International Journal on Advanced Science Engineering Information Technology

Vol.13 (2023) No. 5
ISSN: 2088-5334

Development of AI Liberal Arts Curriculum for the General Public

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***Abstract*—Extending beyond technology, artificial intelligence (AI) is fundamentally changing how people live. It plays a key role in determining the competitiveness of countries and companies and is expected to change the competitive landscape of existing industries fundamentally. The better people understand AI, the better they can utilize it effectively and safely. Therefore, preparing a strategy to ensure that all citizens have access to AI education is important. This study aims to develop an AI liberal arts curriculum to improve the general public's ability to utilize and understand AI. Through literature analysis, AI core competencies for the general public were derived. The core competencies are Adaptability, Public Interest Consideration, Creative and Convergent Thinking, Collaboration, Computational Thinking, and Artificial Intelligence Literacy. The AI curriculum was designed considering AI core competencies, and the validity of the experts was verified for AI technology and education experts. We also conducted a comparative analysis of the content and level of AI curriculum for the general public based on the results of word frequency and topic modeling analysis of AI education-related papers collected from the Web of Science. The areas of the AI curriculum consisted of understanding artificial intelligence, application of artificial intelligence, and artificial intelligence. This study is significant in that the topics discovered are based on the frequency of words extracted from many AI education-related documents, and the results of topic modeling are considered in the curriculum development process.**

***Keywords*— AI; curriculum; AI education; AI curriculum; AI liberal arts.**

Manuscript received 15 Dec. 2022; revised 25 Apr. 2023; accepted 21 Aug. 2023. Date of publication 31 Oct. 2023.

I. INTRODUCTION

Artificial intelligence (AI) is currently extending beyond the boundary of technology, leading to rapid paradigm shifts in society, including jobs, ethics, education, and the economy [1]. The coronavirus pandemic has fundamentally changed the lifestyle of people globally in terms of work, consumption, and leisure, accelerating AI-based digital transformation. Further, AI is emerging as a key factor in national and corporate competitiveness, and it is expected to fundamentally change the competitive landscape of existing industries [2], [3].

The better people understand AI, the more effectively and securely they can use it [4]–[6]. Thus, it is important to prepare a curriculum for all citizens to cultivate basic skills in AI [7], [8]. Liberal arts education focuses on building professional foundations and cultivates intellectual abilities, enabling free thinking and sound judgment. Therefore, knowledge and abilities acquired through liberal arts education are important in modern society, as they become the basis for students to produce new knowledge creatively and independently [9], [10].

AI education policy trends in South Korea and other countries show that science, technology, engineering, and mathematics (STEM) education and research and development policies are mutually dependent. In 2019, the United States announced the "American AI Initiative" executive order and the "National AI R&D Strategy", which aim at strengthening STEM education for universal AI awareness among all citizens. The 'AI4K12' for K-12 (i.e., elementary, middle, and high schools) AI education initiatives have been started, and AI education guidelines are being developed [11]. Similarly, several countries are proactively promoting AI education to foster AI talent. AI and data science are included in educational content based on a concept that expands existing digital literacy and computational thinking. There is a trend to teach AI at each stage of primary and secondary education or to strengthen STEM education to cultivate basic knowledge of AI [12], [13]. AI education for the general public, including vulnerable groups, is being implemented through lifelong education and is characterized

by efforts to secure social acceptance of AI. AI education in the workplace emphasizes securing the AI fusion capabilities of employees. High-level human resources are fostered in various ways, from the establishment of AI courses to reorganizing the academic system, and more effort is dedicated to fostering people with master's or doctoral degrees.

The relevant joint ministries in South Korea announced the "AI National Strategy" in December 2019. They proposed the development of "a country where all citizens can make good use of AI" as a promotion strategy and "cultivating sensitivity to AI technology by job category and systematizing AI lifelong education" as its promotion tasks. Moreover, the government announced "a Plan to Spread AI/SW Education to the Whole Nation" in August 2020, and is creating conditions for active implementation of AI/software education in the field [14]–[18]. To accomplish these tasks, it is necessary to establish educational strategies and support measures to improve the utilization and comprehensibility AI.

