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The mediating digital literacy and the moderating role of academic support in the relationship between artificial intelligence usage and creative thinking in nursing students

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Abstract

Background Artificial intelligence can be an important tool in developing creative thinking while supporting individualized learning and problem-solving skills in educational processes. However, the effect of artificial intelligence on creative thinking may differ depending on factors such as students' digital literacy level and the academic support they receive. In this context, how artificial intelligence can encourage creative thinking in educational processes and how this process is shaped by digital literacy and academic support stands out as an issue to be investigated.

Purpose This study artificial intelligence to determine the effect of artificial intelligence use on creative thinking skills in nursing students, the mediating role of digital literacy in this effect, and the situational mediating effect of academic support.

Method This cross-sectional and descriptive correlational study was conducted with 426 nursing students from three universities in different regions of Turkey during the fall semester of 2024–2025. Simple random sampling method was used. Data were collected through demographic information form and four valid and reliable scales.

Result Research findings show that using artificial intelligence substantially and significantly affects Creative Thinking ($\beta = 0.70$, $p < 0.001$). Digital literacy plays mediating role in this relationship, indirectly strengthening the effect of artificial intelligence use on creative thinking ($\beta = 0.422$, LLCI = 0.357, ULCI = 0.490). As a moderating factor of this relationship, the academic support creates a more limited effect at low levels of academic support (Effect = 0.224). At the same time, it maximizes this effect at high levels of support (Effect = 0.298).

Conclusion The effect of artificial intelligence use on Creative Thinking is significantly strengthened by the mediating role of digital literacy and the moderating role of academic support. These findings suggest that developing digital

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skills and strengthening academic support mechanisms are critical to integrating artificial intelligence technologies into educational processes.

Highlights

- Artificial intelligence significantly increases the creative thinking tendencies of nursing students both directly and through digital literacy.
- The academic support is a critical factor that strengthens the development of creative thinking skills by regulating the effect of artificial intelligence usage on digital literacy.
- Integrating artificial intelligence applications into the curriculum and developing digital literacy skills in nursing education programs can potentially increase the creative thinking and problem-solving competencies of 21st-century health professionals.

Keywords Artificial intelligence usage, Creative thinking, Digital literacy, Academic support, Nursing students

Background

In today's world, where health education is rapidly digitalized, nursing students can significantly contribute to their profession by mainaining their creative thinking skills while developing their professional skills. Some studies conducted at this point also support this view [1, 2]. At this point, the effect of Artificial Intelligence (AI) can make a profound difference. However, there are uncertainties about how the increasing integration of AI into educational environments affects students' creative thinking processes. Moreover, students' digital literacy levels and the academic support they receive may shape this interaction positively or negatively. As a result, in parallel to determining the effect of AI use on creative thinking skills in nursing students, the mediating role of digital literacy in this effect and the situational mediating effect of academic support is aimed at understanding the factors that strengthen or limit the creativity in the educational processes of AI technologies, to develop current pedagogical strategies in nursing education and to develop suggestions that will guide for increasing students' competencies suitable for the digital age.

As a broad field of study that includes many theoretical and applied methods based on efforts to imitate and expand human intelligence, AI has become a concept frequently used in almost every aspect of life today [3]. AI applications have revolutionary effects in many sectors, such as health, transport, education, and finance. In this context, AI research aims to investigate methods and technologies that simulate, extend, and improve human intelligence [4]. In the education sector and curriculum, AI is used for student grading and evaluations, student attendance tracking, sentiment analysis, smart tutoring, class monitoring, research trends and process tracking, and suggestion systems [5].

It is stated that with the increase in digitalization in healthcare services, the use of AI in document management, telehealth, cost, and quality management will increase. Artificial intelligence-based technologies in digital healthcare services are frequently used to improve the quality of care and increase efficiency in early diagnosis, diagnosis and treatment of diseases, research and education, drug production and calculations, epidemic prediction, and radiology [6]. In nursing, the tools used in AI include data analyses, early warning systems, clinical decision-making, mobile health and sensor-based technologies, voice assistants, and robots [7]. The increasing number of new technologies avaliable for nursing can improve the quality of care, improve working conditions, and reduce costs [8]. In this relationship, the adaptation and integration process of nurses, should be planned in the most effective and efficient way. Preparing nursing students and nurses for clinical practice in the age of AI requires a balance between training for current needs and anticipating future demands [9].

In nursing, AI should be included in pre- and postgraduate nursing education, and nurses' knowledge and skills for using AI should be developed [10]. Education about technology and its use will be the future of nursing education because nursing care provided in a highly technological working environment is the trajectory of nursing practice [9]. AI enriches the learning experience by enabling better adaptation of educational materials to learners' strengths and needs [11]. Furthermore, AI adds value to the educational process by supporting teachers and students in gaining the necessary competencies to succeed in an AI -supported learning environment while helping them develop digital literacy and computer skills [12]. With appropriate application and guidelines, AI tools can complement and enhance human interactions in nursing education, prepare students for a rapidly changing healthcare environment, and advance nursing [13].

