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Investigating Factors in Artificial Intelligence Literacy for Korean Elementary School Students

Hyunwoo Moon [a], HakNeung Go [a], Youngjun Lee [a,*], Seong-Won Kim [b]

[a] *Korea National University of Education, Cheongju, 28173, Republic of Korea*
[b] *Chosun University, Dong-Gu, Gwangju, 61452, Republic of Korea*
Corresponding author: [*] yjlee@knue.ac.kr

***Abstract*— In recent years, Artificial Intelligence (AI) has rapidly evolved due to significant improvements in computing performance, increased utilization of large datasets, and algorithm advancements, leading to widespread societal changes. These developments promise innovative applications of AI across various fields but highlight the necessity of ethical use and deep understanding of AI, underscoring the importance of AI literacy. While current research on AI literacy primarily focuses on secondary and higher education, the need for education that impacts cognitive and social development at the elementary level is increasingly emphasized. Furthermore, understanding the factors influencing AI literacy is crucial for educators and policymakers in designing and implementing effective AI education programs. This study investigated how gender, grade level, experiences related to AI, interest in AI, and programming language experience affect AI literacy among elementary students, revealing that these factors significantly impact AI literacy levels. Male students showed higher AI literacy than female students, and AI literacy improved with higher grade levels. Direct and indirect experiences related to AI positively influenced literacy improvement, and high interest in AI and experience with programming languages played essential roles. These findings provide evidence for developing effective AI education strategies for elementary students, emphasizing the importance of educational programs that meet students' diverse backgrounds and needs. These factors in AI education can enhance students' literacy levels and contribute to nurturing talents equipped with the necessary technical, ethical, and problem-solving skills for future society.**

***Keywords*— Artificial intelligence; artificial intelligence literacy; elementary school student; social factors.**

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I. INTRODUCTION

In recent years, Artificial Intelligence (AI) has rapidly advanced due to significant improvements in computing power, increased accessibility to vast data, and progressive algorithm innovations [1]. This advancement has introduced fundamental changes across various sectors of society, from daily life to the labor market [1]. AI technology-led innovations in diverse fields such as education, healthcare, and manufacturing are expected to bring positive shifts in people's lifestyles and work methods [2]. However, alongside these anticipated benefits, ethical concerns related to AI's development highlight the importance of a deep understanding of the technology and the need for AI literacy [3], [4]. AI literacy extends beyond mere technical knowledge to include ethical judgment, problem-solving capabilities, and an understanding of AI technology's societal impact [5]. This skill set is essential for all citizens, especially future generations [6]-[10].

With the growing importance of AI literacy, research focused on K-12 education is on the rise [11]. Although current research on AI literacy primarily concentrates on secondary and higher education [9], [12], education at the elementary level, which significantly influences children's cognitive and social development, is equally important [13], [14]. Education during this period contributes to forming a positive attitude towards technology among children and lays the foundation for lifelong learning. Hence, there is a timely need for research and education on AI literacy within elementary education.

Identifying the factors influencing AI literacy is crucial for educators and policymakers to design and implement effective AI education programs. However, research exploring the factors affecting AI literacy remains scarce. It is

necessary to investigate the impact of various factors on AI literacy [15].

Factors such as the digital divide, educational opportunities, personal interest, and attitudes could influence AI literacy [15], [16]. Most existing studies target students in middle school and above, indicating a research gap for younger age groups. Considering the importance of elementary education in students' learning and understanding of AI-related technologies, there is a compelling need for research on the factors affecting AI literacy among elementary students.

Therefore, this study aims to systematically analyze how factors like the digital divide, educational opportunities, personal interest, and attitudes impact the AI literacy of elementary students. By doing so, it seeks to provide educators and policymakers with insights necessary for developing effective AI education programs and strategies that reflect students' diverse backgrounds and needs.