To ensure inclusiveness in the social benefits of AI, it is essential to establish a nationwide high-quality AI education strategy that covers all generations and occupations for all members of society. In this study, we aimed to develop an AI liberal arts curriculum for the general public to improve all citizens' AI utilization and comprehension ability.

II. Materials and Methods

The main steps towards developing the proposed curriculum are as follows. First, we selected AI core competencies for the general public and designed a curriculum content system based on previous studies. Second, we verified the validity of the proposed curriculum with experts in AI technology and education. Third, we derived the core topics of AI education in South Korea and other countries through topic modeling to review the curriculum content. Lastly, we completed the final curriculum content based on the topic modeling results of AI education core topics.

A. Content Design for the AI Liberal Arts Curriculum

We designed the content of the AI liberal arts curriculum from November to December 2020. First, we selected AI core competencies for the general public through literature analysis. We designed a draft content that reflects the selected core competencies and conducted a review with ten professors and ten elementary and intermediate-level teachers in the field of AI and computer education.

B. Topic Analysis Method

Extracting patterns and relationships from text written in natural language can help identify new significant information. Text analysis techniques such as word frequency analysis and topic modeling help extract semantics from unstructured data [19]. Frequency analysis determines the number of words in a corpus of words or a body of text comprising sentences. In previous studies, word frequency analysis has been used to identify research trends in a specific field [20], [21]. In this study, we used a word cloud to represent word frequency visually. It represents high-frequency words in large fonts, making it easy to identify the keywords emphasized in the document [22]. Topic modeling is an analytical technique used to discover hidden semantic structure in a large amount of text and is effective for discovering topics in unstructured data [23]–[26].

The academic paper data analyzed in this study are the titles, author keywords, and abstracts of SSCI, SCI, SCIE, and A&HCI-level academic papers provided by Web of Science (WoS). We collected papers published from January 1, 2018 to December 31, 2022 for AI education. The search keywords were AI education and artificial intelligence education. A total of 5,752 papers were selected for analysis, excluding those that did not provide abstract information. Table I shows the number of papers by year.

TABLE I
NUMBER OF AI EDUCATION-RELATED PAPERS IN WOS BY YEAR

Year	Number
2022	1524
2021	1148
2020	885
2019	1126
2018	1069
Total	5752

The preprocessing of the collected unstructured data into a form suitable for achieving the research purpose is of utmost importance. In this study, preprocessing was performed through the following procedures. First, we converted the analysis data into a corpus and removed numbers, special characters, and punctuation marks. Second, after the first check of the processed data, we converted the text appearing in uppercase into lowercase and removed the unusable characters using the en function of the text mining (tm) package. Here, the en function is used to include a minimum number of words that are generally not meaningful for analysis, such as "i", "the", and "a". Third, we used the stemming function to replace various forms (tense, singular/plural, etc.) of words that are generally derived from the same meaning or a single word. Fourth, we extracted nouns. Finally, we examined the main frequencies of these words and repeated the process of deleting additional words that did not fit the purpose of the study. In particular, words that were common in almost all documents but did not have significance were deleted. The final number of words used in this study through this preprocessing was 325,202. Finally, we performed word frequency analysis and topic modeling.

III. Results and Discussion

A. Selecting AI Core Competencies for General Public

We conducted a literature review to select the AI core competencies and collected the proposed AI core competencies [27]–[31]. Table 2 shows the core competencies required in the AI era proposed previously. From the collected competencies, we selected Adaptability, Public Interest Consideration, Creative and Convergent Thinking, Collaboration, Computational Thinking, and Artificial Intelligence Literacy as AI core competencies for the general public.

