications, while having the potential to support learning and care processes, may also trigger perceptions of inability to adapt to these technologies, making mistakes, or insufficient professional competence [8]. In this context, AI anxiety can be associated with difficulties in learning processes, uncertainty about professional future perceptions, and avoidance tendencies towards technological change [9]. In the long term, this anxiety may lead students to distance themselves from technology based

clinical applications, weaken their perceptions of competence, and negatively impact their professional adaptation processes [10–12].

Social Cognitive Theory (SCT) assumes that an individual's emotions and behaviors are shaped by the interaction of environmental demands, cognitive resources, and self-regulatory beliefs [13]. According to this theory, whether or not an individual experiences anxiety in a given situation may be closely related to the extent to which they perceive the situation as threatening and their beliefs about their ability to cope with these demands [14]. When considered in the context of artificial intelligence, the complexity and uncertainty of technology, when assessed as an environmental demand beyond the individual's control, may trigger artificial intelligence anxiety [15]. In this context, digital literacy may enhance an individual's perceived competence in interacting with artificial intelligence, thereby contributing to a reduction in perceived threat and a subsequent decrease in anxiety. Accordingly, within the framework of Social Cognitive Theory (SCT), digital literacy and self-efficacy can be considered as two complementary core mechanisms in explaining artificial intelligence anxiety.

Digital literacy and artificial intelligence anxiety

The increasing prevalence of digital technologies and AI-based applications in the health sector requires individuals not only to use these systems but also to understand, evaluate, and cope with the problems they encounter [16]. In this context, digital literacy, which encompasses individuals' capacity to access information in digital environments, use technological tools effectively, solve technical difficulties they encounter, and critically evaluate digital content, emerges as a decisive area of competence in terms of the psychological responses individuals develop when confronted with artificial intelligence [17]. The complex structure and uncertain functioning of artificial intelligence systems can complicate the learning process for individuals with limited digital learning and problem-solving experience; this can lead to technology being perceived as an uncontrollable demand [18]. In contrast, individuals who are more equipped in learning, problem solving, and information evaluation in digital environments may perceive AI-based applications as more predictable and manageable [19]. This difference may suggest that concerns about artificial intelligence are related not so much to the technology itself, but rather to how individuals interpret digital demands and their assessments of their ability to cope with these demands [20]. Therefore, digital literacy, as a resource that plays a role in the cognitive structuring of uncertainty and threat perception regarding artificial intelligence, can provide a meaningful framework for explaining artificial intelligence anxiety.

Within this framework, it is emphasized that individuals' cognitive appraisal processes play a decisive role in the development of technology-related anxiety [21, 22]. Therefore, differences in levels of digital literacy may provide a functional basis for explaining why individuals experience anxiety toward artificial intelligence in varying ways.

Self-efficacy as a mediator in the relationship between digital literacy and AI anxiety

Current approaches to understanding the effects of digital transformation on individuals require considering not only what individuals know when confronted with these technologies, but also the extent to which they believe they can effectively use this knowledge and these skills [23]. In this context, self-efficacy represents a fundamental psychological mechanism that reflects an individual's subjective evaluation of their ability to cope with emerging technological demands [24]. General self-efficacy, in particular, may be considered a broader personal resource that reflects an individual's capacity to manage novel and uncertain situations, rather than competence related to a specific technology. In the context of artificial intelligence, this perception of competence may influence anxiety levels by shaping the extent to which individuals feel capable and in control when confronted with emerging cognitive demands. Therefore, general self-efficacy is regarded as an appropriate psychological resource that reflects individuals' capacity to cope with the demands of new, complex, and uncertainty-laden technological environments such as artificial intelligence, and is consequently examined as a mediating variable in the present study.

Individuals with higher levels of self-efficacy tend to perceive AI-based systems as more manageable and learnable [10]. This perception may contribute to construing technological demands as manageable rather than threatening, thereby fostering lower levels of anxiety [25]. In this regard, self-efficacy can be viewed as a key personal resource that not only supports the functional use of digital literacy skills but also regulates psychological responses to artificial intelligence [26].