II. Materials and Methods

A. Materials

The concept of literacy, originating from the fundamental ability of language decoding necessary for humans as social beings, has evolved alongside the changes in eras. Beginning with acquiring knowledge through ancient texts, this concept expanded into more complex and diversified forms with the advent of the digital age. The emergence of mass media and the development of visual media added visual elements to literacy, extending its concept. At the same time, the ubiquity of computers and the internet introduced the notions of computer literacy and information literacy [17], [18].

This evolution of literacy has brought to the forefront the necessity of a new dimension of literacy, namely AI literacy, with the rapid advancement of AI, a vital technology of the 4.0 Industrial Revolution [10], [19]. As technology progresses, the definition and scope of AI literacy continue to expand. Moving beyond the essential ability to read and write, AI literacy encompasses the understanding and utilization of artificial intelligence technology, critical thinking, and ethical judgment [5].

By synthesizing various definitions and analyses by previous researchers, the core elements of AI literacy are as follows: First, the understanding and application of technology. This refers to the ability to comprehend the basic principles and applications of AI and apply it as a problem-solving tool across various settings such as daily life, education, and the workplace [5], [10], [20], [21]. It contributes to effectively using a range of tools and services AI provides to improve the quality of life for individuals and society.

Secondly, critical thinking and ethical judgment. This involves the ability to evaluate AI technology and its outcomes critically and to make decisions by considering the social and ethical impacts of the technology [10], [22]-[24]. It includes critical thinking about the results and recommendations of AI technology and assessing its ethical and social implications on society and individuals. Recognizing the potential negative effects of AI technology and setting ethical standards to address these issues is essential to AI literacy. This fosters the internalization of necessary ethical attitudes towards using AI, considering its positive and negative impacts on society.

Thirdly, problem-solving capacity. This refers to the ability to identify and creatively solve various problems using AI [9], [21]. It encompasses the capability to program and apply AI in problem-solving, as well as the ability to create outcomes using AI technology. Learners cultivate AI problem-solving skills, enabling them to use AI technology with creative and integrative beyond technical fields.

Fourthly, social participation capacity. Beyond understanding and utilizing AI technology, this entails the ability to actively engage in society on issues arising in an AI society based on critical thinking and ethical values [10], [23]. By cultivating this capacity, individuals can communicate between humans and AI and through AI.

These elements are crucial for individuals to effectively function in future society and maximize the opportunities provided by AI technology. Therefore, emphasizing and enhancing AI literacy is essential in preparing for and responding to future societal needs.

B. Methods

1) Overview: To analyze the factors affecting AI literacy among elementary students, a survey on AI literacy was conducted targeting elementary school students, as shown in Table 1. The analysis focused on identifying the factors that influence AI literacy. Through this process, factors impacting AI literacy were derived.

TABLE I
CHARACTERISTICS OF PARTICIPANTS

Characteristics	N	
Gender		
Male	446	(54.1)
Female	379	(45.9)
Grade		
5th	390	(47.3)
6th	435	(52.7)
Indirect experiences with AI		
Yes	781	(94.7)
No	44	(5.3)
Direct experiences with AI		
Yes	757	(91.8)
No	68	(8.2)
Experiences of AI education		
Yes	682	(82.7)
No	143	(17.3)
Experience with programming language type		
None	241	(29.2)
Block based programming language	398	(48.2)
Text based programming language	54	(6.5)
Both	132	(16.0)
Interest toward AI		
Not at all interested	48	(5.8)
Not interested	108	(13.1)
Neutral	243	(29.5)
Interested	235	(28.5)
Very interested	191	(23.2)

2) Participants: This study included 825 fifth and sixth-grade students from Korean elementary schools. The characteristics of the participants were 54% male and 46% female, with 47% in the 5th grade and 53% in the 6th grade. Regarding experience with AI, more than 90% of the students reported having direct or indirect experience with AI. Therefore, the majority of elementary students had some form of direct or indirect experience with AI. In terms of AI education experience, over 80% of the students had some educational experience with AI. Regarding the programming languages they had experience with, 48% of students had block-based programming languages, 7% had text-based programming languages, 16% had experience with both block-based and text-based languages, and 29% had no experience with programming languages. and 29% had no experience with any programming language. Regarding student interest in artificial intelligence (AI), over half of the students, precisely 52%, indicated a positive interest (ranging from interested to very interested) in AI. Conversely, a smaller fraction, 19% of the students, expressed a lack of interest (spanning from uninterested to not at all interested). The characteristics of the study participants are shown in Table 1.

