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The Relationship Between Pre-service Teachers' Attitude towards Artificial Intelligence (AI) and their AI Literacy

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Abstract

This study examines the relationship between pre-service teachers' general attitudes toward artificial intelligence (AI) and their AI literacy. The study was structured using a correlational survey model, and data were collected from 1,196 randomly selected pre-service teachers. A positive but weakly significant relationship was found between AI literacy and general attitudes toward AI. The findings suggest that AI literacy alone is not sufficient to enhance pre-service teachers' general attitudes toward AI. Variables such as gender, age, field of study, and class level were found to influence both general attitudes toward AI and AI literacy. Male students exhibited more positive attitudes toward AI. Additionally, students with higher academic achievement and those in upper grades demonstrated higher levels of AI literacy. Based on the research findings, it is recommended that AI education be introduced at an early age through practical applications and that concerns affecting attitudes toward AI be addressed.

Keywords: Artificial intelligence attitude, artificial intelligence literacy, pre-service teachers, correlational survey

Introduction

In recent years, artificial intelligence (AI) has undergone significant advancements, leading to substantial transformations across various fields. From healthcare services to the economy, from the automotive industry to the entertainment sector, AI continues to expand and evolve. Numerous studies have shown that a high level of AI literacy plays a crucial role in addressing many fundamental and urgent human needs effectively (Kandlhofer et al., 2016; Jarrahi, 2018; Su 2018; Stembert & Harbers 2019; Tarafdar et al., 2020; Wang et al., 2023). The development of artificial intelligence, progressing in parallel with modern information technologies over the past 60 years, has introduced various intelligent approaches across all sectors of modern life. Since the mid-1950s, the expansion of AI has enabled the integration of intelligent systems into education and instruction. As Mangera et al. (2023, p. 36) state, "Artificial intelligence can play a role in various aspects." AI has become a key feature of ongoing knowledge, technological, and communication revolutions, as its applications provide remarkable capabilities in terms of both accuracy and speed (Almelweth, 2022).

Educational software that combines learning technologies with open content, identifies gaps in students' knowledge, and supports instructional activities at different educational levels (e.g., Knewton) facilitates both learning and teaching processes. Additionally, software that provides real-time feedback and personalized tutoring tailored to students' needs, highlighting their learning habits and areas for improvement for teachers [e.g., Querium, Century (UNESCO, 2019)], as well as initiatives integrating AI technology with virtual assistants (VAs) to enhance critical thinking skills through VA-generated responses (e.g., Cognii), further contribute to effective education.

Artificial intelligence positively impacts daily life in many ways; however, it also raises concerns regarding ethics and privacy. In fact, it has been observed that privacy and ethical considerations are sometimes overlooked in favor of the benefits provided by artificial intelligence.

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"This situation, over time, may transform artificial intelligence into platforms with the potential to process personal data unlawfully" (Başkaya & Karacan, 2022, p. 484). In the process of developing, implementing, and using artificial intelligence technologies, awareness of ethical and privacy issues must be established. This awareness can be achieved through attitudes toward artificial intelligence and the AI literacy that results from these attitudes.

AI literacy has become an essential skill in the 21st century, where knowledge and technology are the dominant forces. "A person is considered AI literate if they can use AI products professionally and reasonably" (Wang et al., 2023, p. 1324). In a study showing the impact of artificial intelligence applications on human life, it has been argued that when people interact with AI, they perceive it as a social actor and apply interpersonal relationship norms (Kim et al., 2019).

Perception and acceptance of artificial intelligence play a crucial role in the widespread adoption of these technologies. A computer program capable of efficiently performing any task based on human intelligence offers significant advantages in education. Contributions that AI can provide to learning and teaching activities include automated grading by simulating a teacher's behavior on answer sheets, providing feedback by analyzing responses, and suggesting personalized teaching plans (Kulkarni & Che, 2019). People are often influenced by media and expert opinions when evaluating the opportunities or threats posed by artificial intelligence. In this context, academic research on artificial intelligence plays a key role in shaping society's approach to these technologies.

