

# Development of a Content Framework of Artificial Intelligence Integrated Education Considering Ethical Factors

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**Abstract**—The rapid advancement of Artificial Intelligence (AI) technology has brought about significant positive changes across society. However, it has also introduced challenges like privacy breaches, data bias, and spreading fake news. In response, several countries, including South Korea, have provided ethical guidelines and policies for AI. Yet, these measures often fall short of keeping pace with the speed and diversity of AI development. To address these issues, this study developed a comprehensive approach by integrating ethical considerations into AI education, covering the entire AI technology development and application process. It involved analyzing previous research on AI and AI ethics education and creating a draft of an integrated AI education program focused on problem-solving based on computational thinking and ethical practicality. The draft was refined and supplemented through two rounds of expert Delphi surveys, ultimately leading to an “Integrated AI Education Program.” This proposed program emphasizes that the knowledge content of AI technology and ethical considerations should not be treated separately but addressed together. It aims to enhance moral and social capacities alongside the experience of thinking like a computer scientist when solving real-life problems. Through this, the program supports the ultimate goal of AI education: to foster computational thinking while providing an educational experience that considers both technology and ethics. This study is expected to advance the discussion on integrating AI ethics into AI education curricula and contribute to developing socially responsible AI developers and users.

**Keywords**— AI education; AI ethical factors; AI ethics education; AI integrated education; AI training content system.

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## I. INTRODUCTION

The advancement of Artificial Intelligence (AI) technology has brought positive changes across society; however, it has also been accompanied by adverse effects, such as privacy invasion, data bias, and the spread of fake news [1]. In response, countries, including South Korea, have attempted to mitigate these adverse effects by providing AI ethics guidelines and announcing AI ethics policies [2]. However, guidelines and ethical policies related to AI technology face limitations owing to the rapid pace of AI development and its universality. Although AI technology has evolved swiftly, policies and laws require significant adaptation time [3]. In addition, owing to the wide range of applications of AI technology, policies focusing on specific areas may not fully reflect the characteristics of other domains [4].

AI ethics education, which involves all members of society, including developers, users, and policymakers, is

crucial to addressing these issues. Such education deepens the understanding of ethical issues and actively incorporates this understanding into technology development and application processes [5], [6]. AI ethics education can help students recognize the ethical dilemmas that may arise with AI technology and provide thought processes and guidelines for responding to these dilemmas [7]. Furthermore, it can strengthen the ethical and social responsibilities and civic consciousness necessary for sustainable technological development [8]. Consequently, there is a trend among countries to emphasize AI ethics education alongside AI technology education [9]. However, there is a lack of research on approaches to cultivating AI ethics, focusing instead on composing ethics guidelines and policy content without adequately addressing how to foster AI ethics [10].

This study explored an integrated approach to AI education and AI ethics education, rather than treating them as separate entities, to foster awareness of AI ethics and enhance practical implementation. To this end, we analyzed the core procedures

of AI education in Korea and other countries. Furthermore, we developed a content system by integrating AI ethics into major areas of AI education programs.

Through this research, we hope to establish the concept of integrated AI education. Although not explicitly named as such, integrating AI ethics into AI education is expected to be an essential element in instructional design. In addition, we anticipate that the developed content system will aid in cultivating AI ethics and enhancing computational thinking skills.

## II. MATERIALS AND METHOD

### A. Prior Research on AI Ethics Education

The Korean Ministry of Education unveiled a draft of the “AI Ethics Principles in Education” in January 2022 and officially announced it in August of the same year [11]. In addition, the Ministry of Science and ICT released a report in 2021 titled “Developing AI Ethics Policy for Human-Centric AI,” which outlined the standards for ethics education content development, learning elements, stakeholders, and post-learning competencies [12]. In the United States, the AI4K12 initiative has structured an AI education system for K-12 students around five central ideas, incorporating discussions on the societal impacts of AI [13]. Finland emphasizes the development of competencies and ethical awareness among AI users across all levels of education [14]. Thus, with national governments showing increased interest in AI ethics, research related to AI ethics is also growing.

According to Mi-ga [15], research on AI ethics in Korea began in 2006, showing modest progress over a decade and steadily increasing from 2016 onwards. Analysis by research field revealed that law accounted for 33.1%, ethics for 22.6%, and education for 13.4%. Ja-mi (2022) stated that without a basic understanding of AI technology, the comprehension of AI ethics is also low. Furthermore, integrating AI is challenging without acquiring basic knowledge or concepts of AI technology [16]. Soon-yong [17] suggested that AI ethics education can be divided into theme-centered, value-centered, and virtue-centered approaches. In particular, the value and virtue-centered approach is based on the ethical principles outlined in the ethics guidelines of Korea and other countries. This approach emphasizes AI ethics education that reflects values and characteristics in the problem-solving process with AI.

An analysis of research on AI ethics education found that many studies have treated AI ethics education as a separate entity, approaching it from an ethical perspective. This study hopes for AI ethics education to be conducted alongside AI education, thereby integrating ethical elements into AI education as much as possible in developing the content system.

