A Study on Measuring AI Literacy of Pre-service Secondary School Teachers

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[Abstract]

With the emergence and advancement of artificial intelligence, the world is rapidly changing. As artificial intelligence is applied across various fields of society, individuals must develop the ability to understand and effectively utilize it. Consequently, interest in AI literacy has been growing. This study was conducted to measure AI literacy among pre-service secondary school teachers. An online survey was administered to 105 students enrolled in the College of Education at A University. Data analysis included descriptive analysis, independent samples t-test, and one-way ANOVA. The results are as follows. First, an analysis of the mean differences in AI literacy sub-factors and overall scores by gender revealed that female pre-service teachers scored higher than males in AI understanding, AI usage, AI application, and AI literacy overall, with these differences being statistically significant. Second, based on the number of courses completed related to teaching methods, there were statistically significant differences in AI creation and AI identification. Specifically, pre-service teachers who had not completed any relevant courses scored lower in AI creation and AI identification compared to those who had completed at least one course. Third, the overall level of AI literacy among pre-service secondary school teachers was found to be relatively low. Based on these findings, implications for teacher education are discussed.

Key Words: Artificial intelligence, Teacher education, AI Literacy, Undergraduate education

I. Introduction

The world is rapidly changing due to artificial intelligence (AI) [1]. As AI technology advances and becomes more integrated into society, significant transformations are emerging across various sectors, such as autonomous vehicles, chatbots, and the Internet of Things (IoT). In the business world, AI is expected to drastically improve productivity and work efficiency, leading to substantial corporate growth and increased profits.

AI is anticipated to have positive impacts across numerous areas of society [2]. For instance, AI-powered autonomous vehicles could provide people with much more comfortable travel experiences while reducing the number of traffic accidents. AI is also expected to address the workforce shortages caused by aging populations by replacing labor-intensive jobs and enhancing efficiency. In the environmental sector, AI could predict temperature changes and offer solutions to mitigate the risks of climate-related disasters, helping humanity better prepare for such events. In healthcare, AI could be utilized to accurately diagnose rare diseases and develop effective treatment plans.

As AI is applied in a growing number of fields, there is a growing consensus that people must develop the ability

to understand and effectively use AI [3]. This has led to increased interest in AI literacy. Literacy traditionally refers to the ability to read and write, so AI literacy refers to the ability to understand various aspects of AI and its mechanisms, and to use this knowledge accurately and ethically to improve human life. As AI continues to advance, developing a strong foundational understanding of AI is crucial for individuals to effectively manage unforeseen challenges, such as AI making incorrect decisions or causing ethical issues.

Recently, a variety of studies on AI literacy have been reported internationally [4,5], including the development of AI literacy scales and efforts to draw insights from precise assessments. However, in Korea, such research is still lacking. Measuring AI literacy levels is essential, as it can provide insights into areas needing improvement [6]. Korea aims to introduce AI-based digital textbooks into school education from 2025 [7]. Therefore, it is necessary for pre-service teachers to evaluate and supplement their AI literacy skills through accurate assessments. This study aims to measure the AI literacy of pre-service secondary school teachers.

II. Theoretical Background

A. The Areas of AI in education

Research related to AI in education has thus far been largely categorized into three areas [8]: AI curricula, AI educational practices, and the application of AI technologies. First, AI curricula involve the delivery of a wide range of knowledge related to AI, including concepts such as AI fundamentals, operational principles, machine learning and deep learning, as well as AI ethics. Second, research on AI educational practices focuses on the development of interdisciplinary education programs that integrate AI technologies with various subject areas, as well as the analysis of their effectiveness. Third, the application of AI technologies in schools aims to support student learning and assist teachers in their tasks, with research analyzing the effectiveness of such implementations.

B. The Definitions of AI Literacy

Regarding the concept of AI literacy, Kim (2024) [9] defined literacy as the ability to read and write— specifically, the ability to accurately understand and apply essential knowledge in a particular field. However, the concept of literacy has recently evolved to encompass the communicative ability to contribute to building a better world using one's skills. Thus, the concept of literacy shifts slightly in response to societal changes. In sum, literacy today can be defined as not only the individual's knowledge and understanding of a particular domain but also their communicative ability to contribute through social practices. In behaviorism, literacy was simply conceptualized as the ability to read and write. Cognitivism, however, describes literacy as the ability of both the knower and the reader to construct meaning from their own perspectives. From the standpoint of social constructivism, literacy is recognized as the capability of individuals to construct meaning from context and communicate it, influenced by various external factors. Finally, in the postmodern era, literacy has been conceptualized as the ability to select and utilize appropriate technologies from the internet and computers to connect various pieces of information meaningfully.