3) Measurements: In this study, the Artificial Intelligence Literacy Scale (AILS), developed by Kim and Lee (2022), was used to measure AI literacy [5]. The AILS consists of six sub-factors: the social impact of AI, AI implementation plans, AI problem-solving, understanding AI, data literacy, and AI ethics. The test includes 30 items, and responses are based on a 5-point Likert scale. The Cronbach's alpha values of the test instrument ranged from .861 to .939, indicating its reliability. The reliability of the test instrument used in this study is presented in Table 2.

TABLE II
THE RELIABILITY OF THE TEST TOOL

Factor	N	Cronbach's α	
Social impact of AI	8	.939	.970
Understanding of AI	6	.919	
AI execution plan	5	.928	
Problem solving with AI	5	.919	
Data Literacy	4	.897	
AI ethics	2	.861	

In addition to AI literacy, characteristics of the study subjects were investigated, including artificial intelligence-related experiences (indirect, direct, education, programming), gender, grade, and interest in AI, referencing prior research [5], [15], [16].

4) Analysis: To investigate the factors affecting AI literacy among elementary school students, a study was conducted targeting elementary school students in Korea. The study examined factors according to the subjects' characteristics. For analysis, independent sample t-tests or ANOVA were used. Additionally, Bonferroni was utilized for post-hoc testing of ANOVA.

III. RESULT AND DISCUSSION

A. AI Literacy According to Gender

When examining the difference in AI literacy by gender, males (M=3.23, SD=.77) had higher AI literacy than females (M=2.98, SD=.70). Furthermore, the difference in gender was statistically significant with t=4.81, p<.01. Upon examining the specific factors, males had higher AI literacy across all factors compared to females (see Table 3).

TABLE III
ELEMENTARY SCHOOL STUDENTS' AI LITERACY ACCORDING TO GENDER

Factor	Group	*M*	*SD*	*t*	*p*
SIAI	Male	3.46	.83	3.13	.00*
	Female	3.29	.76		
UAI	Male	3.09	.87	5.14	.00*
	Female	2.78	.83		
AIEP	Male	3.06	.89	5.18	.00*
	Female	2.75	.82		
PSAI	Male	3.32	.84	3.29	.00*
	Female	3.13	.79		
DL	Male	3.10	.91	5.00	.00*
	Female	2.79	.85		
AIE	Male	3.22	.95	3.83	.00*
	Female	2.98	.85		
Total	Male	3.23	.77	4.81	.00*
	Female	2.98	.70		

SIAI: Social impact of AI, UAI: Understanding of AI, AIEP: AI execution plans, PSAI: Problem-Solving with AI, DL: Data Literacy, AIE: AI Ethics
*p< .05

B. AI literacy According to Grade Level

When examining the difference in AI literacy by grade level, the 6th graders (M=3.19, SD=.81) had higher AI literacy than the 5th graders (M=3.04, SD=.67). Furthermore, the difference in grade level was statistically meaningful with t=-2.78, p<.01. Upon examining the specific factors, significant differences were observed in all aspects except for the social impact of AI (t=-1.85, p=.06) (see Table 4).