The aim of this study is to examine the relationship between pre-service teachers' general attitudes toward artificial intelligence and their level of artificial intelligence literacy. In this context, the research problem is formulated as: *"Is there a relationship between pre-service teachers' general attitudes toward artificial intelligence and their level of artificial intelligence literacy?"* Based on this research problem, the study seeks to answer the following sub-problems.

1. What are the general attitudes of teacher candidates toward artificial intelligence and their AI literacy levels?
2. Is there a relationship between teacher candidates' general attitudes toward artificial intelligence and their AI literacy levels?
3. Do teacher candidates' general attitudes toward artificial intelligence differ based on gender, age, field of study, class level, and Grade Point Average (GPA) variables?
4. Do teacher candidates' AI literacy levels differ based on gender, age, field of study, class level, and GPA variables?

Method

Research Model

This study, conducted to determine the relationship between pre-service teachers' general attitudes toward artificial intelligence and their artificial intelligence literacy, is structured in a correlational survey model. The correlational survey model aims to determine the degree of relationship or effect between two or more variables (Fraenkel et al., 2012).

Participants

The participants of the study consisted of 1,196 pre-service teachers enrolled in the Faculty of Education at a university located in western Türkiye during the spring semester of the 2023-2024 academic year. The participants were randomly selected and voluntarily agreed to take part in the study. Of the participants, 862 (72.1%) were female, and 334 (27.9%) were male. Detailed information about the participating pre-service teachers is presented in Table 1.

Table 1: Demographic Characteristics of Pre-Service Teachers

Variables		*%*
Gender		
Female	862	72.1
Male	334	27.9
Age		
18-19 years old	234	19.57
20-21 years old	537	44.90
22-23 years old	333	27.84
24+ years old	92	7.69
Field of Study		
Verbal	562	46.99
Quantitative	164	13.71
Equally weighted	268	22.41
Language	202	16.89
Class Level		
1st Year	347	29.01
2nd Year	352	29.43
3rd Year	287	24.00
4th Year	210	17.56
Grade Point Average		
0.00-1.99	28	2.34
2.00-2.49	205	17.14
2.50-2.99	513	42.89
3.00-4.00	450	37.63

Data Collection Instruments

In this study, two data collection instruments were used: the "General Attitudes Toward Artificial Intelligence Scale" and the "Artificial Intelligence Literacy Scale". Permission was obtained from the researchers who adapted these scales into Turkish for their use in this study. Detailed information regarding the data collection instruments is provided below.

General Attitudes Toward Artificial Intelligence Scale

The *General Attitudes Toward Artificial Intelligence Scale*, adapted into Turkish by Kaya et al. (2022), aims to determine the effects of personality traits, demographic characteristics, and anxiety toward artificial intelligence on attitudes toward AI. The scale, structured using a 5-point Likert type, consists of two sub-dimensions. The scale includes a total of 20 items: 12 items assessing positive attitudes toward AI and 8 items assessing negative attitudes toward AI. The relevant scale was administered to a total of 350 individuals, including undergraduate students, academic staff, healthcare workers, security personnel, psychologists, business managers, firefighters, engineers, and lawyers. The Cronbach's alpha internal consistency coefficient for the positive items was calculated as 0.82, while for the negative items, it was calculated as 0.84. These findings indicate that the scale is a valid and reliable measurement tool for assessing general attitudes toward artificial intelligence.

Artificial Intelligence Literacy Scale

The *Artificial Intelligence Literacy Scale*, adapted into Turkish by Çelebi et al. (2023), aims to measure the AI literacy levels of non-expert adults. The 12-item scale, consisting of four factors—awareness, usage, evaluation, and ethics—was administered to 402 adult individuals. The validity of the scale was tested through confirmatory factor analysis, and the resulting fit indices indicated that the model had a good fit. Cronbach's alpha internal consistency coefficient for the entire scale was determined to be 0.85. These findings suggest that the scale is a valid and reliable measurement tool for assessing the AI literacy levels of non-expert adult individuals.