From this perspective, it can be argued that the relationship between digital literacy and artificial intelligence anxiety may be shaped through self-efficacy beliefs. Digital skills and technological experiences may inform individuals' evaluations of their effectiveness in interacting with AI-based systems; in turn, these evaluations play a decisive role in whether such technologies are perceived as threatening or manageable [27]. This relational pattern is consistent with the core assumptions of Social Cognitive Theory.

Within this framework, digital literacy may provide individuals with the capacity to understand the

functioning of AI-based systems and to accurately identify the cognitive demands they impose [16]. However, the extent to which this capacity translates into reduced anxiety depends on individuals' beliefs about their ability to effectively cope with these demands. Therefore, self-efficacy can be considered a fundamental psychological mechanism that explains the effect of digital literacy on artificial intelligence anxiety.

Current study

Previous studies have shown that AI-based technologies are increasingly used among university students and that these technologies significantly affect learning, decision-making, and professional preparation processes [28, 29]. However, interaction with artificial intelligence does not produce the same experience for every student; it has been observed that it can be associated with negative psychological responses such as uncertainty, loss of control, and anxiety in some individuals [6, 9]. This situation has led to artificial intelligence anxiety being addressed as an important problem area that can negatively affect students' learning processes, attitudes toward technology, and professional adaptation [7].

The quality of healthcare services in Türkiye largely depends on the adequacy of a qualified healthcare workforce [30]. According to data from the Turkish Statistical Institute (TÜİK), graduates in the field of health and welfare have the highest employment rate (86.7%) [31], highlighting the strategic importance of this sector within the labor market. Therefore, understanding nursing students' adaptation to emerging technologies and the psychological dynamics accompanying this process may be considered a critical determinant of the quality, safety, and effectiveness of future healthcare delivery, given that these students represent the next generation of the healthcare workforce.

A review of the existing literature indicates that studies examining the determinants of artificial intelligence anxiety remain limited, with insufficient attention given to the underlying psychological mechanisms that may explain this phenomenon. A substantial proportion of previous research has addressed attitudes toward and anxiety related to artificial intelligence at a descriptive level; however, model-based approaches that clarify how these relationships emerge and through which psychological processes they operate remain scarce. In particular, the limited number of studies testing mediating variables may constrain theoretical advancement in this field. Furthermore, current research has largely focused on general student populations or various professional groups, whereas studies specifically targeting nursing students remain relatively scarce. Yet, nursing students may be among the groups most profoundly affected by this transformation, as they are expected to transition

directly into healthcare systems where AI-based technologies are being rapidly integrated.

Additionally, the literature reveals a notable lack of comprehensive models grounded in theoretical frameworks, such as Social Cognitive Theory, that examine digital literacy, self-efficacy, and artificial intelligence anxiety within an integrated perspective. This gap highlights the need to conceptualize artificial intelligence anxiety not only in cognitive terms but also within the broader context of motivational and self-regulatory processes. In this regard, rather than explaining artificial intelligence anxiety solely through the characteristics of the technology itself, it is essential to consider how individuals appraise these technological demands and the personal resources that enable them to cope effectively with such challenges.

Accordingly, the present study aims to examine the mediating role of self-efficacy in the relationship between digital literacy and artificial intelligence anxiety within the framework of Social Cognitive Theory. By moving beyond an exclusive focus on the complexity of technology, this approach seeks to contribute to the literature by conceptualizing AI anxiety as a process shaped by individuals' interpretations of digital demands and their perceived capacity to cope with them. The research hypotheses are formulated as follows:

H1a: There is a statistically significant relationship between digital literacy and self-efficacy.

H1b: There is a statistically significant relationship between self-efficacy and artificial intelligence anxiety.

H1c: There is a statistically significant relationship between digital literacy and artificial intelligence anxiety.

H2: Self-efficacy is hypothesized to mediate the relationship between digital literacy and artificial intelligence anxiety.

