

Development of Artificial Intelligence Education Programs Centered on Deep Learning Principles

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The Ministry of Education is pushing to improve the curriculum to develop basic skills and capabilities to respond to future social changes and emphasizes strengthening digital basic skills, including artificial intelligence and software education. In the field of artificial intelligence education, research is being conducted on artificial intelligence literacy, a basic knowledge that can correctly understand social changes caused by the development of artificial intelligence technology and creatively solve problems in real life and various fields by utilizing artificial intelligence. The purpose of this study is to develop and apply an educational program that can learn the concepts and principles of artificial intelligence (nodes, hidden layers, etc.) by using the part that shows the principle of implementing deep learning models in Machine Learning for Kids. The educational program designed the purpose and direction based on the results of analyzing the needs of 50 elementary school teachers, and analyzed the educational effect through the results of artificial intelligence literacy pre- and post-test for 20 elementary information gifted students. As a result of the analysis, it was found that this education program had a positive effect on improving artificial intelligence literacy.

Keywords: Deep Learning, Machinelearning for kids, AI Education, AI literacy.

1. Introduction

Human intellectual ability, which was recognized as a unique area of human beings due to the 4th Industrial Revolution, is realized by computers, and artificial intelligence (AI) is changing the paradigm across all areas of our lives. Against the backdrop of recent innovative technological advances, artificial intelligence technologies, including machine learning and deep learning, are rapidly developing, and education on digital literacy, artificial intelligence, and data science is being promoted worldwide as an expansion concept of computing thinking education (Ministry of Education of Korea, 2020).

One significant application of artificial intelligence is on education. Implementing good and advanced techniques in the education system is aimed at upgrading the levels of thinking for the students and the application of these techniques to get good research results for improving existing technologies. These techniques are making our lives easier, and the

education system smarter, more advanced, and more flexible. With the incorporation of these techniques and other features of AI, the teaching and learning process is also changing a lot from the student's point of view and the teacher's point of view (Harini & Rao, 2019).

In Korea, the Ministry of Education emphasizes strengthening basic digital knowledge, including artificial intelligence and software education, by improving the curriculum that can develop basic knowledge and capabilities to respond to these changes in the future society. The Ministry of Education has decided to introduce artificial intelligence education to school sites from 2025 through the 2022 revised curriculum, and has announced standards for elementary and secondary artificial intelligence education based on software education (Ministry of Education of Korea, 2020 & 2021).

The educational goal based on the content of elementary and secondary artificial intelligence education is to acquire the ability to solve various problems creatively, have convergence, learn the correct and fair use of data, and understand artificial intelligence. The digital basic knowledge presented in the 2022 revised curriculum is included in all subjects and can be seen as artificial intelligence convergence education that creatively solves real-life problems by utilizing artificial intelligence capabilities (Yun & Kim, 2022). As part of this initiative, an educational program was developed to teach elementary school students the concepts and principles of AI, including nodes and hidden layers essential for machine learning (Kushwaha & Badhera, 2022).

In this study, an educational program was developed and applied to learn the concepts and principles of artificial intelligence (node, hidden layer, etc.) by using the elements and principles necessary for artificial intelligence to operate in machine learning for kids. To use and utilize artificial intelligence, an educational program centered on deep learning principles was developed because an understanding of the principles of artificial intelligence must be preceded, and education using artificial intelligence without understanding its principles will only be mechanical.

The purpose and direction of the educational program were designed based on the analysis results of the needs of 50 elementary school teachers and 20 elementary school information gifted students. The effect of the educational program was applied after revising the artificial intelligence literacy test developed for middle school students to elementary school students and reviewing its validity. As a result of pre- and post-test analysis of artificial intelligence literacy, this education program had a positive effect on improving artificial intelligence literacy.

2. THEORETICAL BACKGROUND

2.1 Artificial Intelligence and Deep Learning

Artificial intelligence makes machines think and act similarly to human and includes concepts such as big data and machine learning. Machine learning, which is the basis of artificial intelligence, is a concept defined by Arthur Samuel in 1959 as "the field of learning actions that are not commanded as code, but as data developed into algorithms for machines to execute (Christoph & Daniel, 2013; Park, 2020; Falah 2021; AlZubi, 2023; Cho, 2024).