Reliability

To determine the general attitudes of teacher candidates toward artificial intelligence and their AI literacy levels, an internal consistency analysis was conducted for both scales, and the Cronbach's alpha coefficient, which represents internal consistency, was calculated. In this context, the Cronbach's alpha internal consistency coefficients for the "General Attitudes Toward Artificial Intelligence Scale" and the "Artificial Intelligence Literacy Scale" are presented in Table 2.

Table 2: Cronbach Alpha Internal Consistency Coefficients of the General Attitudes Toward Artificial Intelligence Scale and the Artificial Intelligence Literacy Scale.

Scales	*Cronbach's Alpha Internal Consistency Coefficients*
1. General Attitudes Toward Artificial Intelligence Scale	.86
2. Artificial Intelligence Literacy Scale	.73

Data Collection

The data for this study were collected during the spring semester of the 2023-2024 academic year through the face-to-face administration of the "General Attitude Toward Artificial Intelligence Scale" and the "Artificial Intelligence Literacy Scale" to pre-service teachers studying at the faculty of education of a university in western T**ürkiye**.

Data Analysis

The data collected to determine the pre-service teachers' general attitudes toward artificial intelligence and their artificial intelligence literacy were transferred to and analyzed using the IBM SPSS Statistics 21 software. To determine whether the data in the dataset followed a normal distribution, the skewness and kurtosis values of the items were calculated. It was concluded that the data followed a normal distribution since the values ranged between -1.5 and +1.5. To test the homogeneity of the data, the results of the Levene Statistic test were used. According to the Levene test results, it was determined that the item variances met the homogeneity condition. Therefore, parametric tests were used in the analysis of the data. In this context, independent samples t-test, one-way analysis of variance (ANOVA), and Pearson product-moment correlation analysis were employed. To identify the groups from which the significant differences identified in the one-way ANOVA test originated, Scheffe post-hoc multiple comparison analysis was used in cases where variances were homogeneous ($p>.05$). Additionally, descriptive statistical methods, including standard deviation, arithmetic mean, frequency, and percentage techniques, were utilized in the analysis of the data. The significance level for the statistical analyses in the study was set at $p\leq.05$.

Findings

Findings Related to the First Sub-Problem

The first sub-problem of the study is formulated as follows: *"What are the general attitudes of teacher candidates toward artificial intelligence and their AI literacy levels?"* Table 3

Table 3: Descriptive Statistics for General Attitude Toward Artificial Intelligence and Artificial Intelligence Literacy.

Scales				*Min*	*Max*	*Skewness*	*Kurtosis*
General Attitudes Toward Artificial Intelligence Scale	1196	3.40	0.50	1.25	5	-0.32	1.36
Artificial Intelligence Literacy Scale	1196	5.12	0.68	2.50	7	-0.26	0.28

presents the descriptive statistics related to general attitudes toward artificial intelligence and AI literacy.

According to Table 3, the mean score of pre-service teachers' general attitudes toward artificial intelligence is = 3.40, while the mean score for artificial intelligence literacy is = 5.12. Based on the general attitude score (= 3.40), it can be concluded that the pre-service teachers' attitudes toward artificial intelligence are at a moderate level. Although a positive attitude is observed, it cannot be said that this attitude is strong. On the other hand, the pre-service teachers' artificial intelligence literacy (= 5.12) is quite high. According to the table, it is evident that the level of knowledge is higher compared to the attitude.

Findings Related to the Second Sub-Problem

The second sub-problem of the study is formulated as follows: *"Is there a relationship between teacher candidates' general attitudes toward artificial intelligence and their AI literacy levels?"* Table 4 presents the analysis results regarding the relationship between general attitudes toward artificial intelligence and AI literacy (Table 4).

