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The Effects of an Ethics Education Program on Artificial Intelligence among Middle School Students: Analysis of Perception and Attitude Changes

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Abstract: Artificial intelligence (AI) technology has brought convenience to human lives, but its pervasive impact extends beyond individuals, affecting society as a whole. Consequently, the necessity for an AI ethics education program has become increasingly apparent. This study aims to investigate the influence of an experimental research study that developed and implemented an AI ethics education program for learners' ethical awareness and attitude towards AI. The research methodology involved validating a model of the AI ethics education program by applying it to a group of 10 domain experts. Additionally, pre-test and post-test designs were employed with 17 middle school students as the experimental group. The same assessment was administered before and after the implementation of the AI ethics education program, and the data were analyzed using paired-sample *t*-tests. The findings of this study are as follows: Firstly, an AI ethics education program model was developed, incorporating key competencies such as AI literacy, critical thinking skills in AI, and AI problem-solving skills, all within the context of AI ethics. The implementation of this model was effective in the educational setting. Secondly, significant improvements were observed in the ethical awareness of middle school students across all domains after participating in the program. Thirdly, the attitudes of middle school students towards AI exhibited significant enhancements across all domains. These findings contribute to the broader field of AI ethics education by highlighting the importance of ethical awareness in AI and fostering favorable attitudes towards AI. The implications of this study are significant for the field of AI education.

Keywords: artificial intelligence; ethics education program; middle school students; ethical awareness; attitudes toward artificial intelligence

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1. Introduction

The objective of this study was to develop an AI ethics education program that targets middle school students and to investigate the impact of the program on students' ethical consciousness and attitudes toward AI. Artificial intelligence (AI), a concept that emerged in the 1950s, involves the use of computers to mimic human intelligence. The advancements in computer technology, such as the proliferation of data, computing innovations, and groundbreaking algorithms, have made AI an essential component of human existence [1]. Its rapid advancements have revolutionized various aspects of our lives, but this has also raised concerns about privacy, algorithmic bias, and the impact of automation on employment [2]. AI technology, while offering numerous conveniences, introduces challenges such as unfairness and potential disadvantages [3]. In order to address these challenges, education policies have started recognizing AI literacy and competence in utilizing AI as essential skills for students in primary, middle, and high schools in South Korea starting in 2025 [4]. Therefore, it is essential to provide AI literacy education to students,

fostering problem-solving attitudes and abilities using AI [5–10]. However, with the rapid increase in ethical accidents due to AI [11], there is a pressing need for AI ethics and attitude education to be provided together with AI literacy education. "AI ethics" refers to the principles and guidelines concerning ethical issues related to AI technology, such as data privacy, algorithmic bias, accountability, and transparency. On the other hand, "ethical consciousness" refers to the ability of individuals or groups to understand and make ethical judgments, which is crucial when interacting with AI. The attitudes towards AI play a significant role as they influence learners' interactions with AI. The rapid and convenient positive aspects of AI development coexist with concerns about data inaccuracies and ethical implications, necessitating a focus on AI ethics [12]. According to Shin and Won (2020), failure to align norms with technological advancements may result in self-inflicted harm from the technology developed [13]. This underscores the necessity for students in primary, middle, and high schools to acquire and enhance their abilities to understand and utilize AI technology [14]. NGOs, research institutes, companies, and government agencies have published more than 100 AI ethics guidelines [15], and research analyzing AI ethics guidelines is also actively underway. Based on the principles commonly mentioned in AI ethics guidelines, this study assumed that in order for students to use AI technology meaningfully, they must have a good understanding of these principles and be able to prevent and respond to them.

In January 2021, the discontinuation of a Korean chatbot called "Lee Luda" due to hate speech and personal information breaches highlighted the significance of AI ethics and the necessity of involving all relevant stakeholders in the conversation [16]. In preparation for the upcoming AI era, it is crucial for students to develop the ability to ethically evaluate AI-generated results and examine their AI ethics consciousness [17].

Therefore, this study aims to answer the following research questions:

1. How should the AI ethics education program be structured and developed?
2. What is the impact of the AI ethics education program on middle school students' ethical consciousness towards AI?
3. How does the AI ethics education program influence middle school students' attitudes towards AI?

In order to achieve this objective, we designed an experimental study involving a pre-test and post-test design. The AI ethics education program was implemented using a selected group of middle school students who underwent assessments before and after the program. By comparing the results, we aim to evaluate the program's effectiveness in enhancing ethical awareness and shaping attitudes toward AI.

The anticipated outcomes of this study include a deeper understanding of the potential benefits of AI ethics education for middle school students and insights into the most effective approaches for integrating this program into educational settings. By equipping students with the necessary knowledge and ethical frameworks, we aim to empower them to navigate the ethical challenges posed by AI and contribute positively to the responsible development and use of AI technology.

2. Theoretical Background

2.1. Artificial Intelligence Education

Artificial intelligence (AI) is a technology that realizes human cognitive activities such as prediction, inference, and learning via computers, wielding capabilities like cognition, expression, and judgment [1]. Because of these characteristics, the significance of AI education is consistently underscored.