Deep learning is an algorithm that uses deep artificial neural networks, also known as deep neural networks. An artificial neural network is a computer processing system modeled on a biological brain neural network and consists of three layers: the input layer on the left, the hidden layer in the middle, and the output layer on the right. Each node is connected by a virtual line called weight, and each weight has a value called connection weight. As in synapses, when the value input to the node exceeds the threshold, the value is transferred to the next node, using an activation function that converts the sum of the input signals into one output signal. When a user enters a specific value, the result is derived from the value of the connection weight of the weight connecting each node to the node, so the core of deep learning can be called the value of the connection weight of each weight. As the number of hidden layers deepens, the number of weights connecting nodes increases proportionally, which enables the generation of more sophisticated predictive models. In artificial neural networks, the value of the weight is modified to the value of the optimal weight using methods such as stochastic gradient descent. This process is expressed as learning data through deep learning, and a model in which a completed data learning can be derived (Lee &Koo, 2017).

These concepts of artificial intelligence and deep learning correspond to the understanding of the principles of artificial intelligence (artificial intelligence area-recognition, expression, inference, and learning) in the elementary and secondary artificial intelligence education content standards proposed by the Ministry of Education of Korea. The goal of artificial intelligence education in elementary and secondary schools is not to create artificial intelligence developers, but to foster an understanding of the principles of artificial intelligence for its effective use.

2.2 Artificial Intelligence Education Platform

The artificial intelligence education platform is designed to implement the principles of artificial intelligence education so that it can be easily understood and used. The platform is defined as "something that can create and apply artificial intelligence models using cloud services." Typical examples of artificial intelligence education platforms include Machine Learning for Kids in the UK, Google's Teachable Machine, Korea's Entry, and China's Mblock. These artificial intelligence education platforms implement the principles of actual artificial intelligence while also implementing an easily accessible interface. In a study on the suitability of elementary and secondary classes of these artificial intelligence education platforms, Kim Tae-ryeong classified functional characteristics such as learning objects, algorithms, scalability, and accessibility according to the characteristics of each platform (Kim &Han, 2022).

Meanwhile, this study focused on explaining inside of the artificial intelligence model so that the concepts and principles of artificial intelligence can be examined, and to improve artificial intelligence literacy by creating artificial intelligence programs based on this. Machine Learning for Kids was selected as a platform that satisfies this purpose. Machine learning for Kids can provide explanations of algorithms and directly transfer knowledge to understand artificial intelligence. The model developed by Machine Learning for Kids can be used as a program by connecting to scratches, Python, etc., and the created model can be classified as an artificial intelligence block to receive text, image, sound, and numerical data

to implement machine learning within the project. Machine Learning for Kids can look at how computers create deep learning models that classify themselves, and in this study, how the deep learning model analyzes and scores the data entered through this function was looked into.

2.3 Artificial Intelligence Literacy

Artificial intelligence literacy began to gain attention as the importance of artificial intelligence technology increased. Literacy is the ability to read, write, and speak, and artificial intelligence literacy has recently emerged to allow individuals to understand, explain, and apply artificial intelligence, which has become a general-purpose technology.

Artificial intelligence literacy is defined by Glister as a series of capabilities that allow individuals to critically evaluate AI technology, going beyond the ability to combine and use it in a new form for purpose through various forms of information initially found by computers (Korea Foundation for the Advancement of Science & Creativity, 2020).

The Ministry of Education's basic artificial intelligence subject defines artificial intelligence literacy as "a basic knowledge that can correctly understand social changes caused by the development of artificial intelligence technology, and cultivate ethical awareness as a member of artificial intelligence-based knowledge and information society." Artificial intelligence literacy is also in line with the government's recent "AI-SW Spread Plan" policy, and the "Study Report on Applying Artificial Intelligence Education to Elementary and Secondary Artificial Intelligence Education Schools" released by the Korea Science and Creativity Foundation in 2022 presents artificial intelligence literacy as the goal of artificial intelligence education (Jo & Han, 2023; Park & Yi, 2021).