Method

This study is a correlational research that aims to reveal the relationships between individuals' digital literacy, self-efficacy, and artificial intelligence anxiety. Correlational studies are research types that aim to determine the existence, direction, and strength of relationships between two or more variables and focus on explaining the patterns exhibited between variables [32]. The reporting of this study was guided by the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for observational studies.

Research population and sample

The target population of the study consisted of undergraduate students enrolled in the Nursing Departments of two universities located in the Black Sea Region of Türkiye during the 2025–2026 academic year. Within this context, the accessible population comprised 600 students. The study sample included students selected from

this population who agreed to participate and were voluntarily included in the research.

The adequacy of the sample size was assessed in a priori power analysis conducted using G*Power 3.1. Based on a regression-based mediation model with two predictor variables, the minimum required sample size was calculated as 188 under the parameters of a medium effect size ($f^2 = 0.15$), a significance level of $\alpha = 0.01$, and a statistical power of 0.99. Since the actual sample size ($N = 319$) exceeded this threshold, it was considered to have sufficient statistical power for the analyses.

During the data collection process, data were obtained from 323 out of 600 eligible students, yielding a response rate of 53.8%. Following the data cleaning procedure, data from four participants were excluded due to outliers and violations of assumptions, and the final analyses were conducted with 319 participants.

Data collection tools

The research data was collected using the Personal Information Form prepared by the researchers, along with the Artificial Intelligence Anxiety Scale, Digital Literacy Scale, and Self-Efficacy Scale. The Personal Information Form consists of three questions containing information about the participants' age, gender, and grade level.

Artificial Intelligence Anxiety Scale: The Artificial Intelligence Anxiety Scale (AIAS) was developed by Wang and Wang to measure individuals' levels of anxiety towards artificial intelligence [7]. The Turkish validity and reliability study of the scale was conducted by Akkaya, Özkan, and Özkan (2021) [6]. The AAI consists of a total of 16 items on a 5-point Likert scale and includes four subscales: learning, socio-technical blindness, labor force replacement, and artificial intelligence configuration. The lowest possible score on the scale is 16, and the highest possible score is 80. A high score indicates high artificial intelligence anxiety. The Cronbach's alpha coefficient for the total scale score was reported as $\alpha = 0.937$. The Cronbach's Alpha values for the sub-dimensions were found to be 0.948 for learning, 0.895 for labor force replacement, 0.875 for socio-technical blindness, and 0.950 for artificial intelligence configuration, respectively [6]. In the present study, subscale scores were not analyzed separately; instead, only the total scale score was used in the analyses. Based on the results of this study, the Cronbach's alpha coefficient for the total scale score was calculated as 0.947.

Digital Literacy Scale (DLS): Developed by Ng (2012) and adapted into Turkish by Hamutoğlu et al. (2017), the Digital Literacy Scale (DLS) consists of a total of 17 items on a 5-point Likert scale [17, 33]. The scale consists of four subscales: attitude (items 1–7), technical (items 8–13), cognitive (items 14–15), and social (items 16–17). The total score that can be obtained from the scale ranges

from 17 to 85, and the higher the score, the higher the level of digital literacy. In the Turkish adaptation study of the scale, the internal consistency coefficients for the subscales were reported as 0.88 for the attitude subscale, 0.89 for the technical subscale, 0.70 for the cognitive subscale, and 0.72 for the social subscale [17]. In the present study, however, subscale scores were not evaluated separately; instead, only the total scale score was used in the analyses. As a result of the analyses in this study, the Cronbach's alpha value for the total score of the scale was calculated as 0.837.

Student Self-Efficacy Scale: The Turkish adaptation of the Student Self-Efficacy Scale, developed by Rowbotham and Schmitz in 2013, was conducted by Yurtçiçek Eren and Başgöl in 2023 [34, 35]. The scale consists of a single sub-dimension and comprises 10 items. The original scale was developed for nursing students. The scale is prepared in a 4-point Likert format, with response options ranging from “1: Strongly Disagree” to “4: Strongly Agree.” There are no items in the scale that need to be reverse-coded. The total scores that can be obtained from the scale range from 10 to 40. Higher scale scores indicate that the individual has a high sense of self-efficacy [24]. As a result of the analyses in this study, the Cronbach's alpha value for the total score of the scale was calculated as 0.805.