In South Korea, government agencies have suggested directions for AI education. The Korean Ministry of Education introduced a revised AI curriculum for primary and secondary education in 2022, which accentuates abilities such as creative problem identification and formulation through programming, communication skills for problem-solving in collaboration with AI, and critical thinking skills regarding AI ethics [4]. Han Seon-gwan,

Ryu Mi-young, and Kim Tae-ryeong [18] proposed the overall structure of "AI Education for AI Thinking" in terms of AI literacy, AI utilization, and AI value education.

Upon examining the components of AI education, we see that they include self-management skills, AI utilization skills, creative convergence skills, thinking skills, data processing skills, awareness of AI ethics, openness and sharing skills, and AI collaboration skills. Based on these, this study selected literacy, thinking, and values as the AI education competencies for the development of the ethics education program.

The objective of AI education in middle schools in South Korea, as outlined in the "AI Guide", is to ensure students comprehend the concepts and principles of AI, understand the importance of data and its utilization, and appreciate the differences in problem-solving methods using AI [19]. This is further detailed in "Purpose and direction of middle school artificial intelligence education content system" [3]. The document provides a comprehensive guideline for structuring and implementing AI education in middle schools, which includes understanding the progression and arrangement of AI, the significance of data in problem-solving, data analysis and collection, AI algorithms, and the principles of machine learning visualization. Moreover, it emphasizes the importance of hands-on experience with AI projects and understanding the social impacts and ethical implications of AI from the perspectives of developers, producers, and consumers. The guideline also underlines the importance of all stakeholders understanding the ethical issues arising from AI.

In the teaching and learning process, supervised learning about bias is implemented to recognize the importance of data, enabling learners to understand with ease. For the application of AI education tools in this program, YouTube learning content, Google Doodles, AI Duet Song-Maker, AI DeepAngel, AI Graphic, Entry, Scratch 3.0, Machine Learning for Kids, AIschool.org, Moral Machine, Google Classroom, and Padlet are planned to be utilized.

2.2. Artificial Intelligence Ethics Education Program

As the societal impact of artificial intelligence (AI) increases, the importance of AI ethics education along with AI education is being emphasized. Institutions such as the MIT Media Lab and the Montour School District have designated an independent AI ethics subject—Designing (AI Design) and Values (AI Ethics)—as a compulsory subject. The MIT School of Engineering has also launched an AI ethics education course for middle school students named AI for Everyone. The AI ethics education program is designed based on the MIT Media Lab's AI ethics education for elementary and middle school students, which is translated into Korean as "AI Ethics for All" [20]. Upon examining the five domains of this ethics education program, it includes "understanding the fundamental operating principles of AI systems", "possessing the ability to understand socio-technical systems", "recognizing that socio-technical systems affect various stakeholders differently", "applying technical understanding and knowledge for the objectives of stakeholders", and "contemplating the impact of technology on the world." In 2021, Ryu Mi-young and others developed a teaching and learning model for AI ethics education for elementary and secondary students in three areas: AI and Technology, AI and Society, and AI and Humans [21]. These initiatives demonstrate the active research efforts to reinforce AI ethics education along with AI education and to apply it effectively. Furthermore, regarding AI ethics education, the program recommends the selection and implementation of AI ethical elements from the design phase. According to Lee Ye-sol [22], it is essential to provide education about technologies and knowledge related to AI ethics to nurture the talents needed for the future of society. In line with this, the AI ethics education program in this study aims to present a structured curriculum series to cultivate ethical consciousness for co-existing with AI. This includes the selection and practice of AI ethics elements from the design phase to ensure that individuals are prepared to navigate the ethical aspects of AI.

This study assumes that a practical understanding of AI technology would be the effective basis for cultivating AI ethical consciousness and changing attitudes towards AI.

Therefore, before developing an AI ethics and attitude learning model, this study analyzed the capabilities of AI literacy education and structured an AI ethics education program for middle school students in three areas: AI utilization ability, AI critical thinking ability, and AI problem-solving ability.

2.3. Artificial Intelligence Ethics

A distinguishing feature of AI is that ethical elements are "embedded" from the data selection phase to the design phase [23]. Moreover, the necessity to explore the normative issues of AI across all stages of its technological development has been underscored [24]. AI ethics is being enacted as "ethics realizing", which exerts a significant influence, and it is suggested that it is challenging to put ethical principles into practice without an ethical mindset during the process of internalizing ethical guidelines by AI developers [25].

According to Gong Eun-ju [26], considering the technological advancements, the AI ethics education content that incorporates ethical elements in the system development process using computing technology has been proposed. With the progression of AI, unexpected social and ethical concerns are proliferating. The shift in the discourse of AI ethics underscores the need for responsibility for AI, extending from the machine ethics phase to the stages of developers, suppliers, and users [12]. The need for AI ethics concerning the demands of AI technology is highlighted, as the outcomes of AI technology do not solely make correct judgments [27].

In light of these circumstances, it is proposed that there is a need to understand and apply the AI ethical consciousness that professionals should possess when developers participate in the development process at the design stage [28].

