Effectiveness of Artificial Intelligence Education Program

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Abstract

As technology advances, Artificial Intelligence (AI) is being used in various fields of our lives. Many studies related to AI education have been actively conducted since 2014 to prepare learners for the AI era (Paek & Kim, 2021). Kandlhofer et al. (2016) argue that because AI is used in our daily lives, AI literacy will become as important as classical literacy skills such as reading and writing as technology advances. Therefore, it is important to give students opportunities to become familiar with the basic principles of AI. Druga and Ko (2021) found that the AI learning program was helpful in improving AI literacy overall after conducting an observational study related to assessing the effectiveness of the AI learning program for 52 children. In addition, a lot of initiatives and governments around the world have been trying to gradually introduce AI education in schools (Steinbauer et al., 2021). Because there have been efforts in trying to introduce AI education to schools, various AI education programs have been developed. This paper aims to identify and analyze the effectiveness of an AI education program developed in the previous research with a quantitative approach and to find recommendations to complement the program.

Keywords: artificial intelligence education, learning effect, learning satisfaction

Effectiveness of Artificial Intelligence Education Program

With the rapid development of technology, Artificial Intelligence (AI) is being used in various aspects of our lives, such as using AI assistants on smartphones or using AI speakers at home. Based on this social flow, the ability to properly understand and utilize AI has become important. Most users may not be aware that they are interacting with AI in their daily lives because many AI services do not show the inner mechanism of how AI works. If users do not understand AI properly, they may think of AI as a magic box, like a genie lamp that is able to do everything, or a monster that shows magic (Druga & Ko, 2021). This misconception about AI can lead to a poor understanding of AI, leading to difficulties in its future use. To combat the potential misconceptions and AI difficulties, research on AI education has actively been conducted since 2014. Initial research on AI education for K-12 students was centered around AI systems usage as support for learning. However, since 2018, the foci for research related to AI education have been the definition of AI, what content should be covered in AI education, and the empirical effects of AI for K-12 students (Chai et al., 2021; Paek & Kim, 2021; Park & Shin, 2021). In addition, governments in countries, such as the United States, Singapore, China, South Korea, Australia, and many others have agreed on the need for AI education and have been preparing for implementing AI education gradually (Indiana Department of Education, 2018; Pennsylvania Department of Education, 2020; Steinbauer et al., 2021). However, if education programs are not prepared for AI education, it would be difficult for AI education to be successful. To prepare programs for AI education in the public curriculum, it is necessary to identify the effectiveness of the programs that were previously developed. To identify the effectiveness of AI education programs, this paper first analyzes the meaning and current trends of AI and AI education. From this analysis, this paper delineates identifying and analyzing the effectiveness of an AI education program developed in the previous research based on the learning effects and learning satisfaction and finds recommendations to complement the program. Therefore, the primary question guiding this research would be ‘Does the score which

supports the effectiveness of the program differ by average summed scores of both learning effects (ae) and learning satisfaction (as)?'. To analyze this research question, the null hypothesis would be there is no difference in the average summed scores between learning effects and learning satisfaction ($\mu_{ae} = \mu_{as}$), and the alternative hypothesis would be there is a difference in the average summed scores between learning effects and learning satisfaction ($\mu_{ae} \neq \mu_{as}$).

Theoretical Framework

There are several articles that support the effectiveness of the educational program with learning effects and learning satisfaction. Chiu's (2021) and Lin et al.' (2021) research served as the theoretical framework for this study. Chiu took a holistic approach to curriculum design in AI education after he interviewed 24 teachers from 12 schools in Hong Kong (Chiu, 2021). His conclusions included effects (knowledge) and satisfaction with education (student relevance) and suggested further studies in the future. Lin et al. (2021) conducted an online survey and analyzed it to verify the learning motivation factors of AI education for 420 elementary school students in Beijing. They sought to identify the following six motivational factors and strategies based on Kelly's ARCS model: (1) intrinsic motivation, (2) career motivation, (3) attention, (4) relevance, (5) confidence, and (6) satisfaction. The authors concluded that the relevance of AI and enhancing confidence in AI can increase students' satisfaction. The study will focus on the learning effects and learning satisfaction to analyze the effectiveness of the AI education program.