In order to have artificial intelligence literacy, the ability to enhance it is necessary. Previous research reports that the necessary competencies are understanding the principles of artificial intelligence (artificial intelligence area-recognition, expression, reasoning, learning), the ability to utilize artificial intelligence, and critical thinking skills of artificial intelligence.

AI literacy can be launched in primary and secondary education depending on the age and computer literacy of the students. To do this, it is necessary to define the core competencies for AI literacy according to three dimensions: AI concepts, AI applications, and AI ethics and security. Research has focused on the understanding of the concepts, the functional roles of AI, and the development of problem-solving skills. This has led to proposing a redefinition of the curriculum supported by different ideas that K-12 students should know. Several countries have already made different curricular proposals, where they argue that the curricular design must include different elements such as content, product, and process. It is also convenient for learning AI to follow the computational thinking model, contextualizing the proposed curriculum, and providing it with the necessary resources for teachers. AI literacy should be based on an interdisciplinary and competency-based approach and integrated into the school curriculum. There is no need to include a new AI subject in the curriculum, but rather to build on the competencies and content of disciplinary subjects and then integrate AI literacy into those subjects. Given the interdisciplinary nature of Artificial Intelligence, AI education can break disciplinary boundaries and adopt a global, practical, and active approach in which project-based and contextualized work plays an important role.

Hence, AI literacy should be leveraged to extend and enhance learning in curricular subjects. AI literacy must prioritize the competency of teachers and their active participation in the co-design of didactic proposals, together with pedagogues and AI experts (Otero & Catala, 2023).

As such, an understanding of the principles of artificial intelligence can be seen as directly related to the improvement of artificial intelligence literacy. In this study, the researchers tried to cultivate artificial intelligence literacy based on the deep learning principle by showing the principle of implementing the deep learning model that can be shown in *Machine Learning for Kids*.

2.4 Previous Study Analysis

Ryu and Han (2019) suggested the possibility that the concept of deep learning can be sufficiently applied in the field through the educational program for elementary school students to learn the concept of deep learning. An artificial intelligence education program was developed in the form of examining the deep learning principles of artificial intelligence in the learning process of machine learning for elementary school information gifted children

Moon et al. (2021) focused on developing elementary artificial intelligence education programs that solve daily life problems and cultivating artificial intelligence literacy in the process of solving problems. The content of cultivating artificial intelligence principles and artificial intelligence literacy based on solving problems in daily life through *Machine Learning for Kids* is in line with aim of this study. In this study, machine learning for kids was selected as an educational tool and an educational program was developed focusing on fostering artificial intelligence literacy centered on deep learning principles.

Hong and Kim (2022) developed teaching and learning strategy based on computing thinking skills to foster digital and artificial intelligence literacy in elementary school students. It was suggested that follow-up research is needed to improve digital and artificial intelligence literacy, and an educational program to improve artificial intelligence literacy was developed by referring to suggestions and teaching and learning strategies.

Kim and Lee (2022) developed an inspection tool that can measure artificial intelligence literacy and allow middle school students to measure their problem-solving capabilities using artificial intelligence. In this study, the artificial intelligence literacy test tool for middle school students developed in Kim and Lee's (2022) study was modified for elementary school students, and applied through preliminary tests for elementary school students and computer education expert validity tests.

Park (2023) studied the effect of pre-service teachers' digital literacy attitudes on digital literacy capabilities. Based on the fact that existing literacy is recognized as one of the core competencies of the future era beyond the meaning of simple literacy, the importance of literacy was emphasized, and efforts and implications to develop literacy capabilities were proposed.

3. EDUCATION PROGRAM DESIGN AND DEVELOPMENT

In this study, an educational program was developed as shown in Table 1 in accordance with *Nanotechnology Perceptions* Vol. 20 No.S2 (2024)

the procedure of the most widely used ADDIE model, showing the general form of the teaching system design process.