"AI ethics standards centered on humans" put forth the "three major principles of AI", namely the "principle of human dignity", the "principle of the public good of society", and the "principle of the appropriateness of technology" [29]. These principles resonate with the fundamental principles of AI that coexist with humanness and futurity and bolster human growth, as stated in the "AI Ethical Principles" (draft) for the education field that supports human growth [4]. For the AI ethics education program contemplated in this study, we planned to choose each ethical element that incorporates the new Seoul PACT with four principles based on the ethical guidelines for developers, suppliers, and users, as presented by Kim Myung-ju [30], along with the principles of publicness, responsibility, controllability, and transparency, as specified by the Korea Information Promotion Agency [12].

2.4. Attitude towards Artificial Intelligence

As per Kim Seong-won and Lee Young-jun [31], the efficacy of learning can be enhanced when learners harbor a positive attitude toward AI. Moreover, problem-solving activities, which are tightly intertwined with the students' real-life experiences, can bring about a positive shift in their attitudes toward learning education [32]. Learners who have either direct or indirect experience with programming languages, encompassing both block-based and text-based programming, exhibit a positive attitude toward AI [33]. Hence, the effect on the learners' attitudes toward AI is intimately linked with the learners' outcomes. As stated by The Korea Foundation for the Advancement of Science and Creativity (2020), the "Basic AI" curriculum aimed to foster an attitude of problem-solving using AI [3]. In line with this, the present study endeavors to design an AI ethics education program that incorporates elements of attitudes towards AI.

2.5. Artificial Intelligence Literacy

As delineated by Lee Yu-mi [34], AI literacy pertains to an education that enables coexistence with AI and is a foundational ability to exercise personal freedom while showcasing one's competencies and skills in society. She further underscored that the comprehension and application of AI technology to augment critical thinking skills constitute a crucial facet of AI literacy. The content of AI literacy education can encompass ethics and AI, communication and collaboration with AI, and understanding AI to address problems in

contemporary life [35]. Additionally, Lee Cheol-hyeon [36] proposed that in response to the educational demands stemming from societal changes, basic knowledge of AI, utilization ability, development ability, and ethics/values should be integral components of AI literacy education content.

3. Method

3.1. Participants and Experimental Design

The research procedure for this study is designed to be implemented utilizing the AD-DIE model (Analyze, Design, Develop, Implement, and Evaluate). This model, comprising the stages of analysis, design, development, implementation, and evaluation, serves as the research procedure for an artificial intelligence ethics education program, as depicted in Figure 1.

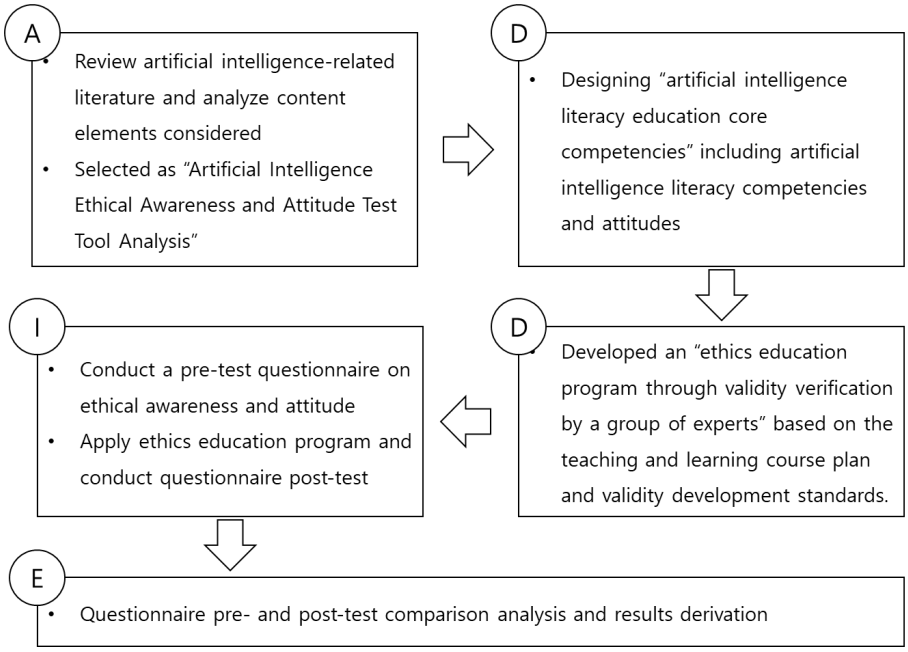

Figure 1. Artificial Intelligence Ethics Education Program research procedure.

This study is designed to examine the impact on the ethical awareness of artificial intelligence and attitudes towards artificial intelligence among middle school students. The design involves verifying the results of a pre-test conducted before the experimental intervention and a post-test conducted after based on the learner's questionnaire responses.

In order to verify the validity of this study, the expert group was composed of 10 people, and the contents are shown in Table 1.

Table 1. Target group of experts.