The research was designed within the framework of self-determination theory, which provides a comprehensive framework for understanding human motivation and personality development and suggests that motivation results from the fulfilment of three basic psychological needs (autonomy, competence, relationship) [14]. It has shown that when these needs are met,

individuals are more likely to experience enhanced motivation, greater well-being, and increased performance in a variety of contexts, including education, health, and sport [15, 16]. In conclusion, the relationship between AI use, digital literacy and creative thinking in nursing students is complex and multifaceted. By utilising the principles of Self-Determination Theory, academics can create an environment that fosters intrinsic motivation and enhances students' ability to effectively navigate digital tools. The mediating role of digital literacy and the moderating effect of academic support are critical components in this process. As nursing education continues to evolve in response to technological advances, prioritising these elements is believed to be essential to prepare future health professionals to succeed in an increasingly digitalised world.

Research gap and importance

In terms of the integration of AI into education, there is no course on the subject in the curricula of universities that provide undergraduate nursing education in Turkey. At the same time, there is no original article in this direction in the literature. According to our knowledge, there has never been any literatüre that directly addressed the connection between the four variables.

The theoretical and applied literature on how digital literacy mediates the effect of AI use on creative thinking and under which conditions academic support strengthens or weakens this mediation cannot yet provide a clear answer.

Research aim, model, and methods

This study was designed to examine the effect of AI usage on creative thinking skills in nursing students. It was also aimed to reveal the mediating role of digital literacy in explaining this main effect and to determine under which conditions and how academic support affects this mediating relationship (situational mediation). For this purpose, the current study, which adopted a cross-sectional design, was designed in a descriptive-correlational type. In order to realise these objectives, pre-nursing students actively studying in the faculties of health sciences of three universities in different regions of Turkey were selected as the sample. Finally, in order to fulfil these objectives, the correlation relations between the variables and the mediating and moderating conditions were investigated based on Hayes's modelling [17].

Theoretical and practical contributions

It is thought that the integration of AI technologies into educational processes will provide an important opportunity for the development of creative thinking skills of nursing students. In particular, it is predicted that digital literacy and positive academic support perception may be a critical mediating variable in the effect of AI use on creative thinking, and structural strengthening of such transformations may benefit students in integrating technological transformation into their professions.

Literature review

Use of AI and creative thinking

Creative thinking is a process that involves generating new and innovative ideas, solutions, or approaches and can be applied in various fields [18]. It involves transforming existing knowledge and ideas into original structures, questioning assumptions, and developing original solutions [19]. Two essential elements of creative thinking are innovation and benefit [20]. AI technology has the potential to significantly increase human creativity in various fields [21]. AI offers innovative solutions in many fields by simulating human-like intelligence characteristics [22]. AI alleviates the burden of routine tasks to facilitate individuals' creative thought processes, helps to overcome the blockages experienced during idea development, and thus enables creative outputs [23]. In addition, it is defined as a new approach that emphasizes using AI to increase human intelligence [24]. Creative thinking leads students to develop new and original designs, formulate different hypotheses, and produce innovative solutions in problem-solving [25]. In education, it is of great importance to assess these skills in order to solve complex problems and encourage creativity [26]. Educational institutions, from primary education to higher education and adult education, are being transformed by artificial intelligence, and intelligent systems enable individuals to learn better and achieve learning goals [27]. While developing creative thinking skills by going beyond routine practices in professions such as nursing that require dealing with unexpected situations and dealing effectively with patients from different backgrounds creates essential effects, encouraging the creativity of nursing students is seen as a critical step for the future of healthcare [28]. For this reason, we propose the following hypothesis, arguing that AI affects creative thinking in nursing students:

H_1 AI usage significantly and positively affects creative thinking.

The mediating role of digital literacy

Digital literacy refers to the ability to find, evaluate, use, share, and create content using information technologies and the Internet. It supports academic, personal, and professional development by enabling individuals to use information and digital technologies safely and critically [29]. It also includes the ability to access, evaluate, understand, and create information in various formats from

different sources using digital technologies and communication tools [30].

Creative thinking ability is also evaluated within the scope of digital literacy [31]. Today, the widespread use of digital technology in every field, together with the effect of these technologies on creative thinking, shows that the tendency to think creatively in the context of digital literacy contributes to the development of innovative ideas and products for humanity and nature [32]. In this context, it is thought that digital literacy can play role in the effect of AI usage on creative thinking. In this direction, the following hypothesis will be tested in the study:

H_2 Digital literacy has a mediating role in the effect of AI usage on creative thinking.

Mediator role of academic support

Academic support is direct and indirect socialization resources, including emotional, instrumental, and cognitive aids, that support students' academic success. This support is usually provided by parents, peers, and teachers [33]. In the university context, academic support provided by faculty members and students is an element that increases psychological well-being and academic success [34].

In this context, the moderating role of academic support in technology-supported learning environments is important in shaping the relationship between students' digital literacy levels and their interactions with AI based tools. Chiu et al. [35] showed that teacher support increased students' perceptions of motivation and efficacy in learning processes using AI -based chatbots. In the study, it was stated that teacher support was particularly effective for students with low levels of expertise and facilitated the learning process by meeting the needs of these students. In addition, it was stated that lack of teacher support may weaken students' commitment to learning even though it increases their perception of autonomy. These results indicate that academic support can create a regulatory effect in AI-based learning environments.

Based on these findings, it is predicted that academic support may moderate the relationship between the use of AI and digital literacy. The hypothesis put forward in this study is as follows:

H_3 Academic support has a moderating role in the relationship between AI usage and digital literacy.

Integrated model

The fourth and final hypothesis of the study is designed to cover the first three hypotheses and explain the research model.

H_4 Academic support perception has a situational mediating role in the effect of AI usage on creative thinking through digital literacy.