Data collection process

Data were collected using an online survey form (Google Forms) that included a Personal Information Form and the measurement scales used in the study. Data collection was conducted online at a single time point during the spring semester of the 2025–2026 academic year, following approval from the institutional ethics committee. Prior to participation, students were informed about the purpose and scope of the study, as well as the voluntary nature of their involvement.

The survey link was distributed through class communication groups via student representatives. Participation was entirely voluntary, and students were explicitly informed that choosing not to participate would not result in any academic or administrative consequences. To minimize any potential perceived pressure, faculty members were not directly involved in the data collection process and were not granted access to individual participation information.

Students who voluntarily agreed to participate were asked to complete the survey after providing electronic informed consent by approving the online consent form. The data collection process was designed to allow participants to respond anonymously and in their own environments, thereby promoting privacy and minimizing response bias.

Data analysis

Before proceeding with data analysis, the data obtained from 323 participants were entered into a computerized dataset. The relationships among variables were examined using Pearson correlation analysis. Considering that the study hypotheses were evaluated using regression-based mediation models, the assumptions of regression analysis were tested.

Standardized z-scores were used to identify univariate outliers, and observations exceeding the threshold of $|z| > 3$ were considered outliers [36]. As a result of these procedures, data from four participants who violated the assumptions of outliers and normality were excluded, and the analyses were conducted on data from 319 participants. The independence of errors assumption was evaluated by examining the Durbin–Watson coefficient. This coefficient was found to be 1.130, which falls within the recommended range of 1 to 3 [37]. Therefore, the independence of error terms was assumed.

Prior to the regression analyses, the assumption of multicollinearity was examined. The tolerance values for the independent variables were found to be above 0.20 (Tol = 0.71), and the variance inflation factor (VIF) values were below 5 (VIF = 1.41). These findings indicate that there was no multicollinearity problem in the model [38–40]. The mediating role of self-efficacy in the relationship between digital literacy and artificial intelligence anxiety was examined using regression-based mediation analysis with PROCESS Macro Model 4, developed by Hayes (2013) [41]. The significance of the indirect effects was evaluated using bootstrap confidence intervals based on 5,000 resamples, and intervals that did not include zero were considered indicative of a statistically significant mediating role [42, 43]. All analyses were conducted using the SPSS 27 statistical software package.

Ethics approval and consent to participate

This study was submitted to and approved by the Scientific Research and Publication Ethics Committee of Gümüşhane University (Approval date: 30 October 2025; Meeting no: 2025/8; Decision no: E-95674917-108.99-379360). Institutional permission was obtained from the relevant institutions prior to data collection. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and with the principles of the Declaration of Helsinki. The purpose and procedures of the study were clearly explained to all participants, and written informed consent was obtained from all participants prior to their inclusion in the study. Participation was entirely voluntary, and confidentiality and anonymity were assured.

Table 1 Demographic information of the students participating in the study

Variable	n	%
Gender		
Female	235	73,7
Male	84	26,3
Grade		
1st grade	76	23,8
2nd grade	65	20,4
3rd grade	74	23,2
4th grade	104	32,6
Total	319	100

Results

Table 1 shows that the research sample consisted of 319 university students. Of the participants, 235 (73.7%) were female and 84 (26.3%) were male. When examining the distribution by grade level, it was determined that 23.8% of the participants were in their first year, 20.4% were in their second year, 23.2% were in their third year, and 32.6% were in their fourth year. Furthermore, the average age of the participants was 20.59 ± 1.75 .