TABLE IV
ELEMENTARY SCHOOL STUDENTS' AI LITERACY ACCORDING TO GRADE LEVEL

Factor	Group	*M*	*SD*	*t*	*p*
SIAI	5th	3.33	.72	-1.85	.06
	6th	3.43	.87		
UAI	5th	2.86	.76	-2.73	.01*
	6th	3.03	.95		
AIEP	5th	2.82	.81	-2.99	.00*
	6th	3.00	.91		
PSAI	5th	3.16	.77	-2.34	.02*
	6th	3.29	.86		
DL	5th	2.87	.82	-2.74	.01*
	6th	3.04	.96		
AIE	5th	3.05	.85	-1.99	.05*
	6th	3.17	.96		
Total	5th	3.04	.67	-2.78	.01*
	6th	3.19	.81		

*p< .05

C. AI literacy According to Indirect Experience with AI

Students who had indirect experience with AI (M=3.14, SD=.74) had higher AI literacy compared to students without any experience (M=2.68, SD=.75), and the distinction between the two groups was found to be statistically

meaningful (t=4.08, p<.01). Significant variances were noted across all examined factors. (see Table 5).

TABLE V
ELEMENTARY SCHOOL STUDENTS' AI LITERACY ACCORDING TO INDIRECT EXPERIENCES WITH AI

Factor	Experience	*M*	*SD*	*t*	*p*
SIAI	Yes	3.41	.79	4.31	.00*
	No	2.88	.92		
UAI	Yes	2.98	.86	3.81	.00*
	No	2.47	.78		
AIEP	Yes	2.93	.87	2.52	.01*
	No	2.60	.79		
PSAI	Yes	3.26	.81	3.83	.00*
	No	2.77	.87		
DL	Yes	2.98	.89	3.20	.00*
	No	2.54	.84		
AIE	Yes	3.14	.91	3.17	.00*
	No	2.69	.80		
Total	Yes	3.14	.74	4.08	.00*
	No	2.68	.75		

*p< .05

D. AI Literacy According to Direct Experience with AI

Students who had direct experience with AI (M=3.14, SD=.74) had higher AI literacy compared to students without any experience (M=2.90, SD=.75), and the variance between the two groups reached statistically meaningful (t=2.53, p<.01). While significant disparities were detected across most factors, exceptions were found in data literacy (t=1.15, p=.25), and AI ethics (t=.66, p=.51) indicating no significant difference in these areas. (see Table 6).

TABLE VI
ELEMENTARY SCHOOL STUDENTS' AI LITERACY ACCORDING TO DIRECT EXPERIENCES WITH AI

Factor	Experience	*M*	*SD*	*t*	*p*
SIAI	Yes	3.40	.80	2.30	.02*
	No	3.17	.83		
UAI	Yes	2.97	.87	2.19	.03*
	No	2.73	.86		
AIEP	Yes	2.94	.87	2.87	.00*
	No	2.63	.84		
PSAI	Yes	3.26	.81	3.11	.00*
	No	2.94	.88		
DL	Yes	2.97	.90	1.15	.25
	No	2.84	.88		
AIE	Yes	3.12	.91	0.66	.51
	No	3.04	.92		
Total	Yes	3.14	.74	2.53	.01*
	No	2.90	.75		

*p< .05

E. AI literacy According to AI education Experience

Students who had experienced AI education (M=3.13, SD=.75) demonstrated slightly higher levels of AI literacy than those lacking such experience (M=3.06, SD=.75). However, the disparity between these two groups did not achieve statistical significance (t=1.12, p=.26). In line with this, no significant differences were identified in all factors pertaining to AI literacy (see Table 7).

TABLE VII
ELEMENTARY SCHOOL STUDENTS' AI LITERACY ACCORDING TO EXPERIENCES OF AI EDUCATION

Factor	Experience	*M*	*SD*	*t*	*p*
SIAI	Yes	3.39	.81	0.84	.40
	No	3.33	.79		
UAI	Yes	2.97	.87	1.09	.28
	No	2.88	.86		
AIEP	Yes	2.93	.87	1.19	.23
	No	2.84	.89		
PSAI	Yes	3.25	.81	1.46	.14
	No	3.14	.85		
DL	Yes	2.97	.90	0.80	.42
	No	2.90	.91		
AIE	Yes	3.11	.91	-0.03	.98
	No	3.12	.93		
Total	Yes	3.13	.75	1.12	.26
	No	3.06	.75		

*p< .05

F. AI Literacy According to Interest in AI

AI literacy showed a significant difference based on interest in AI (F (4, 239) =54.16, p<.01). The more significant the interest in AI, the higher the AI literacy. Post-hoc test indicated that while there were differences in the results across factors, generally, the AI literacy of the group with no interest in AI (not interested, not at all interested) was lower compared to other groups, and AI literacy increased with higher interest in AI (see Table 8).