Methods

Design

Based on the theoretical framework explaining the direct and potential effects of AI on creative thinking designed in Fig. 1, this study consists of a series of research hypotheses that position creative thinking as a dependent variable, AI usage as an independent variable, digital literacy as a mediating variable and academic support perception as a moderating variable. For this purpose, the current study, which adopted a cross-sectional design, was designed to include a descriptive-relational structure and mediation-regulation analysis and guided by the STROBE check-list.

Sampling and participants

The study population consists of nurses actively studying in the health sciences faculties of three universities in different regions of Turkey. In the study, firstly, to determine the current population, the student affairs units of the universities were applied, and it was determined that a total of 478 students were studying in three universities. In addition, in line with the information received from the same units, it was determined that 33 students froze the 2024–2025 autumn term education, and 19 students

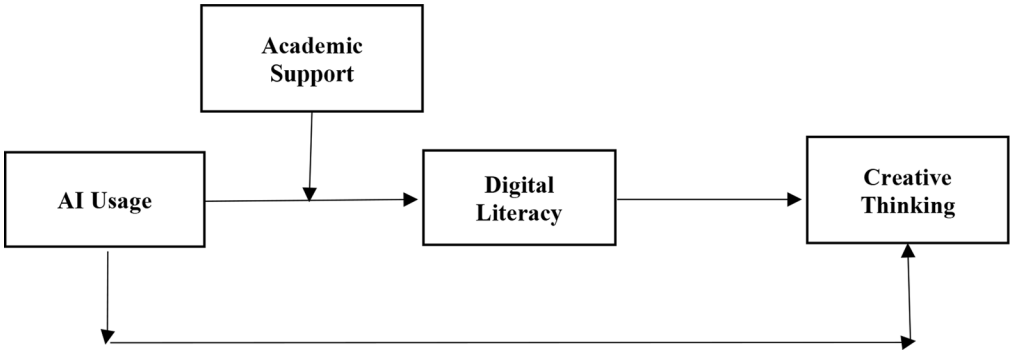

Fig. 1 Research model

were absent from the course on the data collection dates. From this point of view, it was determined that the net sample number consisted of 426 students. Then, it was determined that collecting data from 208 nursing students with a simple random sampling method with a 95% confidence interval and 5% error rate was sufficient in terms of sample size and reliability of the study [36]. Finally, the research data were collected between October and November 2024. Considering the total population of the research, it was determined that the return rate of the questionnaires was 89.1%.

Instruments

Within the scope of the study, five scales were used together with the demographic information form. In the demographic information form, student nurses' gender, age, grade point average, class, mother and father education level, the current level of relationship with technology, knowledge about the use of AI, wanting AI to be included in the curriculum, and AI to be more involved in your life were examined. All scale items were graded on a 5-point Likert scale ranging from "1: strongly disagree to 5: strongly agree".

AI usage perception scale

The 'AI usage perception scale' used by Shahzad et al. [37] in their study was used to measure nurse students' perceptions of AI usage. This scale consists of six items and one dimension. Finally, in the study, the internal consistency coefficient was found to be 0.94.

Creative thinking scale

The "creative thinking tendency scale" developed by Deniz and Demir [38] was used to measure the students' creative thinking tendencies. The scale consists of twelve items and one dimension. Finally, the internal consistency coefficient was determined as 0.80 in the scale's development study.

Digital literacy scale

The 'digital literacy' scale developed by Ng and used by Ibrahim et al. [39, 40] in their study was used to measure the digital literacy of nursing students. The scale consists of ten items and one dimension. Finally, the internal consistency coefficient was found to be 0.86 in the adaptation study of the scale.

Academic support perception scale

The "academic support perception scale" developed by Reyes et al. [41] was used to determine the students' academic support perception levels. This scale consists of three dimensions and twelve items: teacher, peer, and family support. Finally, the internal consistency coefficient was found to be 0.88 in the scale's development study.

Data collection

After obtaining the necessary ethics committee approval for the research, the three university administrations obtained permission for data collection. Then, the researchers applied 426 questionnaires to the nursing students studying at the health sciences faculties of the universities in question. Before the data collection process, the purpose and method of the study were explained to the students in detail, and their written consent was obtained through the informed consent form. After the data collection process was completed, the questionnaire forms were carefully examined to check whether the questions were answered thoroughly, and 9 questionnaires in which the same answer was given to all items were excluded from the scope of the analysis. Thus, the final sample of the research consisted of 417 questionnaires. It was also observed that students spent an average of 15–20 min to answer the questionnaires.

Data analysis

AMOS 22, SPSS 24, and SPSS MACRO plug-ins were used to analyze the research data. Before testing the hypotheses designed in line with the research data, the validity and reliability analyses of the scales were first conducted. Confirmatory factor analyses (CFA) were performed through the AMOS 22 application for validity analysis. With these analyses, the goodness of fit values such as X2/df, RMSEA, CFI, TLI, NFI, and SRMR were determined, and CFA results were given. In addition, in order to determine that the CFA model has convergent validity (AVE and CR) and discriminant validity (MSV), Fornell and Larcker [39] and HTMT analyses were used to test the CFA model. After the validity analysis, Cronbach alpha analyses were performed using SPSS 24 software. Then, frequency analyses were used to analyze the participants' demographic information. After these stages, the variables' correlation coefficients were determined to test the hypotheses designed. In the last stage, to determine the mediating role of digital literacy and the moderating role of academic support perception, The mediating and moderating role was examined using Hayes's [17] SPSS MACRO Model 7 design.