### B. Integrated AI Education

Recently, AI technology has caused positive changes in various fields, such as healthcare, education, and business, by increasing efficiency and productivity. However, it also has negative impacts, including inequalities owing to data bias, privacy violations, ethical issues, and ambiguity in accountability [18], [19].

AI uses vast amounts of data to learn and build models independently. If developers do not consider the ethical aspects during this process, it can lead to problematic outcomes for humans to control or predict [20], [21]. An example is an AI recruitment tool developed by Amazon, which used past hiring data as its training data and ended up favoring male candidates, demonstrating biased decision-making [22]. This issue arose from a lack of ethical review during the development process, without adequately considering the characteristics of AI [23]. To prevent such ethical issues, education on ethical issues that AI can cause should start from K-12 grade, integrating AI concept learning with ethics education. In other words, AI education and AI ethics education should not be separated but integrated [24].

AI ethics education aims to conceptualize ethical elements and the practice of ethics. For learners to naturally consider AI ethics during development, the knowledge content of AI and ethics should not be separated. Jin-ah [25] emphasized that education enhances cognitive capabilities for effectively and efficiently solving real-life problems and improves affective capabilities considering social and ethical impacts. It has also been suggested that integrated AI education and AI education be used interchangeably. AI education aims for project-based learning that solves real-life problems using computers, emphasizing experiential and practice-oriented activities over knowledge-based education to foster thinking similar to that of computer scientists. Thus, an integrated approach must be noted, meaning that AI ethics education should be included.

This paper defines integrated AI education as supporting educational experiences that consider AI technology and ethics in problem-solving. This is expected to aid in cultivating computational thinking, which is the ultimate goal of AI education.

### C. Research Procedure

Integrated AI education aims to develop a content system for AI education that integrates AI education and AI ethics education. As shown in Fig. 1, the research procedure was conducted in three main stages. The first stage involves developing a draft content system for integrated AI education.

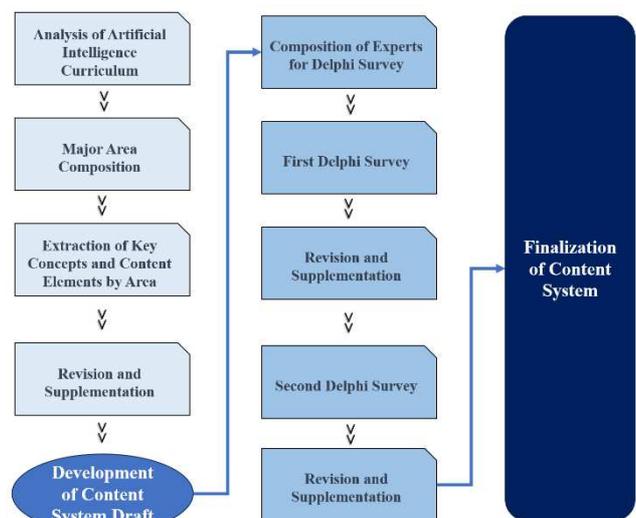


Fig. 1 Development of Content System for Integrated AI Education Program

Prior research on AI ethics education was analyzed to develop the content system. The problem-solving stages were also structured to ensure that AI education aimed at fostering computational thinking and AI ethics occurred together, and these were defined as significant domains. Next, to identify AI education's core concepts and content elements, familiar elements from various curricula were extracted, and significant domains of AI education were established. Finally, the core concepts were revised by including information on values and attitudes and AI ethics content elements, and a draft of the integrated AI education content system was developed. This aligns with the content system for AI education in the research report by Jeong-won et al. [29].

The second stage is the expert Delphi survey phase, aimed at ensuring the validity of the content system and supplementing its content. The Delphi survey was conducted over two rounds with 8 AI and AI ethics education experts, where modifications and supplements were made. Lastly, the final version was derived based on the revised and supplemented content and expert feedback.

### III. RESULTS AND DISCUSSION

#### A. Integrated AI Education Content System (First Draft)

The goal of integrated AI education is to strengthen the practical implementation of AI ethics by integrating AI and AI ethics education while enhancing computational thinking, an essential objective of AI education [26], [27]. In computer science, AI acts as an agent that uses computing power, i.e., artificial intelligence, to solve various problems encountered in daily life [28]. Therefore, this study's major domains of the integrated AI education content system were structured around the problem-solving process. This process involves developing a content system for integrated AI education based on the research report by Jeong-won et al. [29]. Based on prior research on AI education, the six major domains constructed were problem identification and analysis, data collection, data preprocessing, modeling, model application (application), and sharing and reflection, as shown in Table 1.