This section presents the findings obtained from statistical analyses conducted on the data collected in line with the research objective. The correlations and descriptive

Table 3 Total, direct, and indirect effects of digital literacy on artificial intelligence anxiety through self-efficacy ($n = 319$)

	Unstandardized β Coefficient	SE	LLCI	ULCI
DL→AIA Total Effect	-,040	0.11	-,0.6128	-,0.1848
DL → AIA Direct Effect	-,0.21	0.13	-,0.4642	,0.0394
Total Indirect Effect				
DL→SE→AIA	-,0.19	0.08	-,0.3525	-,0.0538

Note: DL: Digital literacy, SE: Self-efficacy, AIA: Artificial intelligence anxiety, LLCI= Bootstrap Confidence Interval Lowest Value, ULCI= Bootstrap Confidence Interval Highest Value, SE= Standard Error

statistics of the variables are presented in Table 2. The results regarding the mediating role of self-efficacy in the relationship between digital literacy and artificial intelligence anxiety are shown in Fig. 1. Additionally, the total, direct, and indirect effects of digital literacy on artificial intelligence anxiety through self-efficacy are reported in Table 3.

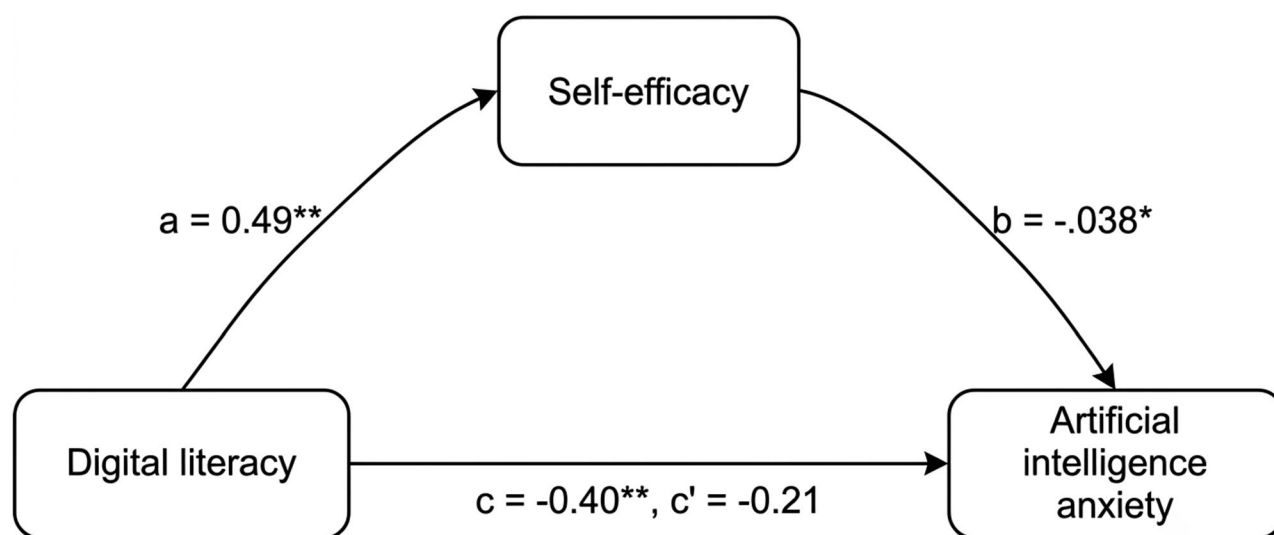
Table 2 shows that the skewness and kurtosis values fall within the ± 1.5 range, indicating that the variables meet the assumption of normal distribution.

According to the Pearson correlation analyses, the relationship between digital literacy and artificial intelligence anxiety was statistically significant, although the

Table 2 Correlations and descriptive statistics for variables ($n = 319$)

Variables	Mean	SD	Skewness	Kurtosis	1	2	3
1. Digital Literacy	3.71	0.41	0.08	0.47	—		
2. Artificial Intelligence Anxiety	3.14	0.80	-0.33	-0.27	-0.20**	—	
3. Self-Efficacy	2.90	0.36	-0.12	1.46	0.54**	-0.23**	—

Note. N = 319. Mean = Average; SD = Standard deviation. ** $p < .01$



Note. N = 319, a = path from X to M; b = path from M to Y; c = total effect; c' = direct effect. ** $p < .001$, * $p < .01$.