Results

Demographic information

When the demographic information of nursing students was analyzed, it was found that 64.5% of the participants were female, more than half of the students (49.6%) were between the ages of 19–21, 44.4% had a grade point average between 1.01 and 2.00, and the highest rate according to the grade level belonged to the 4th-grade students

with 32.6%. In addition, when the relationship level of nursing students with technology was examined, 65% of the students stated that they could use technology at a medium level. Moreover, when the students' knowledge about the use of AI was examined, 65.9% of the students stated that they had "some" knowledge on this subject, 20.9% stated that they had sufficient knowledge, and 13.2% stated that they did not know. Finally, 43.6% of the students stated that they were undecided about including AI in their lives, while 74.1% stated that they wanted AI to be included in the curriculum (Table 1).

Test of the measurement model

In this study, confirmatory factor analysis (CFA) was conducted to evaluate the validity of the variables in a research model that has theoretical foundations and has been tested in previous studies. CFA aims to test whether the theoretically predicted factor structure is compatible with the observed variables [42]. Within the scope of the study, CFA was applied to determine the construct validity of the measurement model, which consisted of AI usage, academic support perception, digital literacy, and Creative Thinking scales. In addition, the problem of standard method variance that may arise in the data collection process was also evaluated [43, 44]. Standard method variance refers to the systematic error sources that may arise when the same individual fills out more than one scale in the same period in the data collected by the survey method [45]. Harman's single-factor test method was used to determine the existence of such systematic errors and to control their effect. This test examines how much of the variance is explained by a single factor. A single factor explaining more than 50% of the total variance is considered a possible sign of method bias and may pose a risk to measurement validity. However, the fact that a single factor explains less than 50% of the variance indicates that the risk of method bias is low and the measurements are reliable [46]. As a result of the analyses conducted in this study, it was found that a single factor explained only 43% of the total variance. This shows that the risk of method bias is low, and the validity of the scales used is ensured [43].

Table 1 Demographic information of nursing students (n: 417)

Socio-demographic characteristics	*n*	%
Gender		
Male	148	35.5
Female	269	64.5
Age		
18 and under	26	6.2
19–21 years old	207	49.6
22–24 years old	113	27.1
25–27 years old	52	12.5
28 years and older	19	4.6
Grade point average		
1.00 and below	36	8.6
between 1,01–2,00	185	44.4
between 2,01–3,00	150	36.0
3,01–4,00	46	11.0
Classroom		
Grade 1	102	24.5
Grade 2	85	20.4
Grade 3	94	22.9
Grade 4	136	32.6
What is your current level of relationship with technology?		
None	58	13.9
A little	271	65.0
Enough	88	21.1
What is your level of knowledge about the use of AI?		
None	55	13.2
A little	275	65.9
Enough	87	20.9
Would you like AI to be more involved in your life?		
Absolutely not	12	2.9
No	59	14.1
Undecided	182	43.6
Yes	140	33.6
Definitely yes	24	5.8
Would you like AI to be included in your curriculum?		
Yes	309	74.1
No	108	25.9

n: Sample, %: percentage

Within the research framework, different model alternatives were also compared to test the construct validity of the variables and the model's fit with the data. Table 1 presents the goodness of fit values of the research's four-factor measurement model and other alternative models (Model 1, Model 2, Model 3, and Model 4).

The confirmatory factor analysis results in Table 2 show the fit indices of the research model and alternative models. Each fit criterion was used to evaluate how well the models fit the data. When Table 2 is analyzed, the four-factor measurement model of the study (use of artificial intelligence, academic support, digital literacy, and Creative Thinking) presents better goodness of fit values compared to the alternative models (Model 1, Model 2, Model 3 and Model 4). The fit indices of this model ($\chi 2/df = 2.01$ RMSEA = 0.04; CFI = 0.93; TLI = 0.93; SRMR = 0.07) meet the general acceptance criteria and reveal that the risk of standard method variance is low. Alternative models show higher error and lower fit compared to the research model. These results show that the research model is the most appropriate in terms of measurement validity, provides a high fit with the data, and is, therefore, the preferred model.

The HTMT analysis in Table 3 is used to assess discriminant validity. HTMT values below 0.85 indicate sufficient discriminant validity between the variables [47]. According to Table 3, the HTMT values between

Table 2 Goodness of fit values for the measurement model and alternative models

Models	CMIN(χ2)	DF	χ2/df	RMSEA	CFI	TLI	SRMR
Research Model	1389.862	691	2.01	0.04	0.93	0.93	0.07
Model 1	2423.966	694	3.49	0.08	0.84	0.82	0.10
Model 2	2512.280	694	3.62	0.08	0.83	0.80	0.09
Model 3	2629.087	696	3.78	0.08	0.82	0.80	0.09
Model 4	2629.931	697	3.78	0.08	0.81	0.79	0.10

N = 417; χ2/df = Ki-Square Fit Test; RMSEA = Mean Square Root of Approximate Errors; CFI = Comparative Fit Index; TLI = Tucker-Lewis index; SRMR = Standardised Root Mean Square Error