Artificial Intelligence Education

The term Artificial Intelligence (AI) was first defined at the Dartmouth Conference in 1956. AI was defined as the engineering and science of creating intelligent machines (McCarthy et al., 1955). As technology is advancing rapidly, AI is being used in many fields. Accordingly, in the research on the definition of AI, researchers defined AI as a technique in the computer

science field that uses the principles of human intelligence to solve problems related to cognition and learning (Ma et al, 2014). According to research compared and analyzed the definitions of various studies, AI is defined as a computer system that performs tasks that require human intelligence and is an activity dedicated to making machines intelligent (Chassingnol & Khoroshavin, 2018). Although there is still no clear agreement upon the definition of AI, several implications can be found. The first is that the definition of AI is gradually expanding. This means that the implications of AI education can also be gradually expanded. The second is that AI relates to cognitive task skills for problem-solving. This means that cognitive tasks for problem-solving can be considered in further AI education.

As technology advances, the use of AI in our daily lives and AI literacy will become just as important as classical literacy skills like reading and writing. Since literacy is a fundamental ability to solve high-level problems, it become more important to give students with opportunities to become familiar with the basic principles of AI (Kandlhofer et al., 2016; Long & Magerko, 2020; Ng et al., 2021). Long and Magerko (2020) defined the term AI literacy as the competencies to utilize AI well for purposes, communicate with AI to utilize it properly, and collaborate with AI when they use AI to solve problems in life. Current K-12 students will be exposed to more AI as technology advances, and more AI literacy may be required of them in the future (Long and Magerko, 2020; Zawacki-Richter et al., 2019). However, when the students use AI in their daily life, they may not be aware that they are interacting with AI. These may occur misconceptions to AI and limit future students' ability to understand, interact effectively, and use AI (Fast & Horvitz, 2017). Therefore, there is a need for AI education, as this would improve AI literacy. Students can learn to understand, utilize, and evaluate AI through learning about AI. In response to this need, there have been efforts to develop an AI curriculum in formal and informal education for K-12 students and adult learners (Knox, 2020; Steinbauer et al., 2021). Although many researchers have focused on AI utilization in the educational system since 2014, research about AI education for enhancing AI literacy has started to be focused on

(Chai et al., 2021). Druga and Ko (2021) verified the improvement of AI literacy through customized machine learning education with mixed research. They found that the AI learning program was helpful in improving AI literacy overall. In addition, Kong et al. (2021) argued the need for AI education by proving the effectiveness of AI education to enhance AI literacy. In view of the previous research, AI education can be defined as education for AI literacy improvement.

AI Education Program

Yu (2020) developed an AI education program for elementary school students based on the literature review. This AI education program presented an Artificial Intelligence (AI) learning module implemented in a K-12 learning environment in South Korea. Learning activities such as group discussions, role-playing, and hands-on activities using Google Teachable Machine were incorporated into the program. This program was developed to address the need for enhancing young learners' knowledge and skills of AI. Table 1 presents the structure and descriptions of the AI education program.

Table 1. Structure and description of the AI education program (Yu, 2020)

Topic	Description
Appreciation of Artificial Intelligence	Discussions: learners will be encouraged to discuss the topics such as: how AI is embedded in everyday life; how it impacts our everyday lives; what ethical issues are related to AI.
Unplugged Activities - Imitating Machine Learning Model	Role-playing: learners act like machine learning models reacting to different data inputs. For example, they would say "Stop" when they were given a "Stop" sign.
Hands-on Activities – Using Google Teaching Machine, Programing in Scratch, and	Learners will be given lessons on how to use Google Teachable Machine to create their own machine learning model

Operating Educational Robots	trained, export their models to Scratch, and operate the model through an educational robot.
Implementing AI in the Real World	Learners will develop a solution to solve a real-world problem by using what they have learned in this module.

Method

To analyze the effectiveness of Yu's (2020) Artificial Intelligence (AI) education program, the survey was conducted based on Kim's (2014) test-tool, which was developed as a survey to support the effectiveness of the program based on the learning effects and satisfaction. The survey items were validated by the Delphi method in the previous research. The survey has 8 items on learning effects and 7 items on learning satisfaction and was based on the 5 points Likert scale.