TABLE I  
CONSTRUCTION OF MAJOR DOMAINS FOR AI EDUCATION PROGRAM

Core Area	Description
Problem definition and analysis	This domain defines the problem to be solved and determines whether it is an efficient problem to be solved with artificial intelligence.
Data collection	This is the data collection area aimed at understanding the characteristics of structured and unstructured data, collecting, storing, and managing data for problem-solving.
Data preprocessing	This is the data preprocessing area where collected data is labeled or the data is structured and processed for modeling.
Modelling	Select and learn machine learning and deep learning models suitable for problem-solving using data. Areas to evaluate and improve models to increase reliability.
Model application	This stage optimizes the model to apply the prepared artificial intelligence model and creates an application program to use it in real life.
Share and reflect	The stage of sharing the final artificial intelligence program, evaluating whether the program is suitable for problem solving, as designed in the first area, and introspection.

Next, an analysis of prior research on AI concepts, knowledge, and AI ethics was conducted to construct a content system for the major AI domains. The content elements were augmented with ethical content elements from the value and attitude categories of South Korea's 2022 revised curriculum, along with the core AI concepts for each of the previously mentioned six stages. The content elements were based on the Korean curriculum and informed by references, such as the United States AI4K12 initiative, as shown in Table 2.

TABLE II  
CONTENT ELEMENTS BY AREA IN THE INTEGRATED AI PROGRAM

Core Area	Core Concept	Main Content
1. Problem Definition and Analysis	(1-1) AI Concepts and Social Impacts	> Understanding the concepts and characteristics of AI > Comparing and analyzing AI and non-AI entities > The impact of AI on personal life, society, and professions
	(1-2) AI Problem-Solving Procedures	> Problems solvable by AI > Problem-solving procedures using AI
2. Data Collection	(2-1) Data Characteristics	> Structured and unstructured data Types and attributes of data
	(2-2) Data Organization	> Data storage and management
3. Data Preprocessing	(3-1) Data Labeling and Structuring	> Labeling according to data and problem types > Dataset segmentation
	(3-2) Data Analysis	> Methods of data analysis > Exploratory Data Analysis (EDA)
	(3-3) Data Processing	> Data augmentation > Data transformation > Generating additional data
4. Modeling	(4-1) Machine Learning and Deep Learning	> Concepts and application areas of machine learning and deep learning > Supervised and unsupervised learning > Types of problems solved by machine learning
	(4-2) Model Training	> Model selection > Model training > Hyperparameters of a model
	(4-3) Model Evaluation and Improvement	> Model performance evaluation > Model and data modification > Application algorithms
5. Model Application (Application)	(5-1) Application Design	> Model optimization > Creating applications
	(5-2) Application Development	> Model optimization > Creating applications
6. Sharing and Reflection	(6-1) Technology Utilization Plans	> Exploration of model application cases
	(6-2) Technology Evaluation	> Reflection on the problem-solving process > Evaluation of project outcomes

AI ethics involves placing ethical elements that learners and developers must consider at each stage of AI problem-

solving. The content elements were informed by South Korea’s “Human-Centered AI Ethical Standards” and the “AI Ethics Principles in the Field of Education” by the Korean

Ministry of Education. Table 3 presents the results of the study.

TABLE III  
ETHICAL CONTENT ELEMENTS IN THE AREAS OF THE INTEGRATED AI PROGRAM

Core Area	Ethical Elements	Main Content
1. Problem Definition and Analysis	Values: Three Fundamental Principles of Humanity:	AI Considering Humanity AI Problem-Solving Considering Social Impact
2. Data Collection	<ul style="list-style-type: none"> <li>Human Dignity</li> <li>The Common Good of Society</li> <li>The Appropriateness of Technology</li> </ul>	<ul style="list-style-type: none"> <li>Guaranteeing Human Rights</li> <li>Solidarity</li> <li>Public Interest</li> <li>Prohibition of Violation</li> <li>Privacy Protection</li> <li>Data Management</li> </ul> Trustworthy Data Collection
3. Data Preprocessing		<ul style="list-style-type: none"> <li>Respect for Diversity</li> <li>Privacy Protection</li> <li>Data Management</li> </ul> Building Datasets that Align with Objectives Data Analysis Considering Diversity Data Augmentation Respecting Diversity
4. Modeling		<ul style="list-style-type: none"> <li>Data Management (Transparency, Security, Accountability)</li> <li>Public Interest</li> <li>Respect for Diversity</li> </ul> Transparent Machine Learning and Deep Learning Responsible Modeling Safe Model Evaluation and Improvement
5. Model Application (Application)		<ul style="list-style-type: none"> <li>Transparency</li> <li>Respect for Human Beings</li> </ul> Application Design Considering Social Impact Application Development Enhancing Public Interest
6. Sharing and Reflection		Sharing Results for Humanity Reflection for a Better Humanity

Furthermore, core concepts that integrate AI ethical elements are outlined based on the major domains, core concepts, and content elements presented in Tables 2 and 3. The core concepts and content elements for AI education that

reflect ethical elements were derived based on these. The final revised draft of the content system for the integrated AI education program is presented in Table 4.