AI usage (AIU) and other variables vary between 0.46 and 0.79. The HTMT values between Academic support (AS) and other variables were between 0.46 and 0.81. The HTMT values between Digital Literacy (DL) and Creative Thinking (CT) are 0.71 and 0.82, respectively. As a result, there is sufficient discriminant validity between the variables, as all HTMT values do not exceed 0.85. According to the Fornell-Larcker criterion in Table 3, the AVE (Average Variance Extracted) value of each variable should be greater than the square root of the correlations of that variable with other variables [42]. When Table 3 is analyzed, the AVE square roots of AIU, AS, DL, and CT variables are higher than the correlations with other variables, which indicates that discriminant validity is provided according to the Fornell-Larcker criterion. CR (Composite Reliability) values above 0.70 in Table 3 indicate reliability. The CR values of all variables (0.85–0.94) are above this limit and show high reliability. AVE values above 0.50 in Table 3 indicate that they are sufficient in terms of measurement validity. All AVE values in the Table (0.76–0.88) meet this threshold. The fact that the MSV and ASV values in Table 3 are lower than the AVE value indicates that the measurement validity of the variables is high. In all variables in Table 3, MSV (0.70–0.77) and ASV (0.63–0.71) values are lower than AVE values. This supports the discriminant validity of the model. As a result, the analyses in Table 3 show that the model meets the discriminant validity and reliability criteria. When the HTMT, Fornell-Larcker, CR, AVE, MSV, and ASV results are evaluated, it can be said that the scales used are both valid and reliable. This reveals that the measurement structure of the research model is based on a solid foundation.

Correlation and reliability analyses

The findings presented in Table 3 provide important information about the correlation and reliability analyses of the scales used in the study (AI Usage, Academic support, Digital Literacy, and Creative Thinking). The findings include the mean ($\bar{x}$), standard deviation (SD), reliability coefficient (α), and correlations with other variables for each variable.

The Cronbach's Alpha values of the research scale in Table 4 show that all variables have high internal consistency. Generally, values of 0.70 and above are considered acceptable reliability levels. The correlation coefficients in Table 4 reveal the direction and strength of the relationships between the variables. It shows a moderate positive relationship with Academic Support Perception ($r = 0.42$, $p < 0.01$). It strongly correlates positively with Digital Literacy ($r = 0.64$, $p < 0.01$). It shows a strong positive relationship with the Creative Thinking ($r = 0.70$, $p < 0.01$). There is a powerful positive relationship with Digital Literacy ($r = 0.79$, $p < 0.01$). There is also a strong positive relationship with the Creative Thinking ($r = 0.71$, $p < 0.01$). The findings reveal significant and generally strong positive relationships between the variables. The strong relationship between digital literacy and Creative Thinking ($r = 0.88$) is especially noteworthy. In addition, the strong positive relationship ($r = 0.70$) between AI usage and Creative Thinking emphasizes the importance of considering these two variables together. The high correlation between the academic support and digital literacy ($r = 0.79$) indicates that the academic support can play a significant role in increasing individuals' digital competences. The variables in the study are within the ± 1 acceptance interval specified by Tabachnick and Fidell [48]. The skewness value for AI usage was found to be + 0.034, kurtosis value − 0.165; for academic support, skewness + 0.265, kurtosis − 0.391; for digital literacy, skewness + 0.139, kurtosis − 0.299; and for creative thinking, skewness + 0.235, kurtosis − 0.131. The fact that the values for all variables are within ± 1 limits shows that the data are suitable for normal distribution. These findings show that the relationships between the variables are consistent with the theoretical framework in the research model, and the scales can be considered reliable measurement tools.

Hypothesis testing

The hypotheses were tested within the framework of the correlation analysis and confirmatory factor analysis results between the research scales. Table 5 contains the regression results evaluating the mediating effect of the Digital Literacy variable in the relationship between AI Usage and Creative Thinking. The findings reveal the significance of the total direct and indirect effects. The

bootstrapping method proposed by Preacher and Hayes [49] was used to test the validity of the mediation effect.

According to the results obtained in Table 5, the direct effect of the use of AI on Creative Thinking is positive and significant (β = 0.517, $p < 0.001$), and the confidence intervals (LLCI = 0.357, ULCI = 0.490) support this effect. This result supports the hypothesis H_1. The second finding in Table 5 is that the use of AI has a significant and positive effect on digital literacy (β = 0.594, $p < 0.001$) and is found to be reliable when confidence intervals (LLCI = 0.525, ULCI = 0.662) are considered. The third finding in Table 5 is that digital literacy has a substantial effect on Creative Thinking (β = 0.711, $p < 0.001$), and confidence intervals (LLCI = 0.658, ULCI = 0.764) support the accuracy of the effects. In the study, regression analysis was applied to test whether digital literacy has a mediating role in the effect of AI usage on Creative Thinking. In this context, the Process Macro package program was preferred to analyze the scales in the study. While applying the analyses, Model 4 and Bootstrap technique and 5000 resampling options were selected. As a result of the analysis, it was determined that the use of AI indirectly affects Creative Thinking through digital literacy (β = 0.422). When the confidence intervals regarding the significance of the indirect effect are examined, it can be said that this effect is significant (LLCI = 0.357, ULCI = 0.490). According to this result, hypothesis H_2 is accepted.

Regulatory variable tests

A moderator variable is a factor that strengthens or weakens the relationship between dependent and independent variables. The effect of the moderator variable reveals the changes that occur in the relationship with the increase or decrease in the level of this variable [48]. In this research phase, the moderator variable, the article's focus, is tested to determine whether the academic support moderates the relationship between the use of AI and digital literacy. Table 6 shows the results of the moderator effect analysis.