In the era of artificial intelligence, literacy has taken on a new dimension. In a super-intelligent, hyper-connected society, literacy serves as a mediating function between AI and humans [5]. Connectivity has evolved around the internet and digital networks, with its importance highlighted by the advancement of big data. AI literacy, a concept that emerged in the early 21st century, has been increasingly used since 2010 as AI technologies became more complex and garnered greater societal attention. AI literacy is defined not merely as the ability to read and write but as the ability to apply and practice knowledge in various fields related to AI. Specifically, AI literacy refers to the ability of individuals to accurately understand AI-related knowledge, objectively evaluate AI technologies, collaborate effectively with AI, and use AI for personal or societal purposes.

C. The Concepts of AI Literacy

Different researchers have defined the concepts of

AI literacy in diverse ways. Researchers approach AI literacy based on their perspective, dividing it into different components and conducting research accordingly. For instance, UNESCO categorizes AI literacy into basic knowledge of AI, its ethical and social implications, and the understanding of AI development and application [10]. Long and Magerco (2020) conceptualized AI literacy into five components [11]. First is the ability to define complex AI concepts and clearly distinguish between AI and non-AI systems. Second, the application of AI involves understanding both the strengths and limitations of AI and being able to utilize it in problem-solving processes. Third, the principles of AI refer to the accurate understanding of the fundamental principles that govern AI operations and its related technologies. Fourth, AI ethics encompass the ability to grasp various ethical issues surrounding AI and evaluate real-world cases. Lastly, AI awareness refers to public perception, aimed at understanding the general public's perspective to advance AI literacy education.

This study utilizes the questionnaire developed in the research of Hwang et al. (2024) [4]. In this study, AI literacy is categorized into AI identification, AI understanding, AI usage, AI application, and AI creation.

First, AI identification consists of two questions: "I know how AI technologies assist my daily life (AI identification 1)" and "I can distinguish between AI-embedded devices and those without AI (AI identification 2)."

Second, AI understanding comprises three questions: "I understand that AI learns from data and implements intelligent functions based on it (AI understanding 1)," "I am aware that AI can implement visual functions through image and video recognition (AI understanding 2)," and "I know how information is processed and reproduced by AI (AI understanding 3)."

Third, AI usage includes four questions: "I can select appropriate models to solve problems using AI (AI usage 1)," "I can choose the most suitable AI applications and products for various specific tasks (AI usage 2)," "I can use AI applications and products to work more efficiently (AI usage 3)," and "I can use data for learning, decision-making, and problem-solving (AI usage 4)."

Fourth, AI application consists of four questions: "I can utilize AI to achieve the necessary outcomes (AI application
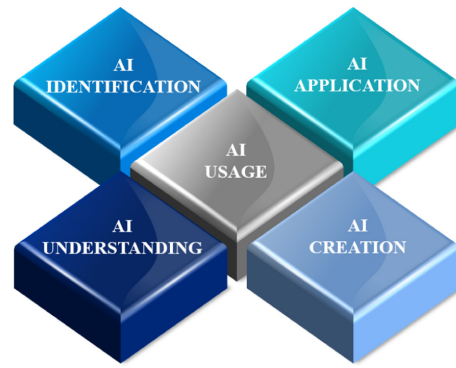

Fig. 1. Five Sub-categories in AI Literacy Scale.

1)," "I have experience interacting with various types of AI, such as chatbots and visual recognition agents (AI application 2)," "I can effectively apply AI applications or products in my daily life (AI application 3)," and "I can use AI to achieve my life goals (AI application 4)."

Lastly, AI creation includes four questions: "I have experience developing AI models, such as neural networks (AI creation 1)," "I can develop new applications in the field of AI (AI creation 2)," "I can choose useful tools to program AI (AI creation 3)," and "I understand the significance of neural networks within AI algorithms (AI creation 4)."