Sample

A purposive sample of participants were elementary school students in South Korea who did not have experience with AI education before. The sample consisted of 27 sixth graders elementary school students who participated in AI education in June 2020. Before participating in the AI education program, they did not have experience with AI education before. Because this data aims to be further supplemented and applied to sixth graders throughout South Korea, the overall population could be the total number of 6th graders in South Korea. As of 2021, 450,931 sixth graders are included in the statistics portal system in South Korea (Korean Statistical Information Service, 2021).

Data Analysis

The previous research presenting the effectiveness of the program can be supported by learning effects and learning satisfaction. Due to the nature of the data, which focused on two different variables coming from the same participants, paired-samples t-tests were used to investigate the differences between the two variables including learning effects and learning

satisfaction. Because the items of learning effects consisted of eight items and the learning satisfaction consisted of seven items, this study set the two variables ‘Average summed scores of learning effects (AE)’ and ‘Average summed scores of learning satisfaction (AS)’. IBM SPSS Statistics 28 (2021) was utilized to analyze the data and the alpha level was set at .05.

Results

Relating to the learning effects and learning satisfaction, the descriptive statistics indicated that both distributions were negatively skewed. Table 2 describes the summary of the descriptive analysis of both data. For example, skewness and kurtosis statistics for the AE are -1.017 and .691, respectively. These report that the distribution is negatively skewed. Similarly, the distribution of the AS is negatively skewed with skewness of -1.176, and kurtosis of 1.056. The mean of each distribution was above 4.00 (i.e., M_{ae} = 4.216, M_{as} = 4.3016).

Table 2. *Descriptive statistics for each valuable*

Average summed score of learning effects (ae)		Statistics	Std.Error
Mean		4.216	.11335
95% Confidence Interval for Mean	Lower Bound	3.9229	
	Upper Bound	4.5122	
Median		4.5000	
Std.Deviation		.74485	
Skewness		-1.017	.448
Kurtosis		.691	.872
Average summed score of learning satisfaction (as)		**Statistics**	**Std.Error**
Mean		4.3016	.15276
95% Confidence Interval for Mean	Lower Bound	3.9876	
	Upper Bound	4.6156	
Median		4.7143	
Std.Deviation		.630	
Skewness		-1.176	.448
Kurtosis		1.056	.872

In addition, Table 3 displays the result of the statistics for paired samples t-test related to the two variables. Since the number of participants was 27, the degrees of freedom for this test are *df* = 26. The critical values for this test are ±2.447. The result of the paired samples t-test is as follows in Table 3.

Table 3. *The result of the paired samples t-test*

	Paired Differences			95% Confidence Interval of the Difference				Significance	
	Mean	Std. Deviation	Std.Error Mean	Lower	Upper	t	df	One-sided p	Two-Sided p
ae-as	-.08399	.31619	.06085	-.20908	.04109	-1.380	26	.090	.179

Note. *$p < .05$

Relating to the learning effects and learning satisfaction, the paired-samples t-test indicated the result related to the significant differences. In sum, results indicate no significant differences in average summed learning scores between learning effects (M = 4.22, SD = .74) and learning satisfaction (M = 4.30, SD = .63), $t(26) = -1.380$, $p > .05$. Figure 1 displays the sampling distribution to support the t-statistic. As a result of the paired samples t-test, the t statistic was -1.380, and the p-value was found to be greater than the decision criterion of .05. (p = .179).