Table 1: Educational Program Development Plan

Procedure	Content
Analysis	- Pre-requisite Analysis
Design	- Goal Set up and Tool selection - Education program design
Development	- Teaching&learning plan, textbook development
Implementation	- Pre-test: AI Literacy Test - Educational Program
Evaluation	- Post-test: AI Literacy Test

In the Analysis, an online survey was conducted on the subject of learning artificial intelligence education methods and artificial intelligence principles for elementary school teachers, and the educational environment was analyzed by setting teaching tools and research directions for this study. In the Design, an artificial intelligence prosecutor, and class contents and teaching and learning activities were organized by referring to the analysis stage of the artificial intelligence education platform along with preliminary inspection. In the Development, specific instructional materials and textbooks were produced to achieve instructional goals. In the Implementation, the educational program was applied and feedback for each level was provided. In the Evaluation, a follow-up test was conducted with an evaluation according to the implementation of the class, and students' achievement and feedback were evaluated to see what changes were made according to this study and the impact of this educational program.

3.1 Prerequisite Analysis

The preliminary demand analysis according to the procedure of the ADDIE model was conducted through an online survey on artificial intelligence education methods and artificial intelligence principles with 50 elementary school teachers who participated in this study within the past three years. Table 2 shows the results of a survey of appropriate methods/tools when teaching artificial intelligence classes for elementary school students. As a result of the survey, 70% of block-based languages, 30% of unplugged languages, and 0% of text languages were found.

Table 2: Appropriate tools for AI Education to elementary school

Unplugged	EPL(Block-based)	Computer Language
15(30%)	35(70%)	0(0%)

The results of the artificial intelligence class experience survey in elementary school are as shown in Table 3. Among the responses, 46% taught programming-based artificial intelligence education using entries or machine learning for kids, 38% for simple experience-

oriented artificial intelligence education such as unplugged or quick draw, and only 10% of them taught artificial intelligence principles.

Table 3: AI Education Experience (Redundant response possible)

Simple Experiences	Programming Based	AI Principles	Never Done Before
19(38%)	23(46%)	5(10%)	18(36%)

Table 4 shows the result of a survey on the need to learn artificial intelligence principles for senior elementary school students. 84% of the teachers said artificial intelligence education was necessary, and only 4% said it was unnecessary.

Table 4: The Need for AI Principles in Upper Grades

Necessity	Response
Very Needed	27(54%)
Somewhat Needed	15(30%)
Netural	6(12%)
Somewhat Unneeded	2(4%)
Very Unneeded	0(0%)

The direction derived based on the results of the pre-requisite analysis are as follows. First, when teaching artificial intelligence for elementary school students, it focuses on the block-based language that has been said to be the most appropriate, but the unplugged method is applied in parallel to help students understand. Block-based language is a computer language designed to minimize the burden on students when encountering programming, and it is applied to this study because it has the advantage of reducing the cognitive burden added to the programming learning process and inducing interest and immersing in programming learning (Moon, Boo & Kim, 2021). Among the artificial intelligence education platforms, machine learning for kids was selected in this study, and Scratch, a block-based language compatible with it, was used.

The program was developed to write a program through scratches of machine learning for kids, and the unplugged method (activity sheet) was used in parallel to help students understand the deep learning principles in the learning process.

Unplugged activities are conducted to experience the scientific principles and basic concepts of computers without using computers, and recently, research using unplugged has been actively conducted at home and abroad in the field of artificial intelligence. Previous studies using unplugged have confirmed that unplugged activities show positive changes in learning motivation and qualitative areas, such as changes in learners' perceptions and attitudes (Lee, 2023). In this study, the principle of deep learning was also intended to help learners understand through unplugged activities.

Second, the demand for the necessity of learning the principles of artificial intelligence for the upper grades of elementary school was high at 87%, but not many cases were actually educated at 10%. Based on this, an educational program that can learn deep learning

principles suitable for the upper grades of elementary school was developed, and artificial intelligence literacy was cultivated.