III. Research Methods

A. Participants

A survey was conducted among students enrolled in the College of Education at A University for this research. The survey was administered in the form of an online questionnaire, and responses from 105 participants

Table 1. Participants by student characteristics

Variable	Details	Number of Students	Percent
Gender	Male	56	53.3
	Female	49	46.7
Grade Level	Freshman	18	17.1
	Sophomore	25	23.8
	Junior	52	49.5
	Senior	10	9.5
Total		105	100.0

were analyzed. The demographic characteristics of the participants are presented in the following Table 1.

B. Instrument

For this study, the questionnaire developed by Hwang et al. (2024) was utilized [4]. In this study, AI literacy is categorized into AI identification, AI understanding, AI usage, AI application, and AI creation. Since the survey items were thoroughly introduced in the literature review, they will not be repeated in this chapter. Background variables included gender, age, academic year, the city where participants grew up, and the number of courses completed related to teaching methods.

The reliability of the AI literacy scale was measured, and the overall reliability coefficient was found to be .941. The reliability coefficients for each sub-factor were as follows: AI identification .685, AI understanding .76, AI usage .939, AI application .935, and AI creation .852.

C. Data Analysis

The data analysis procedure for this study is as follows. Descriptive analysis was conducted to analyze the responses of pre-service teachers for each survey item. Then, t-tests and one-way analysis of variance (ANOVA) were used to examine the differences in AI literacy levels according to background variables. Specifically, the researchers performed an independent samples t-test to analyze AI literacy levels based on gender. Additionally, ANOVA was conducted to analyze AI literacy levels according to grade level and the number of methods courses taken.

IV. Results

A. Mean Differences by Group

1) AI Identification

The results of the analysis on the mean differences according to gender, grade level, and the number of completed courses related to instructional methods are presented in the following Table 2. Among these, the mean difference in AI identification based on the number of completed courses related to instructional methods was statistically significant. A Scheffe post-hoc test revealed that pre-service teachers who had completed two or more courses had a higher mean score than those who had not completed any courses.

2) AI Understanding

The results of the analysis on the mean differences according to gender, grade level, and the number of

Table 2. Mean Differences by Student Characteristics in AI Identification

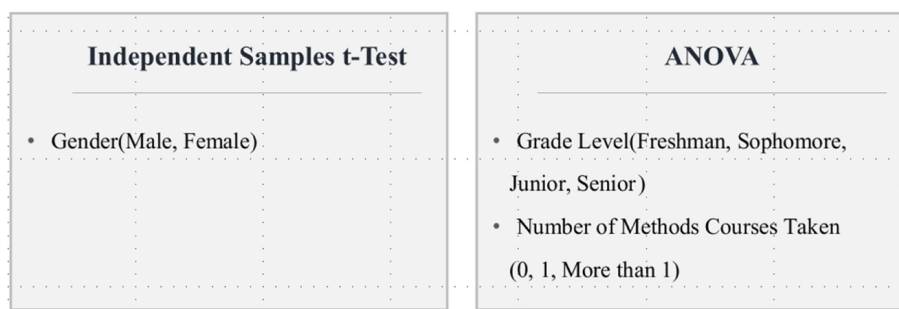| Variable	Details	M	SD	t/F	Scheffe
Gender	Male	3.25	0.78	−1.770	
	Female	3.51	0.65		
Grade Level	Freshman	3.25	0.75	1.141	
	Sophomore	3.30	0.64		
	Junior	3.38	0.78		
	Senior	3.75	0.58		
Number of Methods Courses Taken	0	3.22	0.78	4.554*	More than 1 〉 0
	1	3.24	0.67		
	More than 1	3.67	0.61		

*p〈0.05, **p〈0.01, ***p〈0.001

Fig. 2. Statistical Model.

Table 3. Mean Differences by Student Characteristics in AI Understanding

Variable	Details	M	SD	t/F	Scheffe
Gender	Male	2.98	0.83	−3.378**	
	Female	3.47	0.60		
Grade Level	Freshman	3.31	0.75	0.184	
	Sophomore	3.25	0.65		
	Junior	3.16	0.82		
	Senior	3.20	0.91		
Number of Methods Courses Taken	0	3.22	0.78	0.49	
	1	3.17	0.84		
	More than 1	3.22	0.73		

*$p<0.05$, **$p<0.01$, ***$p<0.001$

completed courses related to instructional methods are presented in the following Table 3. Among these, the mean difference in AI understanding based on gender was statistically significant. Female pre-service teachers had a higher mean score than their male counterparts, and this difference was statistically significant.