Educational Background	Personnel	Major	Degree
More than 21 years of experience	3 persons	Gifted Education	Doctoral degree
		Electronic Computation Education	Doctoral degree
		Information and Computer Science	Master's degree
11 to 15 years of experience	1 person	Convergence Talent and Gifted Education	Master's degree
5 to 10 years of experience	3 persons	Convergence Talent and Gifted Education	Master's degree
Less than 5 years of experience	3 persons	Convergence Talent and Software Education	Master's degree

The Artificial Intelligence Ethics Education Program was carried out with a single group comprising 17 middle school students as the research participants. The participants of the study were selected from among those students who enrolled in a computer academy to learn artificial intelligence. The selection criteria consisted of first to third-year middle school students who had no experience in artificial intelligence education and were capable of basic ICT use (document creation and search). Before applying this program, a questionnaire regarding artificial intelligence ethics and attitudes toward artificial intelligence was pre-tested. After applying the program, the learners held discussions using Padlet and Google Classroom, and based on this, a qualitative evaluation was conducted on changes in artificial intelligence ethics. The program spanned over a period of 4 weeks, with a total of eight sessions. The learning schedule is illustrated in Table 2 below.

Table 2. Artificial Intelligence Ethics Education Program study schedule.

Chapter	Date	Contents
1, 2	25 September 2022	Ability to utilize AI
3, 4	29 September 2022	AI Critical Thinking
5, 6	1 October 2022	AI Critical Thinking
7, 8	9 October 2022	The value of AI problem-solving ability

Prior to the implementation of the program, a pre-test on ethical awareness and attitudes was conducted among the learners. After the program, a post-test was carried out for comparison. A 24-question tool, based on a five-point Likert scale, was used for the test; this tool was developed by Kim Gwi-sik [17] for elementary, middle, and high school students' artificial intelligence ethical consciousness test. The reliability of ethical awareness for middle school students in this study, as indicated by Cronbach's alpha coefficient, is presented in Table 3 below.

Table 3. Internal reliability coefficient of artificial intelligence ethical awareness domain and item composition.

AI Ethical Awareness	Number of Questions	Question Number	Cronbach's Pre-Test	Cronbach's Post-Test
Responsibility	3	1, 9, 17	0.659	0.841
Stability and Reliability	3	2, 10, 18	0.603	0.731
No Discrimination	3	3, 11, 19	0.661	0.787
Transparency, Explainability	3	4, 12, 20	0.612	0.654
People-Oriented Service	3	5, 12, 21	0.646	0.717
Employ	3	6, 12, 22	0.622	0.849
Tolerance and Limitations	3	7, 12, 23	0.604	0.674
Robot's Rights	3	8, 16, 24	0.737	0.644
Total	24	1–24	0.706	0.817

The Cronbach's alpha coefficient for this study was found to be below 0.7, which is typically considered a threshold for acceptable reliability in many research contexts. It is important to note, however, that this lower coefficient value is likely attributed to the small sample size used in the study. Despite this, the reliability of the results should not be seen as compromised. Smaller sample sizes can often lead to variability in such measures, and this does not necessarily reflect on the overall quality or credibility of the research findings.

The attitude test tool towards artificial intelligence, developed by Seongwon Kim and Youngjun Lee, comprises five factors and 17 questions based on a five-point Likert scale [31]. The reliability of the attitudes of middle school students in this study, as indicated by Cronbach's alpha coefficient, is illustrated in Table 4 below.

Table 4. Internal reliability coefficient of middle school students' attitudes toward artificial intelligence.

AI Attitudes	Number of Questions	Question Number	Cronbach's Pre-Test	Cronbach's Post-Test
Social Impact of AI	4	1 *, 2 *, 3 *, 4 *	0.699	0.780
Communication with AI	4	5, 6, 7, 8	0.856	0.879
Interacting with AI	4	9 *, 10 *, 11 *, 12 *	0.604	0.767
Emotional Interactions with AI	3	13, 14, 15	0.650	0.724
Characteristics of Artificial Intelligence	2	16, 17	0.675	0.854
Total	17	1–17	0.799	0.768

(* Reverse Question).

As a research methodology for developing an artificial intelligence ethics education program, this study aimed to create a validity test sheet to verify the validity of the teaching-learning process. The validity test sheet comprises seven areas and eight questions, including learning methods 1 and 2, as well as topic, goal, level, order, study, content, and ethics, evaluated on a five-point Likert scale. In order to incorporate expert opinions, a section has been designed where individuals can freely express their thoughts.

3.2. AI Ethics Education Program for Middle School Students

In this study, the artificial intelligence (AI) ethics education program was established as an independent variable, with the AI education capabilities being knowledge, thinking, and values. The design incorporated elements regarding attitudes towards AI and was comprised of components from Artificial Intelligence Education for AI Thinking and Incheon Artificial Intelligence Education Standards and Guidelines [37]. Further, by taking reference from the AI objectives and educational direction of the middle school AI (2020) subject AI and Future Society [38], this study restructured the core competencies of AI literacy education, as depicted in Table 5.

Table 5. AI literacy education core competencies.