TABLE IV  
DRAFT AI INTEGRATED EDUCATION PROGRAM CONTENT SYSTEM

Core Area	Core Concept	Main Content
1. Problem definition and analysis	(1-1.) AI considering humanity	1-1-1 Understanding the concept and characteristics of AI 1-1-2 Comparison and analysis of AI and non-AI 1-1-3 Impact of AI on individual lives, society and jobs 1-1-4 AI considering humanity
	(1-2.) AI problem solving with social impact in mind	1-2-1 Problems that AI can solve 1-2-2 Problem solving process using AI 1-2-3 AI and social influence
2. Data acquisition	(2-1.) Reliable data collection	2-1-1 Structured and unstructured data 2-1-2 Data form and properties 2-1-3 Efficient data storage 2-1-4 Data copyright, Data Diversity, privacy protection
3. Data preprocessing	(3-1.) Build fit for purpose datasets	3-1-1 Data labeling for Supervised Learning 3-1-2 Data Processing for Learning 3-1-3 Data management to protect privacy
	(3-2.) Data analysis considering diversity	3-2-1 Data analysis method 3-2-2 Exploratory Data Analysis (EDA) 3-2-3 Data analysis and respect for diversity
	(3-3.) Complementing data with respect for diversity	3-3-1 Addition of data 3-3-2 transformation of data 3-3-3 Generative of data 3-3-4 Structuring the dataset 3-3-5 Data management for diversity
4. Modelling	(4-1.) Transparent machine learning and deep learning	4-1-1 Concepts of Machine Learning and Deep Learning 4-1-2 Types of Tasks in Machine Learning (prediction, classification, etc.) 4-1-3 Explainable Learning Model
	(4-2.) Responsible Modeling	4-2-1 Choosing a Learning Algorithm 4-2-2 Model learning 4-2-3 Modifying hyperparameters for model optimization 4-2-4 Learning to be Responsible Together

Core Area	Core Concept	Main Content
	(4-3.) Safe model evaluation and improvement	4-3-1 Model performance evaluation 4-3-2 Supplementing models and data 4-3-3 Safe AI to prevent potential dangers
5. Model application	(5-1.) Application design considering social impact	5-1-1 Application Algorithm Design 5-1-2 Application design considering positive and negative functions
	(5.2.) Development of applications that promote publicity	5-2-1 Optimizing the model for application 5-2-2 Application development 5-2-3 Review the application's social impact
6. Share and Reflect	(6.1.) Sharing Results for Humanity	6-1-1 Share the problem-solving process and results 6-1-2 Discussion of artificial intelligence based on humanity
	(6.2.) reflection for a better humanity	6-2-1 Problem-solving process and result reflection 6-2-2 A Reflection on social impact

### B. Validation Through the First Delphi Survey

The Delphi analysis technique was used to ensure the validity of the content system for the integrated AI education program developed in this study. The panel of experts comprised AI and AI ethics education professionals, as outlined in Table 5. The criteria for Delphi modification were based on the validation index according to the Content Validity Ratio (CVR) distribution values defined by Lawshe [30]. The CVR should be at least 0.75 for a panel of eight experts. This study decided that modifications and supplements would be based on obtaining a CVR value of 0.75 or higher.

TABLE V  
EXPERT GROUP PARTICIPATING IN THE DELPHI SURVEY

Category	Position	Major	Experience
A	Professor	AI Ethics	10+ years
B	Professor	AI Education	10+ years
C	Professor	AI Education	10+ years
D	Professor	AI Ethics	5+ years
E	Professor	AI Education	10+ years
F	Professor	AI Education	15+ years
G	Professor	AI Education	5+ years
H	Professor	AI Education	10+ years

1) *First Delphi Survey Results on the Composition of the Integrated AI Program's Major Domains:* As shown in Table 6, the validation results for the composition of the integrated AI program's major domains indicate that the [Sharing and Reflection] area, with a CVR value of 0.50, requires modification. Reflecting on the qualitative feedback, this was

changed to [Comprehensive Evaluation and Reflection] in the second Delphi survey.

TABLE VI  
QUANTITATIVE DELPHI ANALYSIS RESULTS FOR MAJOR DOMAIN COMPOSITION

Core area	Medium (M)	Median (Md)	Inter-quartile Range	CVR
Problem definition and analysis	4.63	5	5-4	1.00
Data acquisition	4.75	5	5-4.5	1.00
Data preprocessing	4.75	5	5-4.5	1.00
Modelling	4.38	5	5-4	1.00
Model application	4.25	5	5-4	0.75
Share and reflect	4.13	4	4-4	0.50

2) *First Delphi Survey Results on the Content Elements by Area of the Integrated AI Program:* The validation results for the content elements by area of the integrated AI program show that the content elements related to the AI concepts and social impact in the [Problem Definition and Analysis] area, with a CVR value of 0.50, require modification. Reflecting qualitative feedback, content elements regarding the impact of AI on personal life, society, and occupation were removed for the second Delphi survey. Additionally, based on expert opinions, the major domain of model application (application) was changed to application development, the content elements for comprehensive evaluation were adjusted to a thorough review of applications, and the content elements for comprehensive reflection were revised to comprehensive reflection based on evaluation results.