TABLE II
AI CORE COMPETENCIES FOR GENERAL PUBLIC

Researcher	Num. of Competencies	Competencies
WEF (2016)	33	• Flexible cognition • Creativity • Logical reasoning • Sensitivity • Mathematical reasoning • Listening • Critical thinking • Self-examination • Human resource management • Active learning • Presentation • Reading comprehension • Writing skill • ICT competencies • Collaboration • Emotional intelligence • Negotiation skills • Persuasion skills • Time management • Service orientation • Teaching competencies • Decision-making • System analysis • Complex problem solving • Financial management • Asset management • Device maintenance and repair • Device operation and control • Programming • Quality control • User-centered technology and design • Technical problem solving • Visualization
Kim et al. (2017)	6	• Informational thinking • Creative and convergent thinking • Sharing and collaborative thinking • Global thinking • Public interest thinking • Adaptability to change
OECD (2018)	3	• Creating New Value • Reconciling Tensions & Dilemmas • Taking Responsibility
Roberta &Kathy (2018)	6	• Contents • Collaboration • Communication • Critical thinking • Creative Innovation • Confidence

B. Designing a Draft Curriculum

The draft curriculum is organized into three areas: understanding of AI, application of AI, and AI ethics. Each area includes sub-areas, and based on this, content elements and AI core competencies are linked. Table III shows the factors considered to refine each area based on the areas.

TABLE III
AREAS AND SUB-AREAS

Area	Sub-area	Considerations
Understanding of AI	Concept and characteristics of AI AI and society	• Clarity of concept: Provide a concise and clear explanation of the basic concept to help the general public understand the concept of AI. • Utilization of visual information: Use diagrams, graphs, and examples to visually represent complex concepts. • Linking with case studies: Introduce examples of how AI is used in the real world to help learners understand its real-world applicability.
Application of AI	AI-based recognition AI and data AI algorithm AI implementation	• Usability: Facilitate the experience of applying AI in practice while learning theoretical content and enhancing AI methods. Focus on problem-solving using real-world data.
AI Ethics	Proper development of AI Proper use of AI Social impact of AI	•Emphasize ethical considerations: Address privacy, algorithmic bias, and transparency of AI decisions to help learners consider ethical aspects. •Ethical problem-solving methodologies: Think with learners about methodologies and discussion methods to solve ethical problems and develop learners' thinking ability by discussing real-world ethical issues.

Twenty professors and elementary/intermediate-level teachers in the field of AI and computer education reviewed the content system, and Table IV shows the results.

TABLE IV
EXPERT REVIEW COMMENTS BY AREA

Area	Key Comments
Understanding of AI	• It seems that it is necessary to specifically state what the various types of AI are. For example, it is unclear whether AI is classified by strong/weak AI, by knowledge representation type such as rule-based/neural network, by learning method such as supervised learning/unsupervised learning/reinforcement learning, or by agent type. • Rather than learning how to distinguish AI, it seems appropriate to cover the commonalities and differences between human intelligence and AI.

Area	Key Comments
Application of AI	• For the general public, it seems appropriate to remove the concepts and characteristics and intelligent agents. The concepts and characteristics of AI may be redundant in the Understanding of AI section. Furthermore, intelligent agents are considered to be a difficult topic for the general public since it is difficult even for those who specialize in AI. • There should be a clear definition of AI-based recognition. • Considering that the education is aimed at the general public, it is necessary to construct the content elements centered on the use of AI. • It would be helpful if learning elements and achievement standards that can be linked to jobs were presented.
AI Ethics	• AI ethics for the general public should consider social impacts, and contents should be enhanced based on real-world case studies to develop problem-solving skills. • User ethics need to be strengthened. Efforts are needed to provide guidance and raise awareness on the proper use of AI, rather than simply covering the positive and negative functions of AI.
Others	• The curriculum is appropriate because it includes understanding the principles of AI technology used in everyday life and how to utilize it. • The learning elements covered in the sub-areas must be reduced to what is needed.