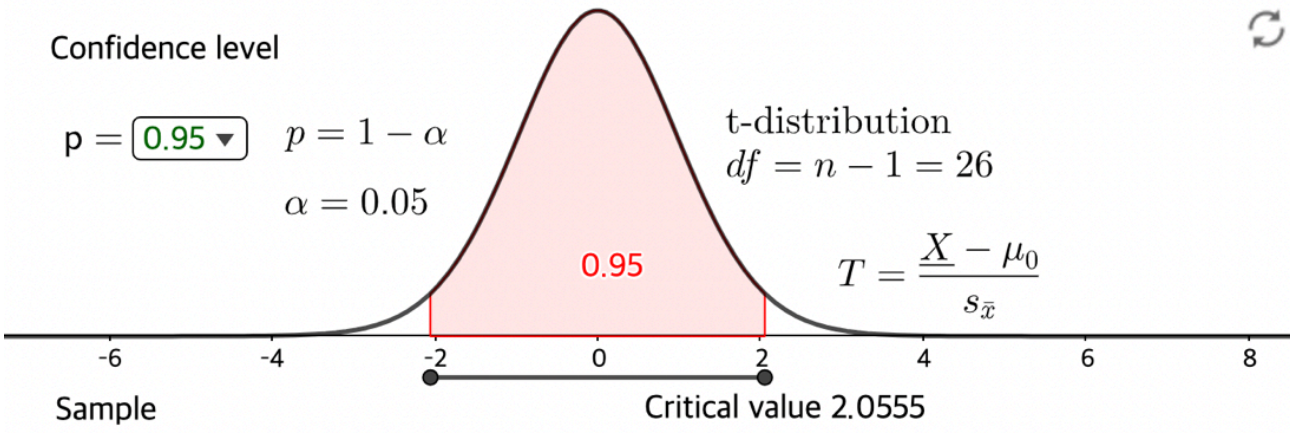


Figure 1.

Sampling distribution for the learning effects and learning satisfaction

Discussion

Based on the sample included in this study, there were no significant differences in average summed learning scores between learning effects and learning satisfaction although the number of average summed scores of both learning effects and learning satisfaction was greater than 4.00. This finding highlights that the learning effect and learning satisfaction may positively support the effectiveness of Yu's (2020) AI education program.

As Wang and Cheng (2021) documented the necessity of preparing the AI education program for introducing AI education to public schools, developing AI education programs and analyzing their effectiveness is important for the improvement of AI education. We question what this finding means for the population, given what existing literature has documented about AI education programs. For example, Yu (2020) analyzed his AI education program based on the Delphi method, supporting the effectiveness of the program. The findings suggest various perspectives support the effectiveness of AI education programs that will be developed and introduced in the future. Because AI education is still considered to be in the early stages of research, various perspectives for analyzing the effectiveness of AI education programs may be needed for future research.

Overall, the findings of this study mirror Chiu's (2021) and Lin et al.' (2021) findings, as they explored the effectiveness of the AI education program based on the learning effects and learning satisfaction. Learning effects and learning satisfaction reinforce the effectiveness of Yu's (2020) AI education program. Additionally, because AI education is in the early stage in research, our findings can be one of the references for analyzing the effectiveness of the AI education program for future study.

Limitations

Although the data supported the effectiveness of the AI education program, there would be limitations as follows. First, additional research needs to be conducted to generalize the results of this analysis to the target population because these data came from the 27 students, which is

a much smaller number compared to the population of 450,931 (Korean Statistical Information Service, 2021). Data from additional samples may be collected and analyzed to support the result of this data analysis. Second, a paired-samples t-test was performed to verify that there is a significant difference between the two variables, 'ae' and 'as' in this study. Further quantitative analyses can be made based on various perspectives to support the effectiveness of AI education programs.

Suggested Practice

Using the findings from this study, we offer the following practice. To verify the effectiveness as a practice, conducting a pilot implementation in some public schools in South Korea can be suggested. Because Daegu, a metropolitan city in South Korea, has been starting the leading city in AI education from 2021, the public schools in Daegu city can conduct pilot education of Yu's (2020) AI education program and further analyze its effectiveness. This pilot implementation of the AI education program can help complement it before generalizing as a public curriculum in South Korea.

Implications for Future Research

While the findings included in this study add to the literature, there are additional ways this research could be advanced for analyzing the effectiveness of AI education programs and improving AI education in public schools. First, more advanced statistical analytic methods can be conducted to analyze the effectiveness of AI education programs before introducing them to public schools. In addition, a mixed-methods approach including qualitative research can collect deep data by conducting interviews or observations as well as quantitative data while practicing AI education programs to help analyze their effectiveness. Second, because AI education is in the early stage of the research, further studies related to analyzing the effectiveness of the program considering various perspectives might be explored based on the data analysis in this study. Third, further studies will be able to be conducted with a larger sample size that is more representative of the sixth graders in South Korea to confirm these findings.

In sum, this study delineates the effectiveness of Yu's (2020) AI education program by analyzing both learning effects and learning satisfaction. This reinforces the theoretical background that learning effects and learning satisfaction can support the effectiveness of the program, as well as suggests an example AI education program with effectiveness (Chiu, 2021; Lin et al., 2021). Based on the implications of this study, further studies are needed to analyze additional data for improving AI education.

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