According to the data in Table 4, there is a positive, low-level, and statistically significant relationship (r=.30) between the scores obtained by pre-service teachers on the General Attitude Toward Artificial Intelligence Scale and the Artificial Intelligence Literacy Scale. As artificial intelligence literacy increases, the general attitude toward artificial intelligence also increases, but this relationship is weak. Based on this, it can be inferred that the level of knowledge alone is not a determining factor for attitude.

Findings Related to the Third Sub-Problem

The third sub-problem of the study is formulated as follows: *"Do teacher candidates' general attitudes toward artificial intelligence differ based on gender, age, field of study, class level, and GPA variables?"* The analysis results of AI general attitude scores according to various variables are presented in Tables 5, 6, 7, 8, 9, 10, and 11 (Table 5).

According to Table 5, there is a significant difference in the pre-service teachers' general attitude scores toward artificial intelligence based on gender (p<.05). This difference favors male students (Table 6).

In Table 6, it is observed that there is a significant difference in pre-service teachers' general attitude scores toward artificial intelligence based on age (p<.05). To identify which groups the significant difference in the pre-service teachers' general attitude scores toward artificial intelligence originated from, the Scheffe multiple comparison technique, which is frequently used when variances are homogeneous, was preferred from the post-hoc multiple comparison

Table 4: Pearson Product-Moment Correlation Analysis Results for the Relationships Between General Attitude Toward Artificial Intelligence and Artificial Intelligence Literacy.

	General Attitudes Toward Artificial Intelligence	*Artificial Intelligence Literacy*
General attitudes toward artificial intelligence	1	.30*
Artificial intelligence literacy		1

*n=1196, *p<.01*

Table 5: Independent Samples T-Test Results for General Attitude Toward Artificial Intelligence Scores Based on Gender Variable

	Gender				***t***	***p***
General attitudes toward artificial intelligence	Female	862	3.37	0.48	-2.75	.01*
	Male	334	3.46	0.545		

df=1194, *<.05

Table 6: One-Way Analysis of Variance (ANOVA) Results for General Attitude Toward Artificial Intelligence Scores Based on Age Variable.

	Age				*SV*	*SS*		*MS*	*F*	
General attitudes toward artificial intelligence	18-19	234	3.32	0.43	B. Groups	2.62	3	0.87	3.48	.02*
	20-21	537	3.40	0.51	W. Groups	298.44	1192	0.25		
	22-23	333	3.45	0.54	Total	301.06	1195			
	24+	92	3.43	0.50						
	Total	1196	3.40	0.50						

*<.05

techniques. The results of the Scheffe multiple comparison analysis are shown in Table 7.

Table 7.: Scheffe Post-Hoc Multiple Comparison Analysis Results for General Attitude Toward Artificial Intelligence Scores Based on Age Variable.

	Significant Differences Between Groups
General attitudes toward artificial intelligence	*3-1

*In favor; Groups: 1) 18-19 years old, 2) 20-21 years old, 3) 22-23 years old, 4) 24 years old +

According to the data in Table 7, statistically significant differences were found between pre-service teachers in the 22-23 age range and those in the 18-19 age range, with the pre-service teachers in the 22-23 age range showing more favorable results (Table 8).

According to Table 8, the pre-service teachers' general attitude scores toward artificial intelligence do not show a significant difference based on the field of study (p>.05). Therefore, it can be concluded that the general attitude scores of the pre-service teachers are independent of the field of study (Table 9).

According to Table 9, the pre-service teachers' general attitude scores toward artificial intelligence show a significant

Table 8: One-Way Analysis of Variance (ANOVA) Results for General Attitude Toward Artificial Intelligence Scores Based on Field of Study Variable

	Field of Study				*SV*	*SS*		*MS*	*F*	
General attitudes toward artificial intelligence	Verbal	562	3.41	0.55	B. Groups	1.07	3	0.36	1.42	.24
Quantitative		164	3.45	0.39	W. Groups	299.99	1192	0.25		
	Equally weighted	268	3.37	0.41	Total	301.06	1195			
	Language	202	3.36	0.56						
	Total	1196	3.40	0.50						