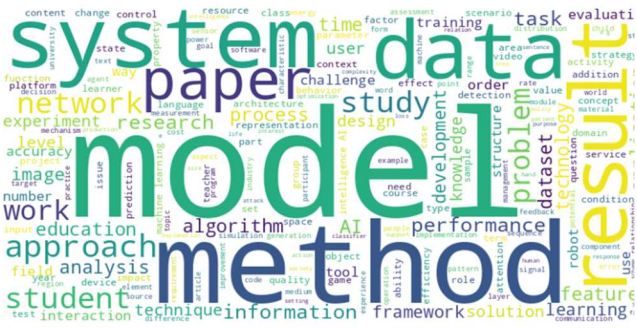
C. Topic Analysis Results of AI Education Literature

Table V shows the word frequency and word cloud results from the word frequency and topic modeling in AI education related studies.

TABLE V
WORD FREQUENCY AND WORD CLOUD VISUALIZATION RESULTS

Word: Frequency				
model: 4587	method: 3574	system: 3459	data: 3414	AI: 2729
learning: 2246	network: 2188	performance: 1841	problem: 1724	task: 1649
education: 1502	technology: 1465	application: 1422	image: 1382	algorithm: 1377
feature: 1325	process: 1318	analysis: 1315	development: 1235	training: 1027

Word cloud



The frequency analysis of the top 20 key words shows that "model" is on the top, followed by "method", "system", "data", and "AI". This means that these words are most frequently appearing across the entire document. In other words, information on implementing or using an AI model for processing data is crucial for students.

TABLE VI
RESULTS OF TOPIC MODELING ANALYSIS

Topic Modeling				
Topic 1	**Topic 2**	**Topic 3**	**Topic 4**	**Topic 5**
model	process	performance	data	network
method	problem	dataset	student	model
research	intelligence	algorithm	approach	learning
learn	experiment	application	result	time
analysis	train	use	task	control
development	language	information	image	detect
result	machine	challenge	method	solution
set	design	function	effect	object
quality	robot	domain	knowledge	evaluation
group	computer	representation	user	number

Considering the topic modeling results in Table VI, we found that Topic 1 comprises “model”, “method”, “research”, “learning”, “analysis”, etc. It can be interpreted as the topic of developing a model to learn and analyze the results. Topic 2 can be considered as the topic of establishing an experimental process utilizing robots, such as physical computing, to solve problems. It is interpreted that Topic 3 comprises the methods of using datasets in algorithms. Topic 4 comprises approaches to solving problems with image data. Topic 5 concerns detecting and evaluating objects using neural network models.

In summary, we can infer that the topics used for AI education include the procedure for developing AI models based on a given problem, methods of utilizing datasets, methods of using robots such as physical computing, and how AI recognizes image data.

D. AI Liberal Arts Curriculum for General Public

We analyzed the results of topic modeling and reviewed the content to develop an AI liberal arts curriculum. In particular, we focused on cases where AI can be utilized or applied in real life, the process and transparency of developing AI models, and methods of using datasets for AI. The final revised AI liberal arts curriculum for the general public comprises content that allows students to understand social and economic changes caused by AI based on a basic understanding of AI, and to cultivate basic aptitudes and competencies to use AI actively and responsibly. It has the following characteristics.

First, AI education for the general public is targeted at all adults from a lifelong education perspective and should be based on a strong foundation of Information & Communications Technology (ICT) utilization and software education. Second, in the elementary and intermediate-level curriculum, basic computing skills, AI concepts, and principles should be taught together, taking into account the general public who have not experienced software and AI education. Third, in conjunction with the AI curriculum,

students should be able to effectively utilize and apply AI technologies in their daily lives, workplaces, and communities. Fourth, the curriculum focuses on experiences and applications to increase access to and utilization of AI and to cope with various environments and situations where AI technology is applied. Fifth, the curriculum supports customized learning to ensure that marginalized and vulnerable groups are not excluded from using AI, and raises social awareness so that all members of society can respect diversity and use AI inclusively.