TABLE VII  
QUANTITATIVE DELPHI ANALYSIS RESULTS FOR CONTENT ELEMENTS OF THE INTEGRATED AI PROGRAM'S MAJOR DOMAINS

Division	Result				Division	Result			
	M	Md	Range	CVR		M	Md	Range	CVR
1-1	4.25	5	5-3.5	0.5	4-2	4.75	5	5-4.5	1
1-2	4.64	5	5-4	1	4-3	4.75	5	5-4.5	1
2-1	4.88	5	5-5	1	5-1	4.50	5	5-4	0.75
3-1	4.75	5	5-4.5	1	5-2	4.50	5	5-4	0.75
3-2	4.63	5	5-4.5	1	6-1	4.38	5	5-4	0.75
3-3	4.63	5	5-4	1	6-2	4.63	5	5-4.5	1
4-1	4.63	5	5-4	1					

3) *First Delphi Survey Results on Integrating Ethical Elements into the AI Integrated Program Content System:* The validation results for deriving core concepts integrated

with AI education and AI ethics education are as follows: In the problem definition and analysis, “AI that Grows Together” was changed to “AI Considering Humanity and the Common Good.”

TABLE VIII  
QUANTITATIVE DELPHI ANALYSIS RESULTS FOR THE INTEGRATED AI PROGRAM CONTENT SYSTEM WITH ETHICAL ELEMENTS

Division	Result				Division	Result			
	M	Md	range	CVR		M	Md	range	CVR
1-1	4.25	5	5-3.5	0.75	4-2	4.25	4	4-3.5	0.5
1-2	4.50	5	5-4	0.75	4-3	4.38	4	4-4	0.75
2-1	4.50	5	5-4	0.75	5-1	4.50	5	5-4	0.75
3-1	4.63	5	5-4	1.00	5-2	4.63	5	5-4	1.00
3-2	4.38	4	4-4	0.75	6-1	4.63	5	5-4	1.00
3-3	4.25	4	4-4	0.75	6-2	4.63	5	5-4	1.00
4-1	4.63	5	5-4	1.00					

The validity results for the development of the content system for the integrated AI program with ethical elements are as follows: In the modeling area, “Responsible Modeling” had a CVR value of 0.50, but it was decided not to make changes after internal discussions. This decision was made because the ethical element of responsibility was deemed necessary in connection with the other core concepts. The final modifications made to the first Delphi survey are presented in Table 9.

the integrated AI program’s major domains concerned the “Problem Definition and Analysis” area. There was deliberation on whether to define the problem before or after the analysis, as well as whether to distinguish between problem definition and analysis. Considering the various opinions, it was ultimately decided to treat problem definition and analysis as a single activity and finalize it as a major domain.

TABLE IX  
CHANGES MADE FOLLOWING THE FIRST DELPHI SURVEY ANALYSIS

Division	Before	After
Core area	Share and reflect	Comprehensive evaluation and reflection
Derivation of content elements by area	The impact of artificial intelligence on individual life, society and occupation	Delete
	Model application	Application development
	How to use technology	Comprehensive evaluation: Comprehensive evaluation of the application
	Skill evaluation	Comprehensive reflection: Comprehensive reflection based on evaluation results
	Artificial intelligence growing together	Artificial Intelligence Considering Humanity and Public Good
	Data cleansing to protect copyright	Data management that protects copyright

### C. Validation Through the Second Delphi Survey

Following the results of the first Delphi survey, changes were made to the content system of the integrated AI program. The results of the second survey indicated that the composition of the major domains shown in Table 13 and the content elements by area shown in Table 14 were appropriate based on their CVR values. Moreover, the integrated core content of AI education and AI ethics education presented in Table 15 also shows suitable CVR values.

1) *Second Delphi Survey Results for the Composition of Major Domains in the Integrated AI Program:* The most frequently mentioned opinions regarding the composition of

TABLE X  
SECOND DELPHI SURVEY RESULTS FOR MAJOR DOMAIN COMPOSITION

Core area	Medium (M)	Median (Md)	Inter-quartile Range	CVR
Problem definition and analysis	4.75	5.00	5-4.5	1.00
Data acquisition	5.00	5.00	5-5	1.00
Data preprocessing	5.00	5.00	5-5	1.00
Modelling	4.88	4.88	5-5	1.00
Model application	4.75	4.75	5-4.5	1.00
Comprehensive evaluation and reflection	4.88	4.88	5-5	1.00

2) *Second Delphi Survey Results on the Content Elements by Area of the Integrated AI Program:* The second Delphi survey results for AI content elements showed significant feedback on the previously deleted element concerning the impact of AI on personal life, society, and jobs. It was concluded that this content element could be sufficiently covered by “1-2-3 The Social Impact of AI” and therefore remained deleted.

3) *Second Delphi Survey Results for Integrating Ethical Elements into the AI Integrated Program Content System:* Key feedback on integrating ethical elements into the content included clarifying the meaning of “learning” in “learning that everyone can be responsible for” to “AI learning that everyone can be responsible for.” This revision was agreed upon. Similar to the results of the first Delphi survey, there was significant feedback on the deleted element concerning AI’s impact on personal life, society, and jobs. It was concluded that this content element, which could be replaced by “1-2-3 The Social Impact of AI,” was adequately addressed and therefore remained deleted.