Fig. 1 Unstandardized regression coefficients for the mediating effect of self-efficacy on the relationship between digital literacy and AI anxiety

correlation coefficient was small ($r = -.20, p < .01$), indicating a limited effect size. In contrast, a positive and strong statistically significant relationship was found between digital literacy and self-efficacy ($r = .54, p < .01$). Furthermore, self-efficacy was negatively and weakly, yet significantly, associated with artificial intelligence anxiety ($r = -.23, p < .01$).

Table 3 presents the regression results for the total, direct, and indirect effects of digital literacy on artificial intelligence anxiety. In the model examining the effect of digital literacy on self-efficacy, the proportion of explained variance was $R^2 = 0.29$. Accordingly, a positive and statistically significant relationship was observed between digital literacy and self-efficacy ($B = 0.49, SE = 0.04, t = 11.42, p < .001, \beta = 0.54$).

In the total effect model, a negative and statistically significant relationship was found between digital literacy and artificial intelligence anxiety ($B = -0.40, SE = 0.11, t = -3.67, p < .001, \beta = -0.20$). The 95% confidence interval for the total effect $[-0.6128, -0.1848]$ does not include zero, indicating that this relationship is statistically significant. The total effect model also showed a small effect size ($R^2 = 0.04$).

When self-efficacy was included in the model, the direct effect of digital literacy on artificial intelligence anxiety became non-significant ($B = -0.21, SE = 0.13, t = -1.66, p = .098, \beta = -0.11$). The 95% confidence interval for the direct effect $[-0.4642, 0.0394]$ includes zero, confirming the lack of statistical significance. In contrast, a negative and significant relationship was observed between self-efficacy and artificial intelligence anxiety ($B = -0.38, SE = 0.14, t = -2.70, p < .01, \beta = -0.17$). The full model including both the independent and mediator variables explained $R^2 = 0.06$ of the variance.

The indirect effect analyses indicated that digital literacy is indirectly related to artificial intelligence anxiety through self-efficacy. Using bootstrap resampling with 5,000 samples, the indirect effect was found to be statistically significant ($B = -0.19, SE = 0.08, \beta = -0.09$). The 95% confidence interval for the indirect effect $[-0.3525, -0.0538]$ does not include zero, demonstrating that self-efficacy plays a significant mediating role in this relationship.

When evaluated according to conventional effect size criteria (Cohen, 1988), the model examining the relationship between digital literacy and self-efficacy showed a large effect size ($R^2 = 0.29$), whereas the total effect model of digital literacy on artificial intelligence anxiety showed a small effect size ($R^2 = 0.04$). The full model including both independent and mediator variables also exhibited a small effect size ($R^2 = 0.06$) [44].

Discussion

The increasing use of artificial intelligence (AI) in nursing education has the potential to influence students' learning outcomes, knowledge and skill acquisition, as well as their attitudes toward AI, trust in AI systems, and self-efficacy levels [45]. In the present study, the mediating role of self-efficacy in the relationship between digital literacy and AI anxiety among nursing students was examined. The findings obtained from the study are discussed in light of the relevant literature.

AI anxiety is a relatively new concept, generally characterized by feelings of fear and unease regarding the integration of AI into society. Concerns about AI often stem from misconceptions regarding the capabilities of related technologies, while sensationalized media narratives and the inherent complexity of AI systems may further amplify these anxieties. The interaction of these factors may contribute to a lack of understanding and increased apprehension toward AI among individuals [46].

The present study identified a statistically significant negative relationship between digital literacy and AI anxiety. A study conducted among nursing students in Jordan reported that digital literacy was a significant predictor of intention to use AI, whereas AI-related anxiety negatively influenced usage intention and acted as a barrier to the adoption of these technologies [47]. Similarly, a study involving university students found a weak but significant negative association between digital literacy and AI anxiety [48]. In addition, another study demonstrated that digital literacy was positively associated with nursing students' trust in AI-based applications [49]. These findings from the literature support the results of the present study [47–49].