>.05

Table 9: One-Way Analysis of Variance (ANOVA) Results for General Attitude Toward Artificial Intelligence Scores Based on Class Level Variable

	Class Level				*SV*	*SS*		*MS*	*F*	
General attitudes toward artificial intelligence	1st Year	347	3.32	0.44	B. Groups	4.04	3	1.35	5.41	.00*
	2nd Year	352	3.39	0.53	W. Groups	297.02	1192	0.25		
	3rd Year	287	3.48	0.50	Total	301.06	1195			
	4th Year	210	3.42	0.52						
	Total	1196	3.40	0.50						

*<.01

difference based on their class level (p<.01). The results of the Scheffe post-hoc multiple comparison analysis, conducted to determine which groups the difference stems from, are presented in Table 10.

According to the data in Table 10, significant statistical differences were found between pre-service teachers in the 3rd year and those in the 1st year, with 3rd-year pre-service teachers showing more favorable results (Table 11).

Table 10. Scheffe Post-Hoc Multiple Comparison Analysis Results for General Attitude Toward Artificial Intelligence Scores Based on Class Level Variable.

	Significant Differences Between Groups
General attitudes toward artificial intelligence	*3-1

**In favor; Groups: 1) 1st year, 2) 2nd year, 3) 3rd year, 4) 4th year*

According to Table 11, pre-service teachers' general attitude scores toward artificial intelligence do not show a significant difference based on their grade point averages (p>.05). Accordingly, their general attitude scores are independent of their academic achievement levels.

Findings Related to the Fourth Sub-Problem

The fourth sub-problem of the study is formulated as follows: *"Do teacher candidates' AI literacy levels differ based on gender, age, field of study, class level, and GPA variables?"* The analysis results of AI literacy scores according to various variables are presented in Tables 12, 13, 14, 15, 16, 17, 18, and 19.

According to Table 12, pre-service teachers' artificial intelligence literacy scores do not show a significant difference based on gender (p>.05).

According to Table 13, pre-service teachers' artificial intelligence literacy scores do not show a significant difference

Table 11: One-Way Analysis of Variance (ANOVA) Results for General Attitude Toward Artificial Intelligence Scores Based on Grade Point Average (GPA) Variable

	Grade Point Average				*SV*	*SS*		*MS*	*F*	
General attitudes toward artificial intelligence	0.00-1.99	28	3.21	0.75	B. Groups	0.97	3	0.32	1.29	.28
2.00-2.49		205	3.41	0.47	W. Groups	300.09	1192	0.25		
	2.50-2.99	513	3.40	0.50	Total					
	3.00-4.00	450	3.40	0.50						
	Total	1196	3.40	0.50						

>.05

Table 12: Independent Samples T-Test Results for Artificial Intelligence Literacy Scores Based on Gender Variable

	Gender				*t*	*p*
Artificial intelligence literacy	Female	862	5.09	0.68	-1.83	.07
	Male	334	5.17	0.67		

df=1194, >.05

Table 13: One-Way Analysis of Variance (ANOVA) Results for Artificial Intelligence Literacy Scores Based on Age Variable

	Age				*SV*	*SS*		*MS*	*F*	
Artificial intelligence literacy	18-19	234	5.01	0.65	B. Groups	3.40	3	1.13	2.50	.06
	20-21	537	5.12	0.71	W. Groups	541.43	1192	0.45		
	22-23	333	5.17	0.64	Total	544.84	1195			
	24+	92	5.13	0.66						
	Total	1196	5.12	0.68						

>.05

Table 14: One-Way Analysis of Variance (ANOVA) Results for Artificial Intelligence Literacy Scores Based on Field of Study Variable

	Field of Study				*SV*	*SS*		*MS*	*F*	
Artificial intelligence literacy	Verbal	562	5.11	0.70	B. Groups	8.64	3	2.88	6.41	.00*
	Quantitative	164	5.06	0.63	W. Groups	536.19	1192	.45		
	Equally weighted	268	5.03	0.68	Total	544.84	1195			
	Language	202	5.29	0.61						
	Total	1196	5.12	0.68						

*<.01

based on age (p>.05). Thus, there is no relationship between AI literacy and students' age.