3.2 Development of Educational Programs

The design of the education program is as shown in Table 5.

Table 5: Design of Education Program

Hour	Learning Theme
1~3	<ul style="list-style-type: none"> - Orientation & Pre-test (AI Literacy) - Learning machine learning for kids (Training, Learning, Evaluation Process) - Making machine learning for kids program using text Smart IOT
4~5	<ul style="list-style-type: none"> - Learning Principles of AI (Deep Learning) (1) * Observe the learning process through model evaluation and learn the changes that occur in the learning process according to the training data
6~8	<ul style="list-style-type: none"> - Learning Principles of AI (Deep Learning) (2) * Look at the deep learning principles, change the training data, and modify the training data to achieve higher accuracy
9~10	<ul style="list-style-type: none"> - Organize and present the training data modification process - Post-test (AI literacy)

In the first to third sessions, the focus was on learning the machine learning process in the order of training, learning and evaluation, and programming, which is the process of creating machine learning with machine learning for kids. Under the theme of smart IOT, the necessary labels were devised, and the appropriate data for each label were entered to examine the model and see if the desired results come out through learning and evaluation.

In the 4th and 5th classes, we used the the description of the model function of Machine Learning for Kids was used to examine how learning proceeds with the principle of deep learning according to the training data as shown in Figure 1. When a word entered by the students is classified into a label to turn off the fan, the program write down the characteristic score and weight score of the word step by step and look at the changes that occur in the learning process according to the trained data. Table 6 shows the composition of the activity site to help students learn the principles of deep learning.

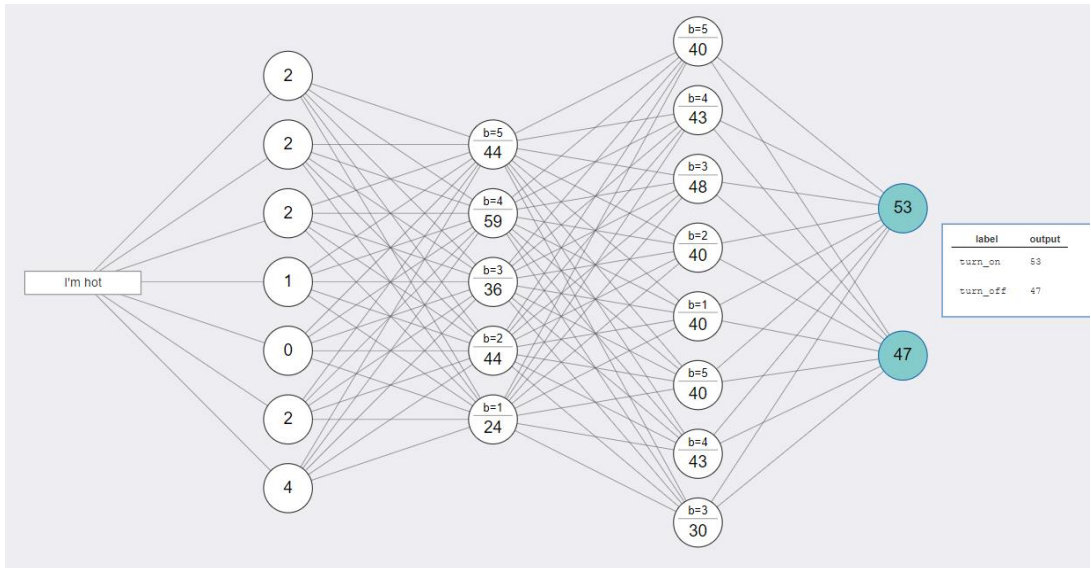


Figure 1: The process of examining how training data is taught by the principles of deep learning

Table 6: Organizing Student Activity Materials

Step	Learning Theme
Explore the features of Data	Figure out the needs of Data (Figure 2&3)
Checking the weights of data features	Looking at changes in weights (Figure 4)
Measuring accuracy	Analyzing the causes of accuracy test results and interpreting data (Figure 5)
Modifying data	Modifying data for higher accuracy (Figure 5)

Figure 2 and 3 are part of an activity paper in which students find the need for data in the process of exploring the characteristics of data. Students observe the characteristics of dogs and cats through the given pictures and through this process, they understand that computers classify data.