Contents	Detail
Ability to Utilize AI	The ability to communicate using tools and interact with artificial intelligence. Attitude: Communicating with artificial intelligence and interacting with artificial intelligence.
AI Critical Thinking	The ability to evaluate the characteristics and social impact of artificial intelligence through critical thinking. Attitude: Artificial intelligence and social influence and the characteristics of artificial intelligence
The Value of AI Problem-Solving Ability	The ability to solve problems and co-operate with artificial intelligence. Attitude: Artificial intelligence and emotional exchange

As depicted in Figure 2 below, this study has established a model for the Artificial Intelligence Ethics Education Program, which incorporates the Four Principles of Artificial Intelligence Ethics (PACT), as well as the core competencies of artificial intelligence literacy education.

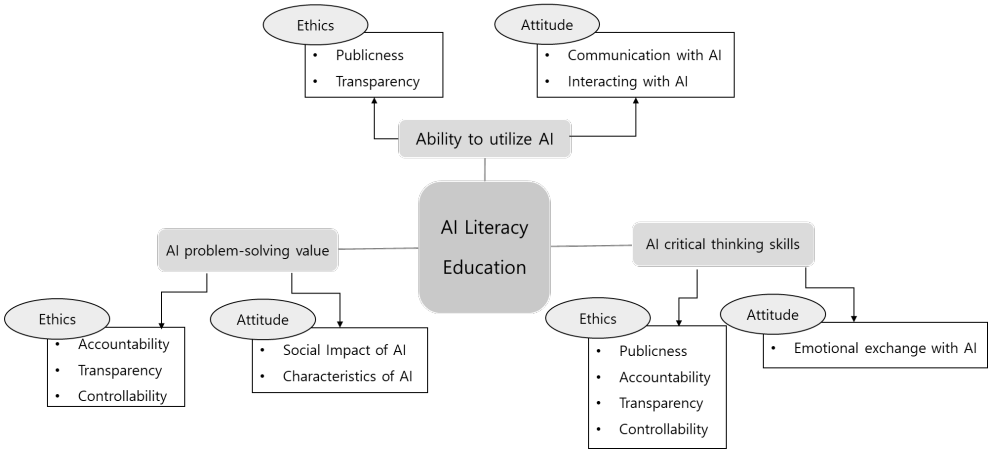

Figure 2. Artificial Intelligence Ethics Education Program model.

As indicated in Table 6 below, the objectives of the program, its phase-by-phase structure, and the elements of ethics, all based on the model for the Artificial Intelligence Ethics Education Program, are presented. Furthermore, Table 7 provides detailed information corresponding to the period-wise structure illustrated in Table 6. Most existing studies have designed AI ethics education programs in accordance with the four main principles of AI ethics: publicness, accountability, controllability, and transparency. This study, however, designed an eight-session education program and applied these four principles based on the core competencies of AI literacy. Additionally, the proposed education program analyzed not only the changes in middle school students' ethical consciousness but also their change in attitude toward artificial intelligence.

Table 6. Overview of an education program based on the Artificial Intelligence Ethics Education Program model.

Index	Detail
Goal	Impact of Artificial Intelligence Ethics Education Program on middle school students' artificial intelligence ethics awareness and attitude
Artificial Intelligence Literacy	• 1∼2 sessions: Applying AI utilization skills and knowledge → publicness and transparency • 3∼6 sessions: Applying AI critical thinking skills → publicness, accountability, transparency • 7∼8 sessions: Applying the value of AI problem-solving skills → Publicness, accountability, control, transparency
Ethics Elements	Program ethics elements of the four new Principles of Artificial Intelligence Ethics (PACT) (publicity, accountability, control, transparency)

All sessions include videos and exercises for learning AI, as well as learning content for AI ethics awareness, as detailed in Table 8.

In the development of the Artificial Intelligence Ethics Education Program for middle school students, a comprehensive model was established and validated by a panel of experts for content validity. This model incorporated the ADDIE procedure design [31], the tools for testing AI ethics awareness, and an assessment of students' attitudes toward AI. The validation process, emphasizing content validity, involved the use of content validity ratio (CVR), a statistical measure created by Lawshe to assess the relevance of test items. In this method, experts rate each item based on its necessity within the domain, with the CVR formula calculating the degree of expert consensus. A positive CVR value, which ranges from −1 to +1, indicates stronger agreement among experts on an item's relevance.

The results from this process, confirming a minimum CVR of 0.62 for groups of 10 or more experts, are detailed in Table 9.

Table 7. Details of Artificial Intelligence Ethics Education Program by period.

Session	AI Ethical Awareness Area	AI Attitude to Learn
1∼2	Transparency and explainability, stability and reliability, non-discrimination	• AI and Communication • Interacting with AI
3∼4	Accountability, employment, transparency and explainability, people-centred services, non-discrimination	• Social Impact of AI • Characteristics of AI
5∼6	Employment, transparency and explainability, accountability, stability and reliability, people-centred services	• Social Impact of AI • Characteristics of AI
7∼8	Employment, non-discrimination, accountability, stability and reliability, transparency and explainability, rights of robots, tolerances and limits, people-centred services	• AI and Emotional Interaction

Table 8. Details of Artificial Intelligence Ethics Education Program.