Table 6 considers the interaction of AI usage and academic support (AIU x AS) to evaluate the moderating effect. The analysis results show that this interaction term significantly affects digital literacy (β = 0.164, $p < 0.001$). This finding reveals that academic support modifies the effect of AI usage on digital literacy and plays a moderating role. Although the effect coefficient indicates an effect size between low and medium levels, its significance is remarkable. As a result, the academic support strengthens the relationship between using AI and digital literacy. The reliability and significance of the model are also supported by the lower and upper confidence interval values (LLCI = 0.023, ULCI = 0.104). These findings indicate that academic support mechanisms are strategically

Table 3 Discriminant validity and reliability analyses

Analysis	HTMT Analysis				Fornell-Lacker Analysis							
Variables	**AIU**	**AS**	**DL**	**CT**	**AIU**	**AS**	**DL**	**CT**	**CR**	**AVE**	**MSV**	**ASV**
AIU	-				0.87				0.85	0.76	0.74	0.70
AS	0.46	-				0.89			0.94	0.80	0.72	0.69
DL	0.71	0.81	-				0.88		0.91	0.78	0.70	0.68
CT	0.79	0.77	0.82	-				0.94	0.88	0.77	0.71	0.63

N = 417; AIU = AI Uusage; AS = Academic support; DL = Digital Literacy; CT = Creative Thinking

Table 4 Correlation and reliability findings of the scales

	x̄	S.S.	AIU	AS	DL	CT	α	Skewness-Kurtosis
AIU	2.95	0.83	-				0.88	+,034/-,165
AS	3.10	0.82	0.42**	-			0.94	+,265/-,391
DL	3.12	0.77	0.64**	0.79**	-		0.91	+,139/-,299
CT	3.09	0.74	0.70**	0.71**	0.88**	-	0.89	+,235/-,131

N = 417; r: Pearson coefcient; **Statistically signifcant at $p \leq 0.05$; α = Cronbach Alpha's; AIU = AI Usage; AS = Academic support; DL = Digital Literacy; CT = Creative Thinking

Table 5 Regression results for mediation effect

Digital Literacy						
Variables	***β***	***SE***	***T***	***P***	**LLCI**	**ULCI**
AI Usage	0.594	0.035	17.044	0.000	0.525	0.662
Creative Thinking						
Variables	***β***	***SE***	***T***	***P***	**LLCI**	**ULCI**
Digital Literacy	0.711	0.027	26.431	0.000	0.658	0.764
AI Usage (Direct Effect)	0.201	0.025	8.059	0.000	0.152	0.249
AI Usage (Total Impact)	0.623	0.031	19.923	0.000	0.561	0.684
			β	***SE***	**LLCI**	**ULCI**
Indirect Impact			0.422	0.034	0.357	0.490

N = 417; LLCI = Lower Limit; ULCI = Upper Limit

Table 6 Regression results for regularisation effect

Digital Literacy						
	β	***SE***	***T***	***P***	**LLCI**	**ULCI**
AI Usage	0.367	0.025	14.456	0.000	0.317	0.417
Academic support	0.578	0.026	22.75	0.000	0.526	0.630
AIU xAS	0.164	0.021	3.107	0.000	0.023	0.104

Note. *N* = 417; LLCI = Lower limit; ULCI = Upper limit

Table 7 Bootstrap situational mediation effect results

Academic support	**Effect**	**BootSE**	**BootLLCI**	**BootULCI**
-1 *SD* (-0.92)	0.224	0.024	0.174	0.270
M (0.00)	0.261	0.023	0.218	0.306
+ 1 *SD* (0.92)	0.298	0.026	0.249	0.352
Index of Moderated Mediation	**0.045**	**0.013**	**0.021**	**0.074**

Note. *N* = 417; LLCI = lower limit; ULCI = upper limit

important in integrating digital transformation processes. According to this result, hypothesis H_3 is accepted.

The situational mediation effect, which is the focus of our research, is the analysis of the effect of the independent variable on the dependent variable with mediating and moderating effects [17, 50]. This research reveals how the indirect effect of AI usage (independent variable) on Creative Thinking (dependent variable) through digital literacy (mediating variable) varies at different levels of academic support perception (moderating variable) [17, 51]. Table 7 shows the results of the situational mediating effect model of the research.

The results of the slope analysis presented in Table 7 show that the indirect effect of AI usage on Creative Thinking through digital literacy was found to be significant at low levels of academic support (Effect = 0.224, BootLLCI = 0.174, BootULCI = 0.270). This finding shows that the indirect effect of AI usage continues even when the level of support is low, but its effect remains limited. It is seen that this indirect effect becomes more potent with a moderate level of academic support perception (Effect = 0.261, BootLLCI = 0.218, BootULCI = 0.306). This situation reveals that the mediating effect of digital literacy gains more strength with academic support. The indirect effect became the strongest at high levels of academic support perception (Effect = 0.298, BootLLCI = 0.249, BootULCI = 0.352). High academic support maximizes the indirect effect of AI usage on Creative Thinking. The index of moderated mediation effect was significant (Index of Moderated Mediation = 0.045, BootLLCI = 0.021, BootULCI = 0.074). This result shows that academic support perception regulates the indirect relationship between the use of AI and Creative Thinking statistically significantly. Therefore, as the level of academic support increases, this indirect relationship becomes more vigorous. According to this result, hypothesis H_4 is accepted.