1. Explore the features of Data

How does a computer classify data?

Computers can't tell the difference between cats and dogs right away like the eyes we use. The computer first finds the unique characteristics that cats and dogs have. Shall we look at the picture below and find out the characteristics of cats and dogs?



the features of a dog		the features of a cat	

Figure 2: Part of the Student Activity Materials

Computers classify themselves. Today, with that function, let's look at how the deep learning model analyzes the data we put in and calculates the score.

First, let's summarize the characteristics of the classified words with a model that was created under the theme of Smart IOT created by Machine Learning For Kids.

Words to Classify:		Words to Classify:	
Characteristics of text		Characteristics of text	

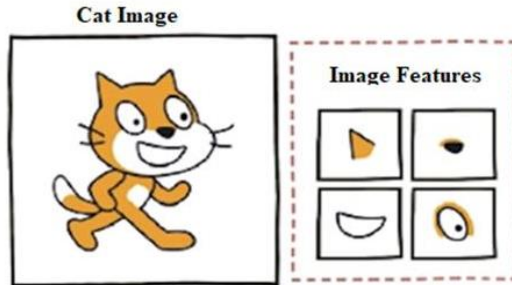
Figure 3: Part of the Student Activity Materials

In the 6th to 8th sessions, in order to increase the accuracy of data classification, an experiment was conducted several times with what criteria to put data in. Figure 4 is a part of the activity where students record scores according to data in this process. Through this process, students can learn the process of artificial intelligence learning based on deep learning principles (nodes, hidden layers, etc.), understand the importance of data labeling and data selection, and modify data.

2. Weight data by feature

Write down the feature scores and weights of the data determined by your computer.

The cat in the picture below has characteristics such as ears, nose, mouth, and eyes. The same goes for dogs. In order to distinguish between cats and dogs, the computer weights them to give more points to more distinctive features among several features, allowing large scores of features that show the characteristics of cats and dogs to appear.



Let's write down the score by clicking on each step to see how much the computer is scoring for the above features.

Words to be categorized by the computer		
Features of text	Feature score	The weight

Let's write down the score for each level that the computer goes through.

Words to be categorized by the computer		
Level 1 score	Level 2 score	Level 3 score

Figure 4: Part of the Student Activity Materials

In the 9th to 10th sessions, the process of modifying training data is organized and shared, and how the accuracy of data classification could be improved and scores by label are announced. Students can compare each other's data and labels to explore ways for higher accuracy, synthesize them, and improve artificial intelligence literacy. Figure 5 is part of the activity paper where students check the accuracy of the classification of computers and check the accuracy of classification according to the score of the highest label. Students

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compare each other's label scores and accuracy and modify the data to increase accuracy. In order to increase accuracy, the principle of deep learning is discovered through activities that find data suitable for the characteristics classified by computers, modify data, and increase accuracy.

3. Measuring Accuracy

Checking the accuracy of computer classification

Let's write down the final score that the computer gave and the score that the computer rated higher.

Words to be categorized by the computer		
Originally classified label	Score by Label	the highest-scoring label

Did the computer categorize the words of its choice correctly? Let's write down the features that have affected the computer a lot when it classifies.

4. To modify the data

Adding data to increase accuracy

In order for a computer to improve its accuracy, let's put data that fits the characteristics it classifies. Let's write down the criteria for putting in the data and the criteria for putting in the data.

Figure 5: Part of the Student Activity Materials

4. Research Methods and Procedures

4.1 Research Hypothesis

Hypothesis: There is no significant difference in learners' pre- and post-artificial intelligence

literacy through elementary artificial intelligence education programs centered on deep learning principles.