TABLE VIII
ELEMENTARY SCHOOL STUDENTS' AI LITERACY ACCORDING TO INTEREST IN AI

Factor	Group	*M*	*SD*	*F*	*p(post-hoc)*
SIAI	Not at all interested	2.78	.89	38.45	.00* (e>d>c>b,a)
	Not interested	2.94	.68		
	Neutral	3.22	.66		
	Interested	3.47	.69		
	Very interested	3.89	.83		
UAI	Not at all interested	2.26	.83	42.29	.00* (e>d>c>b,a)
	Not interested	2.41	.71		
	Neutral	2.80	.68		
	Interested	3.03	.72		
	Very interested	3.52	.97		
AIEP	Not at all interested	2.34	.94	45.30	.00* (e>d,c>b,a)
	Not interested	2.34	.64		
	Neutral	2.78	.68		
	Interested	2.95	.75		
	Very interested	3.51	.94		
PSAI	Not at all interested	2.63	.76	39.75	.00* (e>d>c>b,a)
	Not interested	2.73	.68		

Factor	Group	*M*	*SD*	*F*	*p(post-hoc)*
	Neutral	3.09	.67		
	Interested	3.30	.68		
	Very interested	3.75	.90		
DL	Not at all interested	2.26	.91	35.54	.00* (e>d,c>b,a)
	Not interested	2.44	.67		
	Neutral	2.86	.71		
	Interested	3.01	.77		
	Very interested	3.49	1.04		
AIE	Not at all interested	2.48	.96	33.92	.00* (e>d>c>b,a)
	Not interested	2.60	.68		
	Neutral	2.94	.69		
	Interested	3.27	.83		
	Very interested	3.59	1.04		
Total	Not at all interested	2.49	.65	54.16	.00* (e>d>c>b,a)
	Not interested	2.61	.55		
	Neutral	2.98	.56		
	Interested	3.19	.60		
	Very interested	3.65	.85		

a: Not at all interested; b: Not interested; c: Neutral; d: Interested, e: Very interested. p< .05

G. AI Literacy According to Experience with Programming Language Type

Analysis revealed a significant effect of programming language experience on AI literacy (F (3, 199) = 32.32, p<.01). The highest AI literacy scores were observed among students with experience in both block and text programming languages (M=3.58, SD=.85). This group was followed by students with experience in text-based programming languages (M=3.24, SD=.70) and those familiar with block-based languages (M=3.14, SD=.69). Students with no experience of programming languages had the lowest level of AI literacy (M=2.80, SD=.64). Subsequent analyses showed that students with any programming language experience had higher levels of AI literacy than those without, with the highest levels of literacy observed among those with experience in both block and text programming languages (see Table 9).