The situational mediation effect graph in Fig. 2 shows how the effect of AI Usage on digital literacy varies according to the Academic support. The graph explains

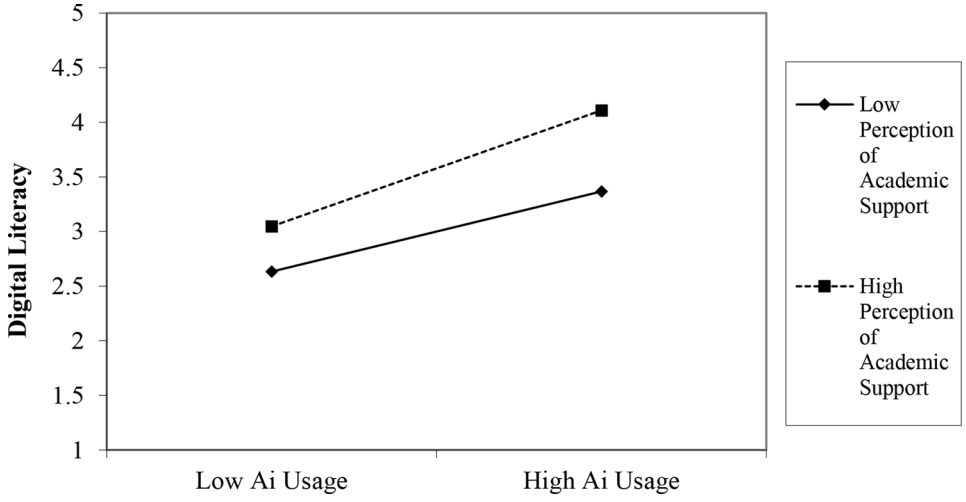

Fig. 2 Situational mediation effect graph

the different trends in low and high levels of academic support.

The situational mediation effect graph in Fig. 2 shows that the use of AI usage positively affects digital literacy. It is observed that when the use of AI usage is low, the level of digital literacy is lower, and as the use of AI usage increases, the level of digital literacy increases. This finding indicates that the use of AI usage contributes to the development of individuals' digital skills. When the academic support is low, the effect of AI use on digital literacy shows a positive but more limited trend. The slope of the line indicates that a low academic support weakens this relationship. This finding suggests that when individuals are motivated by academic support, the effect of AI usage on digital literacy is significantly strengthened. The graph reveals the moderating effect of academic support perception. It is seen that high academic support perception increases the positive effect of AI usage on digital literacy, while low academic support perception weakens this effect. This finding suggests that academic support mechanisms can play a critical role in increasing individuals' digital literacy levels.

Discussion

In this study, it was determined that AI significantly supports creative thinking through digital literacy. While the use of AI increased nurse students' creative thinking skills, digital literacy was found to be an important mediating factor in this effect. In addition, academic support as a moderating factor was found to significantly strengthen the relationship between AI use and digital literacy.

In this context, if we make an evaluation in parallel with the research hypotheses, firstly, according to the H_1 hypothesis, it was determined that the AI usage by nurse students significantly and positively affects their creative thinking. When the literature is evaluated; The study of Fang et al. [52] emphasizes the positive effects of AI -supported tools on generating ideas and improving creative fluency in creative processes. The research showed that AI technologies encourage creative thinking by increasing individuals' ability to develop ideas. However, it was noted that these tools could sometimes provide decontextualized suggestions, which suggests the need for further technology optimization. Similarly, Solihat et al. [53] examined the impact of AI -based learning tools on creative thinking. They showed that these tools optimize creative problem-solving processes by providing personalized, interactive, and adaptive learning environments. The study emphasizes that AI supports individuals in producing innovative solutions without being limited only by existing knowledge and can be considered an active partner in educational processes. Finally, Liu et al. [54] examined the potential of ChatGPT, an AI -based language model, to support creative thinking processes. The study found that the personalized and interactive learning environments offered by ChatGPT provide positive effects on creative problem-solving and innovative idea generation. However, the importance of being aware of the limitations of information accuracy and supporting the technology with traditional methods was emphasized.

According to the H_2 hypothesis accepted within the scope of the findings, it was determined that digital literacy has a mediating role in the relationship between nurse students' AI usage and their creative thinking. In this context, when the literature was examined, it was observed that there is literature in parallel with our research results. These studies reveal the significant and positive effect of AI on the development of individuals' creative thinking capacities and also show that these technologies play a role as both a tool and an active

partner in innovation processes. The impact of AI technologies on digital literacy has been studied in different fields in recent years. For example, Kazanidis and Pellas [55] emphasize that AI tools improve digital literacy skills, especially their benefits in pedagogical content production. The research revealed that AI can potentially enhance learning performance and user experience. Similarly, Bender [56] stated that generative AI tools such as ChatGPT can improve aesthetic engagement and critical thinking skills by supporting digital literacy skills. Studies in the health sector also point to a similar effect. Božić and Poola [57] showed that AI is an important tool in developing digital skills, significantly increasing the digital literacy of healthcare workers through clinical decision support systems and electronic health records.