Adversarial Hypothesis: There is a significant difference in learners' pre- and post-artificial intelligence literacy through elementary artificial intelligence education programs centered on deep learning principles.

4.2 Participant of this Study

The participants of this study were 20 students in the 5th to 6th grades of the elementary information gifted course at the J Institute of Education. As a result of the preliminary survey, most of the 20 students have an experience with artificial intelligence education, but their self-understanding evaluation scores on artificial intelligence learning principles, deep learning concepts, and artificial intelligence program production were low. Table 7 shows the distribution of the participants as per gender.

Table 7: Gender of the Participants

Male	Female	Total
12	8	20

4.3 Measuring Tools

The artificial intelligence literacy test tool for middle school students developed by Kim and Lee (2022) was modified and used to measure the artificial intelligence literacy of the study subjects, and the use of the test tool was approved by the copyright holder for use in this study. The inspection tool was developed to allow the tester to self-evaluate using the self-evaluation 5-point Likert scale.

The artificial intelligence literacy test tool consisted of four areas of AI literacy, and consisted of 20 questions. The four areas were AI Execution Plans, Problem solving with AI, Understanding of AI, and Data Literacy.

The test tool was found to be reliable with a Cronbach α coefficient of .970, and the validity was also high with a CVR value of .814 to .936. However, since it is an inspection tool originally developed for middle school students, terms and concepts were difficult to apply to elementary school students, so it was revised and supplemented to suit their level.

The revised and supplemented test was first revised by measuring facial validity whether it was suitable for the level of elementary school students through preliminary tests by five elementary school students, and completed the test tool question through a content validity review (CVR) of five computer education experts. The questions for the artificial intelligence literacy test tool completed based on this are as shown in Table 8.

Table 8: AI Literacy Test Tool

Areas	No	Learning Theme
AI Execution Plans	1	I can make a plan to make an artificial intelligence program.
	2	I know what kind of data is needed to make an artificial intelligence program.

	3	I try to solve problems on my own in the process of making AI programs.
	4	I can make an AI program with artificial intelligence knowledge that I know.
	5	I can make an artificial intelligence program on my own.
Problem Solving with AI	6	I can make the program I want using artificial intelligence.
	7	I can distinguish between problems that can be solved with artificial intelligence and problems that cannot be solved.
	8	I can tell you the advantages and disadvantages of the problem-solving process using artificial intelligence.
	9	I can select an appropriate model (text, image, sound, number) for problem solving through artificial intelligence.
	10	I can test the accuracy of the artificial intelligence program I made.
Understanding of AI	11	I can explain the learning process of artificial intelligence.
	12	I know how artificial intelligence recognizes letters or images.
	13	I can explain the changes brought by artificial intelligence in life.
	14	I can simplify and explain the operating principles of artificial intelligence.
	15	I can state the principle that artificial intelligence classifies images.
	16	I can say how AI improves the accuracy or speed of image discrimination.
Data Literacy	17	I know what data is needed to create an artificial intelligence program.
	18	I can choose the type of data according to the situation I need.
	19	I can make artificial intelligence that solves problems using data.
	20	I can determine if the content of the data fits the subject well.

5. RESULT

5.1 AI Literacy Test Normality Test

Since the sample size was 20 people located at '10<n<30', a normality test was conducted to confirm whether the results of the artificial intelligence literacy test of the experimental group satisfied normality. For the normality test, the Shapiro-Wilks test was performed, and the results were presented in Table 9.

Table 9: Normality Test (Shapiro-Wilks)

Subscales	Descriptive Statistics				stat	p
	M	SD	Max	Min		
AI Execution Plans	3.30	4.30	10	-6	.962	.633
Problem Solving with AI	2.55	3.57	9	-4	.799	.832
Understaning of AI	2.60	5.57	10	-9	1.24	.238
Data Lliteracy	2.80	5.01	11	-6	1.12	.642

As a result of the normality test, the AI execution plan area was 0.633; the problem-solving area using AI was 0.832; the understanding area of AI was 0.238; and the data literacy area was 0.642, all of which were larger than 0.05, satisfying normality.