The goal of the AI liberal arts curriculum is to help the general public understand the characteristics of the AI era, recognize the importance and value of AI, develop the ability to solve various problems, and develop the ability and attitude to use AI technology actively and responsibly in their lives. Table VII shows the areas and details of the AI liberal arts curriculum for the general public. The curriculum consists of understanding artificial intelligence, application of artificial intelligence, and artificial intelligence ethics. Each area includes detailed areas, content elements, and AI core competencies derived through literature research and expert opinion collection. The artificial intelligence liberal arts curriculum is shown in Table 7.

TABLE VII
AI LIBERAL ARTS CURRICULUM FOR GENERAL PUBLIC

Area	Sub-area	Content Elements	AI Core Competencies
Understanding of AI	Concept and characteristics of AI	• Concept of AI • Types and characteristics of AI	• Adaptability • AI literacy
	AI and society	• Progress and future of AI • AI and social changes • AI and Job changes	• Adaptability • Public interest thinking
Application of AI	AI-based recognition	• Understanding and experiencing sensors • Understanding and experiencing recognition tec hnology	• Adaptability • Computational thinking • AI literacy
	AI and data	• Big data and AI • Concepts and properties of data	• Adaptability • Computational thinking • AI literacy
	AI algorithm	• Concept of machine learning • Types and characteristics of machine learning • Concept and characteristics of deep learning	• Adaptability • Computational thinking • AI literacy
	AI implementation	• Use of AI technology	• Adaptability • AI literacy • Computational thinking • Collaboration skills • Creative and convergent thin king
AI Ethics	Proper development of AI	• Data bias • Ethical use of AI	• Adaptability • AI literacy • Public interest thinking
	Proper use of AI	• Positive and negative effects of AI • Diversity and fairness	• Adaptability • Public interest thinking

IV. CONCLUSION

Korea operates universities and graduate schools to train AI experts, but its AI technology level is only 81.6% of that of the United States, and its AI brain index is below the world average. AI training for vulnerable groups is also being promoted, but the number of people trained is limited. AI/SW education opportunities for the general public are lacking. In this study, we proposed an AI liberal arts curriculum for the general public to successfully prepare for the AI era that will accelerate after COVID-19. Matters to be considered along with the curriculum are as follows. The most important thing is to provide all citizens with AI education learning experiences.

In other words, if we overcome spatial constraints and build an AI education platform that allows AI and SW learning anywhere in virtual space and the real world, anyone can easily access AI and SW education. In addition, it is urgent to secure AI and SW education systematicity between elementary, middle, and high schools and universities, which has been insufficient so far. If the AI/SW education system is secured, it is expected that education for employment, starting a business, and strengthening the capabilities of employees will be possible based on this. Lastly, creating a self-sustaining AI/SW education cultural ecosystem is important. A bright AI era will be possible when a culture is created where everyone can sufficiently experience AI and SW education in their region, develop AI knowledge, and think about and solve local problems together. To achieve this, cooperation between companies, governments, and universities, all local community members is essential.

This study is significant in that the topics discovered are based on the frequency of words extracted from many AI education-related documents, and the results of topic modeling are considered in the curriculum development process. The AI liberal arts curriculum for the general public focuses on adapting to rapid social changes caused by the advancement of AI and cultivating the ability to actively solve problems in various fields based on a basic understanding of

AI. To take advantage of the AI era, the curriculum was developed to (1) cultivate basic AI skills, AI utilization skills, and AI ethics and (2) develop the ability to solve problems creatively, convergently, and efficiently based on basic concepts and principles of AI and utilization of various AI models. In a future study, we plan to identify the application and effectiveness of the curriculum in the educational field.

ACKNOWLEDGMENT

The Korea National Open University Research Fund supported this research. This research received data from the Korea Foundation for the Advancement of Science & Creativity (No. 2020-0-01365).

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