According to Table 14, pre-service teachers' artificial intelligence literacy scores show a significant difference based on their field of study (p<.01). The results of the Scheffe post-hoc multiple comparison analysis, conducted to determine which groups the difference stems from, are presented in Table 15.

Table 15: Scheffe Post-Hoc Multiple Comparison Analysis Results for Artificial Intelligence Literacy Scores Based on Field of Study Variable.

	Significant Differences Between Groups
Artificial intelligence literacy	*4-1, *4-2, *4-3

**In favor; Groups: 1) Verbal, 2) Quantitative, 3) Equally weighted, 4) Language*

According to the data in Table 15, statistically significant differences were found in favor of students studying in the language field compared to students in the verbal, quantitative, and equal weight fields.

According to Table 16, pre-service teachers' artificial intelligence literacy scores show a significant difference based on their class level (p<.01). The results of the Scheffe post-hoc multiple comparison analysis, conducted to determine which groups the difference stems from, are presented in Table 17.

Table 17: Scheffe Post-Hoc Multiple Comparison Analysis Results for Artificial Intelligence Literacy Scores Based on Class Level Variable

	Significant Differences Between Groups
Artificial intelligence literacy	*4-1, *2-1

**In favor; Groups: 1) 1st year, 2) 2nd year, 3) 3rd year, 4) 4th year*

Table 16: One-Way Analysis of Variance (ANOVA) Results for Artificial Intelligence Literacy Scores Based on Class Level Variable

	Class Level				*SV*	*SS*		*MS*	*F*	
Artificial intelligence literacy	1st Year	347	5.01	0.69	B. Groups	6.89	3	6.89	5.09	.00*
2nd Year		352	5.16	0.64	W. Groups	537.95	1192	537.95		
	3rd Year	287	5.11	0.69	Total	544.84	1195	544.84		
	4th Year	210	5.22	0.66						
	Total	1196	5.12	0.68						

*<.01

According to the data in Table 17, statistically significant differences were found in favor of fourth-year pre-service teachers compared to first-year pre-service teachers and in favor of second-year pre-service teachers compared to first-year pre-service teachers.

According to Table 18, pre-service teachers' artificial intelligence literacy scores show a statistically significant difference based on their grade point averages (p<.01). The results of the Scheffe post-hoc multiple comparison analysis, conducted to determine which groups the difference stems from, are presented in Table 19.

Table 18: One-Way Analysis of Variance (ANOVA) Results for Artificial Intelligence Literacy Scores Based on Grade Point Average (GPA) Variable

	Grade Point Average				*SV*	*SS*		*MS*	*F*	
Artificial intelligence literacy	0.00-1,99	28	5.04	0.80	B. Groups	5.65	3	1.88	4.16	.00*
2.00-2,49		205	5.03	0.69	W. Groups	539.18	1192	0.45		
	2.50-2.99	513	5.08	0.67	Total	544.84	1195			
	3.00-4.00	450	5.20	0.66						
	Total	1196	5.12	0.68						

*<.01

Table 19: Scheffe Post-Hoc Multiple Comparison Analysis Results for Artificial Intelligence Literacy Scores Based on Grade Point Average (GPA) Variable

	Significant Differences Between Groups
Artificial intelligence literacy	*4-2

*In favor; Groups: 1) 0.00-1.99, 2) 2.00-2.49, 3) 2.50-2.99, 4) 3.00-4.00

According to the data in Table 19, a statistically significant difference was found between pre-service teachers with a GPA in the range of 3.00-4.00 and those with a GPA in the range of 2.00-2.49, in favor of the pre-service teachers with a GPA of 3.00-4.00.