Session	Learning AI (Video and Practice)	Learning AI Ethics and Attitude (Discussion)
1∼2	• Understanding the principles of deep learning and machine learning technologies that utilize artificial intelligence (video) • Communicating using artificial intelligence (artificial intelligence practice)	Utilization of machine learning 4Kids (climate response Dexter input), ethical awareness of data bias (Scratch 3.0)
3∼4	• Understanding GAN technology, recognizing the need for ethics in deepfake dysfunction (artificial intelligence practice) • Understanding the need for improved Iruda chatbot ethics due to the social impact of artificial intelligence technology (video)	Recognizing the need for artificial intelligence ethics as a result of image classification (using entries)
5∼6	• Understanding artificial intelligence characteristics and social impacts through the pros and cons of autonomous vehicles (video) • Change map using AI4school.org, find the fastest route (artificial intelligence practice)	After practicing the moral machine, discuss any critical judgments arising from the trolley dilemma and ethical dilemma based on iRobot standards using thinking skills.
7∼8	Learn about collaboration with artificial intelligence and problem-solving machines through future videos	• Sad Robot and Artificial Intelligence Spot, Ethics as a Social Member of Atlas (Publicity, accountability, control, transparency) • Sad Robot and Artificial Intelligence Spot, Ethics as a Social Member of Atlas (Publicity, accountability, control, transparency)

Table 9. Results of validity verification analysis from the group of experts.

Item	Total	Method 1	Method 2	Subject	Goal	Level	Procedure	Detail	Ethics Elements
CVR	0.95	1	0.95	0.95	0.95	1	0.90	0.95	0.95
Stability	0.09	0.06	0.08	0.10	0.09	0.09	0.09	0.09	0.10
SD	0.45	0.34	0.43	0.43	0.46	0.50	0.47	0.47	0.48
M	40.74	40.88	40.80	40.83	40.70	40.70	40.63	40.78	40.63

Based on the evaluations and insights provided by experts, the sequence of the learning process, as well as the focal points, were revised. The previously mentioned (Tables 6–8) present a comprehensive plan for the learning process, incorporating all enhancements.

4. Discussion

4.1. Artificial Intelligence Ethics

Based on the outcomes of the program proposed in this research, we will explore the influence of the Artificial Intelligence Ethics Education Program on middle school students' awareness of artificial intelligence ethics. The artificial intelligence ethics survey sample is as follows: "I believe that in the event of an unavoidable accident, an autonomous car driven by artificial intelligence should prioritize the protection of the driver over pedestrians", "I believe that most artificial intelligence technologies can be trusted and are safe", "I believe that another form of discrimination or injustice can be caused by strong artificial intelligence that thinks and judges like a human", and "I believe that even when collecting data and developing artificial intelligence technology for the benefit of the nation, organization, society, and all people, personal information and privacy must be protected".

In this study, the statistical analysis of the Artificial Intelligence Ethics Education Program's effectiveness was conducted using SPSS software. The primary method of analysis was a paired-sample *t*-test, which was applied to the results of the pre and post-test questionnaires to assess the impact on the participants' ethical awareness of artificial intelligence. This approach aimed to determine any significant changes in the mean scores between the two groups, reflecting the level of improvement in AI ethics awareness, with the results indicating a notable increase. The level of artificial intelligence ethics awareness improved by 0.773 points ($t = -14.235$, $p < 0.000$). A significant difference was identified, as displayed in Table 10 below.

Table 10. AI ethics pre · post matched sample *t*-test.

AI Ethics	Pre (n = 17)		Post (n = 17)		t	p
	M	SD	M	SD		
Accountability	4.178	0.458	4.686	0.416	−5.124	0.000 ***
Stability, Reliability	3.647	0.448	4.353	0.448	−10.188	0.000 ***
No Discrimination	3.353	0.464	3.980	0.464	−9.898	0.000 ***
Transparency, Explainability	3.667	0.500	4.459	0.424	−10.323	0.000 ***
People-centered service	3.608	0.426	4.353	0.478	−8.444	0.000 ***
Employ	3.784	0.470	4.688	0.416	−7.097	0.000 ***
Tolerances and Limits	3.588	0.580	4.471	0.501	−11.360	0.000 ***
Robot Rights	2.588	0.763	3.529	0.537	−7.709	0.000 ***
Total	3.553	0.490	4.326	0.380	−14.235	0.000 ***

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

In this regard, the results of learners' awareness of artificial intelligence ethics after implementing the Artificial Intelligence Ethics Education Program of this study align with the discussion from previous research [5,36,39–41] that emphasized the cultivation of ethical awareness through the application of core competencies in artificial intelligence literacy education. The qualitative analysis of learners' understanding of artificial intelligence ethics after the application of the Artificial Intelligence Ethics Education Program is as follows. The learners' ethical sense of responsibility pertains to ensuring that the artificial intelligence system adheres to the rules and that, in the event of an accident, it is possible to trace back the condition to explain the specific design and outcomes of artificial intelligence technology. This is consistent with the notion of accountability examined in previous studies [42–44]. In addition, the ethical consciousness of developers aligns with existing research findings, indicating that the ethics of AI developers are essential for learners to internalize and practice AI ethics [25]. Learners stressed the importance of transparency, insisting that sources should be cited for images or videos that contain artificial intelligence technology. This demonstrates that the learning process around deepfakes acknowledges