3) AI Usage

The results of the analysis on the mean differences according to gender, grade level, and the number of completed courses related to instructional methods are presented in the following Table 4. Among these, the mean difference in AI usage based on gender was statistically significant. Female pre-service teachers had a higher mean score than their male counterparts, and this difference was statistically significant.

Table 4. Mean Differences by Student Characteristics in AI Usage

Variable	Details	M	SD	t/F	Scheffe
Gender	Male	2.61	1.04	−3.011**	
	Female	3.16	0.82		
Grade Level	Freshman	2.48	1.03	1.710	
	Sophomore	3.14	1.04		
	Junior	2.84	0.85		
	Senior	3.05	1.21		
Number of Methods Courses Taken	0	2.68	0.99	1.406	
	1	2.97	0.99		
	More than 1	3.03	0.93		

*$p<0.05$, **$p<0.01$, ***$p<0.001$

Table 5. Mean Differences by Student Characteristics in AI Application

Variable	Details	M	SD	t/F	Scheffe
Gender	Male	2.88	0.94	−3.089**	
	Female	3.42	0.81		
Grade Level	Freshman	2.95	1.10	0.344	
	Sophomore	3.21	0.88		
	Junior	3.18	0.83		
	Senior	3.05	1.15		
Number of Methods Courses Taken	0	3.03	1.03	0.585	
	1	3.14	0.89		
	More than 1	3.26	0.78		

*$p<0.05$, **$p<0.01$, ***$p<0.001$

4) AI Application

The results of the analysis on the mean differences according to gender, grade level, and the number of completed courses related to instructional methods are presented in the following Table 5. Among these, the mean difference in AI application based on gender was statistically significant. Female pre-service teachers had a higher mean score than their male counterparts, and this difference was statistically significant.

5) AI Creation

The results of the analysis on the mean differences according to gender, grade level, and the number of completed courses related to instructional methods are presented in the following Table 6. Among these, the mean

Table 6. Mean Differences by Student Characteristics in AI Creation

Variable	Details	M	SD	t/F	Scheffe
Gender	Male	1.79	0.82	−0.854	
	Female	1.92	0.70		
Grade Level	Freshman	1.45	0.63	2.635	
	Sophomore	1.99	0.78		
	Junior	1.86	0.73		
	Senior	2.20	0.92		
Number of Methods Courses Taken	0	1.51	0.63	10.965***	1 > 0
	1	2.32	0.76		More than 1 > 0
	More than 1	1.95	0.74		

*$p<0.05$, **$p<0.01$, ***$p<0.001$

Table 7. Mean Differences by Student Characteristics in AI Literacy Overall

Variable	Details	M	SD	t/F	Scheffe
Gender	Male	2.62	0.73	−3.073**	
	Female	3.03	0.58		
Grade Level	Freshman	2.59	0.73	0.965	
	Sophomore	2.92	0.68		
	Junior	2.81	0.64		
	Senior	2.95	0.91		
Number of Methods Courses Taken	0	2.65	0.70	2.168	
	1	2.92	0.76		
	More than 1	2.94	0.61		

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

difference in AI creation based on the number of completed courses related to instructional methods was statistically significant. A Scheffe post-hoc test showed that pre-service teachers who had completed one or more courses had a higher mean score than those who had not completed any courses.

6) AI Literacy Overall

The results of the analysis on the mean differences according to gender, grade level, and the number of completed courses related to instructional methods are presented in the following Table 7. Among these, the mean difference in AI literacy overall based on gender was statistically significant. Female pre-service teachers had a higher mean score than their male counterparts, and this difference was statistically significant.

V. Discussion and Conclusion

This study was conducted to measure AI literacy among pre-service secondary school teachers. The findings are as follows.