Conclusion and Discussion

In the study, it was found that students' general attitudes toward artificial intelligence were weaker compared to their AI literacy levels. A study conducted with pre-school teacher candidates (Mart & Kaya, 2024) revealed that teacher candidates had insufficient knowledge of artificial intelligence but expressed a desire to improve themselves. According to Çam et al. (2021), artificial intelligence technologies are considered by teacher candidates as a tool that will make life easier and save time from workload. The result obtained, which shows a positive but low-level relationship between teacher candidates' general attitudes toward artificial intelligence and their AI literacy, is consistent with the data from similar studies. Factors such as age, experience, field of study, class level, and gender have been found to influence attitudes toward artificial intelligence, with this effect varying in degree across each of these factors. Social learning (Bandura, 1977) is based on the claim that individuals learn through observation. In social learning, how individuals who possess a certain behavior perform it is crucial for the learning of that behavior. In social learning, how a behavior is performed by individuals who possess that behavior is important for its learning. The outcome or gain achieved by the individual performing the behavior is also influential in social learning. In social learning, factors such as gender, age, and status between the individual performing the behavior and the observer can play a role in the imitation of that behavior. In this study, which investigates the link between attitudes toward artificial intelligence and AI literacy, it has been identified that factors such as gender, age, class, field of study, and GPA should be considered in AI literacy processes. As a result, in the context of social influence, it is understood that teacher candidates affect one another and exhibit similar perspectives.

Male teacher candidates have a more positive general attitude toward artificial intelligence than female students. The lack of experience in STEM applications among female teacher candidates (González-Pérez et al., 2020), the existence of gender stereotypes (Eaton et al., 2020; Moè et al., 2021), uncertainties related to artificial intelligence, and their reservations regarding potential risks may have influenced their attitudes toward AI. The more positive attitude of male students compared to female students can be explained by cultural norms, their interest in technology, as well as individual interests and experiences.

It has been determined that the grade point average does not affect teacher candidates' general attitudes toward artificial intelligence. Individual and environmental factors have a greater impact on attitudes toward AI than the grade point average. The result related to the grade point average can again be explained by Bandura's (1977) social learning theory. It has been observed that teacher candidates' general attitudes toward artificial intelligence differ according to class level. This difference is particularly evident between the 1st and 3rd years. This situation can be explained by the fact that students in higher grades have more knowledge and experience, leading them to develop a more positive attitude toward artificial intelligence. AI applications can provide virtual facilitators to support teachers' work in the classroom. For example, at the Georgia Institute of Technology, students were introduced to a new teaching assistant named Jill Watson (JW) in their courses. JW independently responded to student

inquiries, answered routine frequently asked questions, and posted weekly announcements (Wolff et al., 2016).

In a study where the age factor was found to be related to attitudes toward artificial intelligence, it was observed that as the age of teacher candidates increases, their attitudes also become more positive. This suggests that with the increase in age, teacher candidates' perceptions of technology may mature as well.

Another finding in the study is that teacher candidates' general attitudes toward artificial intelligence do not differ based on the fields of study. The fact that their overall attitudes are independent of their fields of study suggests that attitudes toward artificial intelligence are shaped more by general and personal perceptions. Although there is no difference in attitudes toward artificial intelligence across different fields of study, it is believed that artificial intelligence will be capable of performing human activities to the extent that it could replace humans in various professions in the future. "As artificial intelligence and advancing technologies make progress in workplaces, it is clear that many routine, repetitive tasks will be taken over by virtual personal assistants and chatbots, and individuals will likely be given more time and freedom to focus on creative and cognitive tasks" (Sheikh, 2021, p. 9). As with all technological revolutions, in the future, companies will replace humans with algorithms, transportation will be provided without human intervention, transaction counters will replace cashiers, and so on. For this reason, it is necessary to shape the fields of study based on future developments in artificial intelligence and to act in the context of the reality that computers will replace human workers.