the serious crime of illicit videos and exhibits an ethical awareness of the necessity for transparency. Furthermore, this ethical consciousness concerning transparency aligns with existing research findings that highlight the need for data bias to be made transparent in accordance with the characteristics of artificial intelligence through a deep learning process [23]. Learners' ethical consciousness regarding bias aligns with existing research discussions that advocate for data consistency by being objective and excluding subjective intervention [45]. With respect to the ethical consciousness of publicness, learners stated that the development of artificial intelligence should be conducted in such a way that it can be utilized by everyone with fair and equal rules and that differences in the application of artificial intelligence according to age and gender are taken into account. This is in line with discussions about using artificial intelligence technology efficiently, respecting humans in various situations, protecting users, and improving unfair circumstances [27].

Ethical consciousness pertaining to control can be observed in the areas of employment, permissions, and limitations. Learners demonstrated an understanding that professions may be supplanted by artificial intelligence technology or that certain job roles, such as painters or taxi drivers, could become obsolete due to the advent of autonomous vehicles or generative adversarial network (GAN) technology. In the context of robotics, a principle of respecting robots within the purview of human-centric ethics has emerged, along with an ethical consciousness of tolerance and limitations that aims to prepare for the controllability of humans and potential errors in artificial intelligence. This aligns with the perspective where learners view robots through the lens of design, production, and user ethics and restrict the rights of robots within the confines of human ethics [24].

4.2. Attitude Toward Artificial Intelligence

Based on the outcomes of the program proposed in this study, we aim to discuss the influence of the Artificial Intelligence Ethics Education Program on the attitudes of middle school students toward artificial intelligence. The artificial intelligence attitudes survey sample is as follows: "I think that future society will be dominated by artificial intelligence*", "If artificial intelligence has emotions, I would feel anxious*", "I can communicate fluently with artificial intelligence", and " I understand how useful artificial intelligence is". The asterisk (*) indicates a reverse-scored item.

In order to compare and investigate the impact on attitudes toward artificial intelligence among the experimental group of middle school students in this study, a paired-sample *t*-test was executed on the questionnaire responses from the pre-test and post-test utilizing the SPSS statistical software. The attitude level toward artificial intelligence exhibited an improvement of 1.038 points (t = −8.936, $p < 0.004$). The results indicated a significant difference, as depicted in Table 11 below.

Table 11. Attitude toward AI pre · post paired samples *t*-test.

AI Attitude	Pre (n = 17)		Post (n = 17)		t	p
	M	SD	M	SD		
Social Impact of AI	2.279	0.514	3.721	0.522	−11.123	0.011 *
AI and Communication	2.926	0.683	3.750	0.565	−9.675	0.001 ***
Interacting with AI	3.221	0.592	4.015	0.562	−11.579	0.001 ***
AI and Emotional Interaction	2.725	0.625	3.784	0.485	−9.490	0.002 **
Characteristics of AI	3.588	0.537	4.706	0.435	−8.033	0.003 **
Total	2.885	0.546	3.923	0.357	−8.936	0.004 **

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

The following is a qualitative analysis of the learners' attitudes toward artificial intelligence after the implementation of an AI ethics education program. The learners

showcased an interactive attitude with AI while engaging in music creation using AI educational tools. A familiar communication attitude towards AI was observed in AI assistants, drone delivery, medical kits, and information searches. The learners' interaction and communication with the improved chatbot, Lee Luda, demonstrated a positive attitude towards AI, shifting from previous indifferences due to misconceptions about AI [16]. The reactions to traffic accidents caused by autonomous AI vehicles, the reduction in environmental pollution, and crime prevention reflected the learners' positive attitudes towards the social impacts of AI.

However, concerns were also noted, such as the significance of roles in the context of autonomous cars to prepare for potential accidents in unforeseen environments, as well as the necessity for attitudes toward AI, as discussed [13]. The learners' perception that the world could become artificial due to GAN technology indicated a negative stance towards illicit videos that could cause harm. This aligns with Hwang Jung's (2021) research on preventing the misuse of deepfake technology as a criminal tool and educating learners about its social impact [46]. The trolley dilemma and ethical dilemmas, based on the learners' standards, displayed an attitude of decision-making according to a system standard that prioritizes the vulnerable and children in society. This ethical dilemma of the social impact caused by artificial intelligence echoes the discussion of social responsibility and ethics by Gong Eun-joo (2022) and the learner's attitude toward its social impact [26]. After viewing a video of a robot's funeral and an experiment, the learners exhibited an attitude of emotional interaction with AI. They expressed a positive attitude towards the characteristics of AI after observing the quick and precise actions of bipedal and quadrupedal robots, which are challenging for humans to perform.