5.2 Comparison of Artificial Intelligence Literacy Pre- and Post-Test

The results of the artificial intelligence literacy test secured normality, and the comparison of the results of the pre- and post-test was conducted with a Paired T-test, and the results are as shown in Table 10.

Table 10: Changes in AI Literacy (Paired T-test)

Subscales	Pre-test		Post-test		t	p
	M	SD	M	SD		
AI Execution Plans	17.40	3.06	20.70	3.02	3.428	.003*
Problem Solving with AI	18.15	2.53	20.70	2.47	3.189	.005*
Understaning of AI	17.65	3.19	20.25	3.27	2.085	.051
Data Literacy	17.80	2.85	20.60	3.10	2.499	.022*

*p<0.5

As a result of the comparison between the pre- and post-test, the average of the areas of artificial intelligence execution planning, artificial intelligence problem solving, and data literacy increased by more than 2.5 points, and the probability of significance was within 0.05, showing a statistically significant improvement. The area of understanding of artificial intelligence is not a statistically significant change with a significant probability of 0.051, but the average score has risen from 17.65 before to 20.25 after. Taken together, it was found that the educational program developed in this study had a positive effect on the improvement of artificial intelligence literacy.

6. CONCLUSIONS AND SUGGESTIONS

In this study, in accordance with the trend of the times when the need for artificial intelligence basic literacy education is emphasized, an elementary artificial intelligence education program centered on deep learning principles was developed and its effect on

artificial intelligence literacy was studied.

Such a program was developed based on the ADDIE model, and the direction and tools of education were selected through preliminary demand analysis of 50 elementary school teachers with software education experience within the past three years. The artificial intelligence literacy test tool previously developed for middle school students was modified for elementary school students and used as a pre- and post-test tool after reviewing student facial validity tests and computer education experts. For education, the 10th instructional program was applied to 20 elementary information gifted courses at Researcher J and the educational effect was analyzed. As a result of the artificial intelligence literacy test before and after education, there was a statistically significant change along with the overall average score improvement. Accordingly, elementary artificial intelligence education programs centered on deep learning principles were found to be useful in improving artificial intelligence literacy.

Artificial intelligence literacy seems to have been improved in the process of understanding the principles of artificial intelligence learning by using Machine Learning for Kids, which was focused on in this study. To help students understand these principles, they were asked to learn through four major steps. First, by examining the characteristics of the data, the result value varies depending on what data is entered, and the need for data was identified in this way. Second, the change in weight according to the characteristics was checked and the change in weight was examined. Third, they tried to interpret the data in the process of measuring the accuracy and finding the cause. Finally, they were instructed to modify the data for higher accuracy, compare each other's data with the resulting results, and discuss how to obtain higher accuracy.

However, the experimental group of this study did not secure more than 30 participants necessary for the general correlation study, and there is a limit to clearly generalizing the correlation because the experimental group's pre-post test results were conducted without the comparison group. In addition, the subject of education was not general elementary school students, but elementary information gifted students with prior artificial intelligence education experience, so follow-up research on what changes occur when targeting general students will be needed. In future studies, it is necessary to secure more than 30 participants for general students, and to form an experimental group and a comparison group to systematically analyze more the factors of the research results. In addition, as artificial intelligence education is being activated, many studies should be conducted to analyze the effectiveness of education through artificial intelligence literacy.

The suggestions in this study are as follows. First, the function that shows the principle of implementing deep learning models in Machine Learning for Kids is effective in not only guiding the concepts and principles of artificial intelligence but also improving artificial intelligence literacy, so it can be used in future research. Second, an artificial intelligence curriculum should be organized so that an understanding of the principles of artificial intelligence can precede simple artificial intelligence-based education. Third, in the part of helping students understand the principles of artificial intelligence, it is effective to examine how the accuracy of the result values changes according to the data entered by students and their weights. The process of recording and comparing each data and weight, and discussing

how to produce high accuracy was also selected as the most memorable moment in the students' reviews.

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