TABLE XI  
QUANTITATIVE DELPHI ANALYSIS RESULTS FOR THE CONTENT ELEMENTS OF THE INTEGRATED AI PROGRAM'S MAJOR DOMAINS

Division	Result				Division	Result			
	M	Md	Range	CVR		M	Md	Range	CVR
1-1	4.38	4	4.5-4	1	4-2	4.88	5	5-5	1
1-2	5.0	5	5-5	1	4-3	4.88	5	5-5	1
2-1	5.5	5	5-5	1	5-1	4.88	5	5-5	1
3-1	5.5	5	5-5	1	5-2	4.88	5	5-5	1
3-2	5.5	5	5-5	1	6-1	4.88	5	5-5	1
3-3	5.5	5	5-5	1	6-2	4.88	5	5-5	1
4-1	5.0	5	5-5	1					

TABLE XII  
QUANTITATIVE DELPHI ANALYSIS RESULTS FOR THE INTEGRATED AI PROGRAM CONTENT SYSTEM WITH ETHICAL ELEMENTS FROM THE SECOND DELPHI SURVEY

Division	Result				Division	Result			
	M	Md	Range	CVR		M	Md	Range	CVR
1-1	4.75	5	5-4.5	1	4-2	4.5	5	5-4.5	1
1-2	5.0	5	5-5	1	4-3	4.75	5	5-5	1
2-1	4.88	5	5-5	1	5-1	5.0	5	5-5	1
3-1	5.0	5	5-5	1	5-2	5.0	5	5-5	1
3-2	5.0	5	5-5	1	6-1	4.88	5	5-5	1
3-3	4.88	5	5-5	1	6-2	5.0	5	5-5	1
4-1	4.75	5	5-4.5	1					

#### D. Integrated AI Education Content System

Table 13 presents the integrated AI education program developed in this study. The integrated AI education program encompasses both AI's technical and ethical aspects, thus forming a comprehensive educational content system. The main content and instructional objectives for each major domain are as follows:

1) *Problem Definition and Analysis*: Cultivate the ability to define and analyze AI-related problems by understanding the concepts and characteristics of AI, comparative analysis, and considering humanity.

2) *Data Collection*: Learn about reliable data collection, understand the types and properties of data, efficient data storage, and learn about copyright and privacy protection.

3) *Data Preprocessing*: Learn the importance and methods of data preprocessing, including building datasets that align with objectives, labeling and processing data, and respecting diversity.

4) *AI Learning*: Aim for transparent and responsible modeling by understanding the concepts of machine and deep learning, types of problem-solving, and explainable learning models.

5) *Application Development*: Design and develop applications considering social impact, considering positive and negative functions, and reviewing social influence.

6) *Comprehensive Evaluation and Reflection*: Emphasize reflection for better humanity by sharing results for humanity, discussing AI, and reflecting on social impact.

TABLE XIII  
FINAL VERSION OF THE INTEGRATED AI EDUCATION PROGRAM

Core Area	Core Concep	Main Content
1. Problem Definition and Analysis	1-1 AI Considering Humanity	1-1-1 Understanding the Concepts and Characteristics of AI 1-1-2 Comparing and Analyzing AI and Non-AI 1-1-3 AI with Humanity in Mind
	1-2 AI Problem Solving Considering Social Impact	1-2-1 Problems Solvable by AI 1-2-2 Problem-Solving Procedures Using AI 1-2-3 The Social Impact of AI
2. Data Collection	2-1 Trustworthy Data Collection	2-1-1 Structured and Unstructured Data 2-1-2 Data Types and Attributes 2-1-3 Efficient Data Storage 2-1-4 Data Copyright, Diversity, Privacy Protection
3. Data Preprocessing	3-1 Building Datasets that Align with Objectives	3-1-1 Data Labeling for Supervised Learning 3-1-2 Data Processing for Learning 3-1-3 Data Management for Privacy Protection
	3-2 Data Analysis Considering Diversity	3-2-1 Data Analysis Methods 3-2-2 Exploratory Data Analysis (EDA) 3-2-3 Data Analysis and Respect for Diversity
	3-3 Data Augmentation Respecting Diversity	3-3-1 Adding Data 3-3-2 Data Transformation 3-3-3 Data Generation 3-3-4 Structuring Datasets (Training, Validation, Test)