TABLE IX
ELEMENTARY SCHOOL STUDENTS' AI LITERACY ACCORDING TO EXPERIENCE WITH PROGRAMMING LANGUAGE TYPE

Factor	Group	*M*	*SD*	*F*	*p(post-hoc)*
SIAI	None	3.04	.76	28.29	.00* (d>b>a)
	Block	3.45	.72		
	Text	3.34	.79		
	Both	3.81	.86		
UAI	None	2.63	.76	29.19	.00* (d>c,b>a)
	Block	2.94	.82		
	Text	3.12	.80		
	Both	3.50	.95		
AIEP	None	2.61	.77	26.04	.00* (d>b>a)
	Block	2.90	.82		
	Text	3.16	.79		
	Both	3.42	.96		
PSAI	None	2.91	.73	24.41	.00* (d>c,b>a)
	Block	3.28	.77		
	Text	3.29	.76		
	Both	3.63	.90		
DL	None	2.68	.79	20.07	.00* (d>b>a)
	Block	2.94	.86		
	Text	3.21	.79		
	Both	3.42	1.02		
AIE	None	2.83	.77	18.55	.00* (d>b>a)
	Block	3.12	.89		
	Text	3.38	.85		
	Both	3.51	1.03		
Total	None	2.80	.64	32.32	.00* (d>c,b>a)
	Block	3.14	.69		
	Text	3.24	.70		
	Both	3.58	.85		

a: None; b: Block; c: Text; d: Both; p< .05

A. Discussion

In computer science or coding education, a gender gap exists, and research is being conducted to address this issue [25]-[27]. This study also found a difference in AI literacy by gender, with males exhibiting higher AI literacy than females. This suggests that like computer-related subjects, gender plays a significant role in AI literacy. Therefore, the development of educational topics and strategies that consider gender is necessary.

The digital divide, used to emphasize inequality in accessing and using digital technologies like computers and the internet, arises due to socio-cultural factors [28]. This can lead to differences in capability or application, manifesting as differences in technology use in daily life [29], and the gap may widen over time [30]. When examining experiences related to AI, a difference in AI literacy was found based on whether students had direct or indirect experience with AI, with those having experience showing higher AI literacy. However, no difference in AI literacy was found based on the presence of AI-related education experience. Therefore, providing appropriate experiences with AI to prevent a digital divide among elementary students is crucial for cultivating AI literacy.

In this study, the higher the interest in AI, the higher the AI literacy among elementary students, identifying it as a significant factor influencing AI literacy. Thus, strategies to increase interest in AI are needed to enhance AI literacy. Experience with programming languages significantly impacted AI literacy among elementary students, with those having experience in programming languages exhibiting higher AI literacy. Specifically, students who had experience with both block and text languages showed higher AI literacy than those who only had experience with block languages. This suggests that learning both block-based and text-based programming languages is effective for cultivating AI

literacy. However, the current educational curriculum in Korea recommends using block-based programming languages for elementary students [31]. Therefore, the development of educational strategies that can teach both block-based and text-based programming languages, tailored to the learner's level, is necessary.

IV. Conclusion

This study investigated the factors influencing AI literacy among elementary school students. The findings revealed that gender, grade level, experience related to AI, interest in AI, and experience with programming languages significantly impact AI literacy. These results present essential considerations for designing and implementing AI literacy education. The difference by gender showed that male students exhibited higher AI literacy than female students, echoing the gender gap observed in computer science and coding education. This similarity underscores the need for customized AI literacy education that considers gender, particularly developing programs that make AI technology more accessible and interesting to female students. The trend of increasing AI literacy with grade level underscores the need to adjust educational content to match students' age and cognitive development levels, suggesting that AI education programs should be designed progressively, considering the developmental stages of learners. Both direct and indirect experiences related to AI positively influenced AI literacy, highlighting the importance of providing opportunities for students to experience AI. Conversely, the presence or absence of AI education experience alone did not create a significant difference in AI literacy, indicating the need to examine the quality and content of education.

Interest in AI emerged as a critical factor influencing AI literacy. Educational approaches that can stimulate students' interest and motivation are crucial for enhancing AI literacy, fostering positive attitudes towards AI technology, and encouraging more active participation in learning. Experience with programming languages also positively impacted AI literacy, with experience in both block-based and text-based programming languages being particularly important. This suggests that a variety of programming education contributes to the development of AI literacy, emphasizing the need to expose students to diverse programming environments.

In conclusion, this study identified several factors affecting AI literacy among elementary school students and provided insights necessary for developing effective AI education strategies. Future AI education programs should consider these factors to meet the diverse backgrounds and needs of students.

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