According to the other accepted hypotheses H_3 and H_4 of the study, it was determined that nurse students' perceptions of academic support have a regulatory role in the relationship between the use of artificial intelligence and digital literacy and also have a situational mediation role in this complex relationship. In this context, when the literature was examined, it was also seen that there is literature compatible with our research results. The effect of digital literacy on creative thinking has been directly addressed in the literature, and the links between these two skills have been emphasized in various studies. Rizal et al. [58] stated that digital literacy supports creative thinking and that these two skills complement educational processes. Sangra Dempo et al. [59] showed that digital literacy positively affects creative thinking by strengthening teaching processes. Syefrinando et al. [60] found that digital literacy in the context of online education contributes to success in learning processes by increasing students' creative skills. Although the effect of AI usage on digital literacy and the contribution of digital literacy to creative thinking have been addressed separately in the literature, it is not yet clear whether there is a mediating role between these two relationships. Our hypothesis suggests in a theoretical framework that digital literacy may play a mediating role in the effect of the use of AI on creative thinking. In this context, it is thought that digital literacy should be considered a potential mediating variable since it improves individuals' ability to use technological tools effectively and contributes to creative processes.

Academic support is a critical factor that increases students' motivation in their educational processes and facilitates their learning activities. The literature has widely discussed that academic support is effective in increasing students' satisfaction and motivation in their educational processes [61]. Especially in the context of online learning, teachers' support has a strong link between students' satisfaction and motivation levels. This finding suggests that academic support can help individuals overcome the difficulties they face in their learning process. Zhao et al. [62] also emphasize the impact of school support mechanisms on technology adaptation and academic engagement. In particular, it was stated that the academic support can increase students' ability to develop digital skills and integrate them into educational processes. In this context, academic support can play a regulatory role in developing students' digital literacy skills. Although there is no direct evidence that academic support moderates the relationship between AI usage and digital literacy, existing studies indirectly support this hypothesis.

Conclusion

The research findings reveal that AI significantly supports creative thinking through digital literacy. While AI increases individuals' creative thinking skills, digital literacy is a key mediating variable in this effect. The finding of a robust positive relationship between digital literacy and Creative Thinking clearly shows the importance of digital competencies in creative processes. Moreover, as a moderating factor, the academic support significantly strengthens the relationship between the use of AI and digital literacy. While this effect is limited when the level of academic support is low, this effect is maximized as the level of support increases. These findings suggest that the potential of AI technologies to support creative thinking skills can be revealed more effectively with digital literacy and academic support mechanisms. The effective integration of AI technologies in educational environments provides an opportunity to improve students' digital skills and increase their creative thinking capacities. However, academic support can further strengthen the positive effects of using AI by increasing students' motivation. This suggests that integrating academic support mechanisms into digital transformation processes in education programs is strategically important.

Implications for nursing students

The integration of AI technologies into educational processes offers significant opportunities to support the development of creative thinking skills in nursing students. In this regard, the development of digital literacy should be prioritized in educational programs. In addition, structurally strengthening academic support mechanisms that increase students' motivation is a critical step in maximizing the impact of AI and digital skills on creative thinking.In particular, including AI applications in the nursing curriculum can be used as a tool to improve students' problem-solving and creative thinking capacities. In this context, including awareness training and practical studies on digital health technologies and AI in the curriculum will improve students' academic and clinical skills.

Previous studies reveal that digital literacy is critical for health professionals to adapt to future technological requirements [63–65]. The findings of this study point to the need to increase the technological competencies of nursing students and emphasize the importance of pedagogical approaches to the use of artificial intelligence. Effective implementation of academic support systems will create a learning environment that encourages creative thinking skills while facilitating students' adaptation to technology. These results suggest that nursing education programs should be restructured to adapt to technology-supported learning processes, and both instructors and students should take active roles in this process.

Limitations

This research has some limitations. Firstly, adopting a cross-sectional design limits the identification of causal relationships; therefore, the findings are based only on the relationships between variables. The study was conducted with a limited sample of nursing students from three universities in Turkey, and the generalisability of the findings to student groups in other countries or different fields is limited. Furthermore, only specific scales were used in the study, and different dimensions of AI usage, subcomponents of digital literacy, and long-term effects of academic support were excluded. It is recommended that future studies address these limitations using longitudinal designs and larger samples.

Abbreviations

AI	Artificial intelligence
AIU	Artificial intelligence usage
AS	Academic support
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CT	Creative thinking
DL	Digital literacy
LLCI	Lower limit
RMSEA	Root mean square error of approximation
SRMR	Standardised root mean square error
TLI	Tucker-Lewis index
ULCI	Upper limit

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Author contributions

Idea - FOA, ST, MB,; Design - FOA, ST; Supervision - FOA, MB, ST; Resources - FOA, MB, ST, LOE; Data Collection and/or Processing - FOA, ST, MB, LOE; Analysis and/or Interpretation - MB, ST; Literature Review - FOA, ST, LOE; Writing - FOA, ST, MB, LOE, NBA; Critical Review - FOA, ST.

Data availability

The corresponding author can provide the datasets created and analysed for this study upon reasonable request.

Declarations

Ethical approval

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Erzincan Binali Yıldırım University Ethics Committee (E-88012460-050.04-399975-09/14). Informed consent was obtained from all individual participants included in the study. We noted in the introductory statement that the study was to be completed anonymously and that completing the questionnaire in its entirety and submitting it constituted voluntary participation in our survey. The study data are strictly confidential and are for research use only.

Informed consent

Written informed consent was obtained from the patients participating in the study.

Competing interests

The authors declare no competing interests.

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