Core Area	Core Concep	Main Content
4. AI Learning	4-1 Transparent Machine Learning and Deep Learning	3-3-5 Data Management for Diversity Respect
		4-1-1 Concepts of Machine Learning and Deep Learning
		4-1-2 Types of Problems Solved by Machine Learning (Prediction, Classification, etc.)
	4-2 Responsible Modeling	4-1-3 Explainable Learning Models
		4-2-1 Choosing Learning Algorithms
		4-2-2 Model Training
4-2-3 Hyperparameter Adjustment for Model Optimization		
4-3 Safe Model Evaluation and Improvement	4-2-4 AI Learning that Everyone Can Be Responsible For	
	4-3-1 Model Performance Evaluation	
	4-3-2 Model and Data Augmentation	
5. Application Development	5-1 Application Design Considering Social Impact	4-3-3 Safe AI Preventing Potential Risks
		5-1-1 Application Algorithm Design
	5-2 Application Development Enhancing Public Interest	5-1-2 Designing Applications Considering Positive and Negative Functions
		5-2-1 Model Optimization for Applications
6. Comprehensive Evaluation and Reflection	6-1 Sharing Results for Humanity	5-2-2 Application Development
		5-2-3 Reviewing the Social Impact of Applications
	6-2 Reflection for a Better Humanity	6-1-1 Sharing the Problem-Solving Process and Results
		6-1-2 Discussing AI with Humanity as the Foundation
		6-2-1 Reflecting on the Problem-Solving Process and Results
		6-2-2 Reflecting on Social Impact

Integrated AI education highlights the need to address the knowledge content of AI technology and ethical considerations together. It aims to enhance cognitive capabilities for solving real-life problems like a computer scientist, along with affective capabilities considering social and ethical impacts. This supports educational experiences that foster computational thinking and consider both technology and ethics, ultimately aiming to cultivate the ultimate goal of AI education.

#### IV. CONCLUSION

This study aimed to develop a content system for an integrated AI education program aimed at enhancing the practical implementation of AI ethics and fostering computational thinking. AI education and ethical guidelines in Korea and other countries were analyzed to achieve this goal. Moreover, based on expert reviews and Delphi surveys, the integrated AI education program was structured into 6 primary domains, 13 core concepts, and 41 content elements. The content system developed in this study integrates ethical elements that must be emphasized in the major domains and key content of AI education. While all ethical elements should be considered at each stage, the content system was developed to highlight the ethics emphasized at various stages of AI development.

However, content integration and an integrated approach to teaching methods and evaluation are required to align with the goals of integrated AI education. Future research should further establish the concept of integrated AI education. Additionally, further research on educational content, teaching methods, and evaluation for AI-integrated education is anticipated in the future.

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#### REFERENCES

- [1] D. Schiff, J. Borenstein, J. Biddle, and K. Laas, "AI Ethics in the Public, Private, and NGO Sectors: A Review of a Global Document Collection," *IEEE Trans. Technol. Soc.*, vol. 2, no. 1, pp. 31-42, Mar. 2021, doi:10.1109/TTS.2021.3052127
- [2] L. Vesnic-Alujevic, S. Nascimento, and A. Pólvara, "Societal and ethical impacts of artificial intelligence: Critical notes on European policy frameworks," *Telecommun. Policy*, vol. 44, no. 6, 2020, doi:10.1016/j.telpol.2020.101961
- [3] D. Schiff, J. Biddle, J. Borenstein, and K. Laas, "What's Next for AI Ethics, Policy, and Governance? A Global Overview," in *Proc. AAAI/ACM Conf. AI, Ethics, Soc. (AIES '20)*, New York, NY, USA: ACM, pp. 153-158, 2020, doi:10.1145/3375627.3375804
- [4] S. Chang, "A Study on the Contents Exploration SIG 2021 for K-12 AI Ethical Education," *Korea Educ. Res. Inf. Serv.*, RR 2022-08, 2022.
- [5] J. Borenstein and A. Howard, "Emerging challenges in AI and the need for AI ethics education," *AI Ethics*, vol. 1, pp. 61-65, 2021, doi:10.1007/s43681-020-00002-7
- [6] W. Holmes, K. Porayska-Pomsta, K. Holstein, et al., "Ethics of AI in Education: Towards a Community-Wide Framework," *Int. J. Artif. Intell. Educ.*, vol. 32, pp. 504-526, 2022, Year, doi:10.1007/s40593-021-00239-1
- [7] N. Garrett, N. Beard, and C. Fiesler, "More Than 'If Time Allows': The Role of Ethics in AI Education," in *Proc. AAAI/ACM Conf. AI, Ethics, Soc. (AIES '20)*, New York, NY, USA: ACM, pp. 272-278, 2020, doi:10.1145/3375627.3375868.
- [8] S. Akgun and C. Greenhow, "Artificial intelligence in education: Addressing ethical challenges in K-12 settings," *AI Ethics*, vol. 2, pp. 431-440, 2022. doi:10.1007/s43681-021-00096-7
- [9] Z. Kilhoffer et al., "How technical do you get? I'm an English teacher": Teaching and Learning Cybersecurity and AI Ethics in High School," in *Proc. 2023 IEEE Symp. Secur. Privacy (SP)*, San Francisco, CA, USA, pp. 2032-2032, 2023, doi:10.1109/SP46215.2023.10179333.
- [10] M. Park, K. Han, and S. Sin, "Analysis of research status on domestic AI education," *J. Korean Assoc. Inf. Educ.*, Oct. 31, 2021, doi:10.14352/jkaie.2021.25.5.683
- [11] Ministry of Education, Republic of Korea, "Artificial Intelligence, Safely Utilized in the Educational Field!" 11 Aug. 2022. [Online]. Available: <https://www.moe.go.kr/boardCnts/viewRenew.do?boardID=294&lev=0&statusYN=W&s=moe&m=020402&opType=N&boardSeq=92297>, Accessed on: Jun. 5, 2023
- [12] Ministry of Science and ICT, "Development of Artificial Intelligence Ethics Policy for Human-Centered AI Implementation," 2021. [Online]. Available:

- <https://www.msit.go.kr/bbs/view.do?sCode=user&mPid=112&mlid=113&bbsSeqNo=94&nttSeqNo=3179742>, Accessed on: Jun. 27, 2023
- [13] D. Touretzky, F. Martin, D. Seehorn, C. Breazeal, and T. Posner, "Special Session: AI for K-12 Guidelines Initiative," in *Proc. 50th ACM Tech. Symp. on Comp. Sci. Educ. (SIGCSE '19)*, New York, NY, USA: ACM, pp. 492–493, 2019, doi:10.1145/3287324.3287525
- [14] Elements of AI, "A free online introduction to artificial intelligence for non-experts." Accessed on: January 11, 2023. [Online]. Available: <https://course.elementsofai.com/>, Accessed on: Dec. 12, 2023
- [15] M. Lim, "A systematic literature review of research on artificial intelligence ethics," *Journal of Ethics*, vol. 135, no. 0, pp. 47-66, 2021.
- [16] J. Kim and Y. Kim, "A Study on Artificial Intelligence Ethics Education based on AI Technology Dilemma," *The Korean Society for Creative Information Culture*, vol. 8, no. 2, pp. 87-95, 2022, doi:10.32823/jcic.8.2.202205.87
- [17] Byun, Soon-yong, "A Study on the Necessity of AI Ethics Education," *The Korean Society For The Study Of Elementary Education*, vol. 31, no. 3, pp. 153-164, 2020, doi:10.20972/kjee.31.3.202009.153
- [18] T. Hagendorff, "The Ethics of AI Ethics: An Evaluation of Guidelines," *Minds & Machines*, vol. 30, pp. 99–120, 2020, Year, doi:10.1007/s11023-020-09517-8
- [19] K. Siau & W. Wang, "Artificial Intelligence (AI) Ethics: Ethics of AI and Ethical AI," *Journal of Database Management (JDM)*, vol. 31, no. 2, pp. 74-87, 2020, doi:10.4018/JDM.2020040105
- [20] Y. Jongmo, "The ethics/policy/social issues of artificial intelligence," *Issue Paper No. 08, KIST, Korea Policy Center for the Fourth Industrial Revolution*, Dec. 2019.
- [21] B. Young-Im and K. Yu-na, "A Exploratory Study on the Ethical Issues of Artificial Intelligence," *Gyeonggi Research Institute, [Basic Research 2022-06], Researcher in Gyeonggi Province*, 2022.
- [22] BBC Korean, "[Gender Discrimination: Amazon Abandons Artificial Intelligence Recruitment Program Over 'Women's Discrimination' Controversy]," *BBC News*, 12 Oct. 2018. [Online]. Available: <https://www.bbc.com/korean/news-45820560>., Accessed on: Jan. 10, 2024
- [23] C. Zhang and Y. Lu, "Study on artificial intelligence: The state of the art and future prospects," *J. Ind. Inf. Integration*, vol. 23, 2021, doi:10.1016/j.jii.2021.100224
- [24] J. Bae, J. Lee, M. Hong, and J. Cho, "The Development of AI Ethical Competence Scale for Secondary School Students," *J. Korean Assoc. Comput. Educ.*, vol. 25, no. 6, pp. 103-118, 2022, doi:10.32431/kace.2022.25.6.008.
- [25] J. Bae, J. Lee, and J. Cho, "An Artificial Intelligence Ethics Education Model for Practical Power Strength," *J. Ind. Convergence*, vol. 20, no. 5, pp. 83-92, 2022.
- [26] J. M. Wing, "Computational thinking," *Commun. ACM*, vol. 49, no. 3, pp. 33-35, 2006.
- [27] M. Lodi and S. Martini, "Computational Thinking, Between Papert and Wing," *Sci. & Educ.*, vol. 30, pp. 883–908, 2021, doi:10.1007/s11191-021-00202-5
- [28] A. E. Putra et al., "Designing and Developing Artificial Intelligence Applications Troubleshooting Computers as Learning Aids," *Asian Soc. Sci. and Humanities Res. J. (ASHREJ)*, vol. 2, no. 1, pp. 38-44, 2020, doi:10.37698/ashrej.v2i1.22
- [29] J. Cho, M. Hong, and K. Lee, "The Research on Incorporation ethical elements AI education program for High school student," *Korea Education & Research Information Service*, RR 2023-04, 2023.
- [30] C. H. Lawshe, "A quantitative approach to content validity," *Personnel Psychology*, vol. 28, no. 4, pp. 563-575, 1975.