In this study, the effect size of the relationship between digital literacy and AI anxiety was found to be relatively small, and the proportion of variance explained by the total effect model was limited. This finding suggests that digital literacy alone may not be sufficient to explain AI anxiety. Although digital literacy appears to be an important factor in reducing AI anxiety, AI anxiety itself should be understood as a more complex and multidimensional construct. Demir-Kaymak et al. (2024) emphasized that AI anxiety is influenced not only by individuals' level of knowledge but also by multiple factors, including daily AI usage, perceived professional threat, and trust in AI systems [50].

Discussion of the mediating role of self-efficacy in the relationship between digital literacy and AI anxiety

Digital literacy, within the context of library and information sciences, refers to the effective use of critical thinking skills in the creation and sharing of information through digital devices and platforms [51]. In the present study, a positive and significant relationship was

identified between nursing students' digital literacy and self-efficacy levels. The relatively higher proportion of explained variance in the model examining the effect of digital literacy on self-efficacy suggests that digital literacy may be more strongly associated with individuals' perceptions of their own competence. This finding indicates that digital literacy may enhance students' confidence in managing technology, using digital tools effectively, and adapting to emerging learning demands. Similarly, Solahudin et al. (2022) reported a positive and significant relationship between digital literacy and students' self-efficacy perceptions [52]. Likewise, Zakir et al. (2025) found that digital literacy had a positive and statistically significant effect on online learning self-efficacy [53].

With the increasing prevalence of AI technologies, individuals' beliefs in their ability to use these technologies effectively—that is, their self-efficacy perceptions—play a critical role in technology-based learning environments [54]. In this context, self-efficacy may be considered an important protective factor that reduces individuals' anxiety toward AI [10]. In the present study, a negative relationship was identified between nursing students' self-efficacy levels and AI anxiety, indicating that higher levels of self-efficacy were associated with lower levels of anxiety toward AI. This finding is consistent with previous studies reported by Varol (2025) and Chen et al. (2024) [10, 55]. Similarly, Obateru et al. (2025) reported that digital literacy was associated with AI anxiety among university students, with higher digital literacy levels linked to greater confidence in AI and reduced anxiety [56].

The findings of this study further demonstrate that self-efficacy plays a mediating role in the relationship between digital literacy and AI anxiety. Accordingly, as digital literacy increases, individuals' perceptions of self-efficacy appear to strengthen, and this enhanced self-efficacy functions as a mechanism that helps reduce anxiety related to AI. This finding can be interpreted more comprehensively within the framework of Social Cognitive Theory. According to this theory, individuals' behaviors and emotional responses are shaped through their self-efficacy beliefs [13]. In this context, individuals with higher levels of digital literacy may be more likely to perceive AI technologies as useful and easier to use [57].

Access to digital technologies, the degree of technology integration within educational systems, and broader societal attitudes toward technology may all influence individuals' levels of digital literacy and self-efficacy perceptions. This suggests that perceptions of AI, attitudes toward technology, and patterns of technology interaction may be shaped by cultural context [58, 59]. Therefore, although the mediating role of self-efficacy may represent a universal psychological mechanism, the way

this mechanism operates and the strength of its effects may vary depending on cultural factors.

Structured and practice-based AI education may contribute to reducing students' technological anxieties and preparing them for healthcare environments in which AI is increasingly integrated. The incorporation of applications such as virtual patient simulations, AI-assisted clinical decision-making tools, and AI-based communication assessment systems into nursing curricula may provide students with valuable hands-on experience with emerging technologies [45]. Furthermore, Erkeyiran (2025) demonstrated that integrating AI-supported assessment tools into standardized patient-based educational processes represents an effective and feasible approach for enhancing and objectively evaluating nursing students' therapeutic communication skills [60].