The study found no significant difference between teacher candidates' artificial intelligence literacy and their gender. The general belief is that female teacher candidates are more likely to adopt technology compared to males (Zhang et al., 2023). However, despite this traditional perception, there are studies that show no significant effect of gender on the adoption and use of artificial intelligence (Teo, 2010; Teo et al., 2015; Papadakis, 2018; Zhang et al., 2023). Similarly, this study found no significant difference between artificial intelligence literacy and gender.

The findings of the study indicate that students with higher academic achievement have higher artificial intelligence literacy. This result supports the expected relationship between achievement levels, access to information, and learning capacity. Personalized learning is made possible through artificial intelligence applications. Artificial intelligence applications in the education sector can customize the teaching approach according to each student's learning pace and optimize it according to individual needs (Mohd & Shahbodin, 2015). Personalized learning, the development of curriculum materials, technology-rich field experiences, administrative support, and the limitations of using technology in teacher training programs are seen as barriers to artificial intelligence literacy (Polly et al., 2010).

There is a significant difference in the artificial intelligence literacy of teacher candidates based on their grade levels. As the grade level increases, students are found to have higher levels of AI literacy. This difference may be explained by factors such as experience, the duration of education, and the courses taken. Holmes et al. (2023) stated that the integration of AI into education affects individuals' attitudes towards these technologies and, consequently, the development of AI literacy could be achieved through the integration of AI into education.

The study found that age does not have a direct effect on artificial intelligence literacy. Education and individual knowledge have a much greater impact on AI literacy than age. Spaced repetition aims to review information that is about to be forgotten (Spitzer, 1939). The SuperMemo application developed by Polish inventor Peter Woźniak is an application based on the effect of spaced repetition (Woźniak & Gorzelańczyk, 1994). The application, using artificial intelligence techniques, can determine when the likelihood of the user forgetting something is high and recommend a review.

Students' artificial intelligence literacy varies according to their field of study. Moreover, it has been found that students studying in the language field have higher AI literacy levels compared to those in other fields. This could be interpreted as language students possibly using technology and AI applications more intensively, or it may be due to the richer resources available in the language field. In the use of AI in education, the course content is tailored to each student's learning preferences and specific interests. Unlike traditional classroom teaching, AI-supported AI systems are designed to optimize learning efficiency. For example, Yixue Squirrel AI (Yixue) collects and analyzes students' behavioral data, updates student profiles, and provides timely personalized feedback to each student accordingly (Cui et al., 2018). The study has revealed the relationship between general attitudes toward AI and AI literacy, and evaluated the factors that influence the social acceptance and adoption of AI. It was concluded that integrating AI into education will enable teacher candidates to use technology consciously and effectively.

Suggestions

To develop positive attitudes toward AI and AI literacy, more practical AI education could be provided starting from primary and even preschool levels.

Efforts can be made to address concerns, ethical issues, and other barriers to the development of positive attitudes toward AI and AI literacy.

Inclusive approaches can be developed by parents and educators considering demographic factors such as gender differences and age.

Based on the understanding that both knowledge level and experience, as well as the field of study, influence attitudes toward AI, efforts can be made to provide students with hands-on experience and demonstrate the applicability of AI in every scientific field.

Limitations and Future Research

This study is limited to 1,196 pre-service teachers enrolled in the Faculty of Education at a university located in western Türkiye during the spring semester of the 2023-2024 academic year. The data collection instruments used in the study were the *General Attitudes Toward Artificial Intelligence Scale* and the *Artificial Intelligence Literacy Scale*. Accordingly, the findings of this research are restricted to the specified participants and the measurement tools employed. Results may vary if a different sample group or alternative assessment instruments are used. Future research can be conducted with different participants to examine pre-service teachers' attitudes toward artificial intelligence and their AI literacy levels in greater depth. In particular, investigating the relationship between attitudes toward AI technologies and AI literacy levels among pre-service teachers from various disciplines may provide significant contributions to the field.

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The authors contributed equally to this research.

Ethical Statement

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