5. Conclusions

This research aimed to develop an AI ethics education program that fosters the cultivation of ethical consciousness and a positive attitude towards AI among middle school students in order to prepare them for coexistence with AI. The focus of the AI education curriculum was to make learners understand that the judgments made by AI are based on human decisions, and the consequences of these decisions are human responsibilities. This was achieved by providing practical exercises related to data bias. Furthermore, the curriculum aimed to enhance learners' understanding of AI principles and technologies to effectively manage AI, as well as to educate them about AI's characteristics. Based on AI literacy core competencies, we designed an eight-session education program that applied these four principles. Additionally, the proposed educational program analyzed not only changes in middle school students' ethical awareness but also changes in their attitudes toward artificial intelligence. To this end, the teaching and learning process was structured using practical and video materials appropriate for each session, such as AI education series videos, robot videos, and AI future videos, so that the participants could easily comprehend the content. Our approach, which emphasized practical exercises related to data bias and the enhancement of learners' understanding of AI principles and technologies, was informed by the guidelines provided by official documents and research in the field, echoing the core competencies of AI literacy that have been underscored [47]. In order to develop this AI ethics education program, a model was constructed by researching and analyzing previous studies on AI ethics education, ethical consciousness, attitudes, and the core competencies of literacy. A preliminary teaching and learning process was then designed by applying these core competencies to each of the 8 hours in a total of four classes in the developed model. In order to ensure the validity of the teaching and learning process content, a validation process was carried out by a panel of 10 experts. Upon validation, the development of the AI ethics education program was completed.

The experimental group in this study was comprised of 17 middle school students who participated as a single group of research participants. A significant difference was found in the paired sample *t*-test results of the pre-test and post-test scores of AI ethical consciousness and attitudes, indicating the positive effect of the education program. Based on the learning

activities of the participants who underwent the AI ethics education program and the measurement items of AI ethical consciousness and attitudes toward AI, this study arrived at the following conclusions:

Firstly, the AI ethics education program model was designed around the core competencies of AI literacy education, namely AI utilization ability, AI critical thinking ability, and AI problem-solving ability. It also incorporated AI ethics and attitudes. Upon the application of the developed model to the teaching and learning process, the AI ethics education program was validated by a group of 10 experts, with a CVR = 0.95, proving its effectiveness in facilitating education.

Secondly, a significant difference was observed between the AI ethics education program and the AI ethical consciousness of the middle school student participants ($p < 0.000$). After the implementation of the AI ethics education program, a positive effect was observed across all eight areas of the learners' AI ethical consciousness. The learners in this study acknowledged the necessity of correctly and objectively inputting a substantial amount of data to prevent bias. They also recognized that AI ethical consciousness is not solely the responsibility of the developer but is shared amongst all parties involved, including users and consumers. In the supervised learning curriculum, learners were able to comprehend the outcomes driven by weights at each layer. This was achieved by collecting and refining data and training AI's learning using educational AI tools. This process allowed them to recognize the transparency required for demanding explainability, a key characteristic of AI technology, by disclosing the source of usage. Furthermore, their ethical consciousness regarding the public nature of disclosing the technological process for the benefit of all was enhanced. They also recognized that the ethical standards of AI entities, such as Lee Luda, which had been ostracized due to unfair and hateful remarks but has since been improved and reintegrated, had been applied in accordance with social consensus as societal impact change. Consequently, the AI ethics education program, as implemented in this study, demonstrated its effectiveness in enhancing AI ethical consciousness with respect to public interest, responsibility, controllability, and transparency among the learners. Moreover, these learners were able to discern that the application of AI ethics aligns ethical standards with societal norms, reflecting changes as per social consensus.

Thirdly, a significant difference was found between the AI ethics education program and the attitudes toward AI among the middle school student participants ($p < 0.004$). Following the implementation of the AI ethics education program, a positive influence was observed in all five areas of attitude toward AI.

Through the implementation of this education program, a marked improvement was observed in learners' attitudes towards AI. Their emotional interaction with AI, coupled with their acceptance of AI as a societal member, resulted in a decrease in anxiety and an overall positive shift in their attitude toward AI. Additionally, learners exhibited a high regard for the beneficial attributes of AI that facilitate collaboration to solve complex problems. This is in line with Long and Magerko's discussion [6] on AI literacy competencies, reinforcing the importance of critical thinking and problem-solving abilities in navigating AI ethics.

The participants' familiarity with AI improved through regular interaction using AI educational tools, thereby fostering a practical attitude by acknowledging the material value AI offers, owing to its faster and more precise computational capabilities compared to humans. Accordingly, learners exhibited a mindset that recognizes the necessity for AI ethical principles, norms, and standards for co-existing with AI. They also acknowledged the importance of being adept at handling AI and the need for a comprehensive understanding and knowledge of AI. In this regard, the AI ethics education program demonstrates its positive impact on learners' AI ethical consciousness and attitudes toward AI. Therefore, the AI ethics education program, as implemented in this study, proved effective in influencing middle school students' AI ethical consciousness and attitudes toward AI, fulfilling its intended purpose.

Based on the results of this study, future research plans to track the long-term effects of AI ethics education programs on students' ethical consciousness and attitudes toward

AI. Additionally, while this study focused on middle school students, the research will be expanded to include other age groups and professional categories in order to provide a more comprehensive understanding of the effects of AI ethics education. The study relied on a specific group of middle school students, which may limit the generalizability of the findings to other age groups or educational settings. Future research could extend this study by comparing the impact of AI ethics education across various age groups, educational levels, or cultural contexts.

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