First, when analyzing the mean differences in AI literacy sub-factors and overall scores by gender, female pre-service teachers scored higher than their male counterparts in AI understanding, AI usage, AI application, and AI literacy overall, with these differences being statistically significant. This suggests that female pre-service teachers have higher competencies in AI knowledge and application and are more prepared to utilize AI in instruction. However, these findings differ somewhat from previous research. Altun (2013) reported that male students exhibited a higher sense of self-efficacy in technology due to more frequent use of technologies such as the internet [12]. Similarly, Yoon (2022) found that while male pre-service teachers had higher general digital competence than females, they showed lower digital efficacy in activities aimed at instructional purposes [13].

Second, when analyzing the differences in AI literacy sub-factors and overall scores based on the number of completed courses related to teaching methods, significant differences were found in AI creation and AI identification. Specifically, pre-service teachers who had not completed any relevant courses scored lower in AI creation and AI identification compared to those who had completed at least one course. These results suggest that courses such as teaching methods, educational technology, and subject-specific pedagogy may have a potential link to the development of AI literacy among pre-service teachers. Therefore, continuous support should be provided to ensure that instructors of these courses can integrate AI literacy content into their teaching.

Third, the overall AI literacy level of pre-service secondary teachers was not high. In particular, AI creation scored the lowest among all sub-domains, falling below the average, which indicates the urgent need for education in this area. AI creation involves developing models or new applications related to AI. Teacher educators should strive to enhance pre-service teachers' competencies in this area. Similarly, AI usage was also found to be at a low level, suggesting the need for additional training.

The Korea Ministry of Education has recommended that from the 2024 academic year, all teacher education programs include a compulsory course titled "Digital Education." All universities offering teacher training programs are required to offer this course, which must incorporate at least 50% AI-related content. This initiative is expected to significantly improve the AI educational competencies of pre-service teachers.

AI education is currently being emphasized in schools. Starting in 2025, the Korea Ministry of Education plans to introduce AI digital textbooks and expand their use over

time. Accordingly, teacher education institutions need to accurately assess the AI literacy of pre-service teachers and support the enhancement of their AI teaching competencies. Researchers hope that this study will serve as foundational data in these efforts.

References

[1] K. Chowdhary, *Fundamentals of Artificial Intelligence*, Springer, 2020.

[2] J. Finlay, *An Introduction to Artificial Intelligence*, Crc Press, 2020.

[3] B. Schmarzo, *AI & Data Literacy: Empowering Citizens of Data Science*, Packt Publishing Ltd., 2023.

[4] H. Hwang, Y. Hwang, J. Park, M. Shin, and H. Lee, "A study on the development and validity verification of measurement tool for AI literacy," *The Korean Journal of Literacy Research*, vol. 15, no. 2, pp. 247-278, 2024.

[5] B. A. Anders, "The AI literacy imperative: Empowering instructors & students," Independently published, 2023.

[6] T. Lintner, "A systematic review of AI literacy scales," *npj Science of Learning*, vol. 9, no. 1, p. 50, 2024.

[7] S. Kim and J. Choi, "English Teachers' Post-COVID-19 adoption of digital textbooks and their prospects for future learning platforms and textbook formats," *Korean Journal of English Language and Linguistics*, vol. 24, pp. 689-707, 2024.

[8] J. Velander, M. A. Taiye, N. Otero, and M. Milrad, "Artificial intelligence in K-12 education: Eliciting and reflecting on swedish teachers' understanding of AI and its implications for teaching & learning," *Education and Information Technologies*, vol. 29, no. 4, pp. 4085-4105, 2024.

[9] S. Kim, "Conceptualizing AI literacy and educational considerations: Focusing on the reconception of literacy and Korean language education," *Reading Research*, vol. 70, pp. 101-136, 2024.

[10] F. Miao and K. Shiohira, "K-12 AI curricula. A mapping of government-endorsed AI curricula," UNESCO Publishing, 2022.

[11] D. Long and B. Magerko, "What is AI literacy? Competencies and design considerations," in Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, 2020.

[12] T. Altun, "Examination of classroom teachers' technological, pedagogical and content knowledge on the basis of different variables," *Croatian Journal of Education*, vol. 15, no. 2, pp. 365-397, 2013.

[13] S. H. Yoon, "Gender and digital competence: Analysis of pre-service teachers' educational needs and its implications," *International Journal of Educational Research*, vol. 114, p. 101989, 2022.

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