Limitations/strengths

This study has several limitations that should be considered when interpreting the findings. The use of a convenience sampling method may have increased the risk of selection bias. In particular, students with greater interest in digital technologies or those who are more active users of online platforms may have been more likely to participate in the study. Therefore, caution should be exercised when generalizing the findings to the broader population of nursing students. Additionally, the cross-sectional design of the study, the reliance on self-reported data, and the use of a single sample group constitute further limitations. Furthermore, the proposed model captures only a specific cognitive–motivational pathway underlying artificial intelligence anxiety, and a substantial proportion of the variance may be explained by other factors such as professional identity concerns, ethical dilemmas, clinical readiness, and technology-related professional competencies.

Despite these limitations, this study makes an important contribution to the existing literature by simultaneously examining the relationships among digital literacy, self-efficacy, and artificial intelligence anxiety among nursing students, and by demonstrating the mediating role of self-efficacy in this relationship.

Conclusion

In conclusion, as digital literacy levels increase, nursing students' concerns about artificial intelligence decrease; this relationship is largely shaped through students' perceptions of self-efficacy. The fact that the direct effect of digital literacy on AI anxiety loses its significance when self-efficacy is included in the model indicates that self-efficacy is a fully mediating variable in this relationship. These results stem from the fact that anxiety towards AI-based technologies develops not only based on the complexity of the technology but also on the individual's

belief in their ability to cope with these technologies. Digital literacy contributes to nursing students' better understanding of artificial intelligence systems and their perception of these systems as more predictable and controllable, while self-efficacy plays a critical role in transforming these cognitive gains into an anxiety-reducing effect. In this context, addressing digital literacy and self-efficacy together in nursing education contributes significantly to the development of holistic and sustainable educational strategies aimed at reducing artificial intelligence anxiety among nursing students.

Based on these findings, greater emphasis should be placed in nursing education on practical training aimed at enhancing digital literacy and self-efficacy, including AI-based simulations and technology-supported learning experiences. Supporting students' confidence in their ability to use AI systems safely and effectively may contribute to reducing AI-related anxiety.

Furthermore, future research is recommended to examine additional factors, such as ethical concerns, trust in technology, and perceptions of professional identity, in order to provide a more comprehensive understanding of the determinants of AI anxiety.

Abbreviations

AI	Artificial Intelligence
SCT	Social Cognitive Theory
AIAS	The Artificial Intelligence Anxiety Scale
DLS	Digital Literacy Scale
DOY	Digital literacy
SE	Self-efficacy
AIA	Artificial Intelligence Anxiety
LLCI	Bootstrap Confidence Interval Lowest Value
ULCI	Bootstrap Confidence Interval Highest Value
SE	Standard Error

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Author contributions

GA, US, YS, HO and E.S.K. led the conception and design of the study, as well as the acquisition and analysis of data, and drafted the manuscript. GA, and US contributed to the design of the study and provided critical revisions to the manuscript. GA, US and H.O. assisted with data acquisition and contributed to the analysis. GA, US, YS, HO and E.S.K. provided significant input in the interpretation of data and helped to revise the manuscript for important intellectual content. All authors read and approved the final version of the manuscript.

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Data availability

Due to ethical restrictions and the need to protect participant confidentiality, the datasets generated and/or analysed during the current study are not publicly available. However, they are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was submitted to and approved by the Scientific Research and Publication Ethics Committee of Gümüşhane University (Approval date: 30

October 2025; Meeting no: 2025/8; Decision no: E-95674917-108.99-379360). Institutional permission was obtained from the relevant institutions prior to data collection. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional and/or national research committee and with the principles of the Declaration of Helsinki. The purpose and procedures of the study were clearly explained to all participants, and written informed consent was obtained from all participants prior to their inclusion in the study. Participation was entirely voluntary, and confidentiality and anonymity were assured.

Consent for publication

Not applicable.

Informed consent

Written consent has been obtained from the participants.

Competing interests

The authors declare no competing interests.

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