



Exploring the Trends and Challenges of Artificial Intelligence Education through the Analysis of Newspapers in Korea, 1991–2020: A topic-modeling approach

Sung-ae Kim * 

Department of Liberal Arts, Duksung Women's University, Seoul 01369, Republic of Korea

Abstract

Artificial intelligence (AI), an essential skill of the Fourth Industrial Revolution, is being actively taught in higher education; however, AI education is only in the preparatory stage in elementary, middle, and high schools. Investigating various newspaper articles related to AI education to date can aid in basic data collection, which is an important process in the preparatory stage. Accordingly, 13,378 newspaper articles were collected from a total of 21 newspapers, and five topics were extracted using the latent Dirichlet allocation (LDA)-based topic model along with frequency analysis. Newspaper articles from the early 2000s expanded to technologies related to the Fourth Industrial Revolution. Accordingly, education in AI fields should be linked with education in AI-based technology. In addition, efforts should be made to secure the continuity and sequence of AI education in cooperation with related higher institutions and companies.

Index Terms: Artificial intelligence education, Topic-modeling approach, Big data of newspapers in South Korea, Technology & engineering education, Informatics education

I. INTRODUCTION

The transition to digital media, triggered by the Fourth Industrial Revolution, is rapidly spreading across all areas of politics, the economy, society, and culture, and is changing our lives.

In particular, clicking on videos recommended by YouTube, ordering food recommended by delivery apps, or purchasing books recommended by shopping malls are examples of how life is shifting and adapting to digital technologies. We live with artificial intelligence (AI) every moment. AI technology, which is improving at an exponential rate, is not only driving disruptive innovation in terms of technology but also brings about unimaginable changes throughout life.

The emerging importance of knowledge regarding the

infiltration of AI technology in our daily lives and society as a whole has not only motivated universities but also elementary, middle, and high school students to pursue AI-education. The Korean government has systematized the AI education provided by universities through a project called the Software-Centered University and established a comprehensive AI education plan to lay the foundation for AI education in elementary, middle, and high schools [1].

AI is currently seen as the center of computer science and an essential element for organizing a system for computer-related education [2]. Therefore, it can be said that to be in line with government policies, schools must emphasize SW education. Additionally, because there are many intersections between various streams of humanities such as psychology, philosophy, literature, and art studies in AI education, these


Received 17 October 2020, Revised 28 November 2020, Accepted 03 December 2020

*Corresponding Author Sung-ae Kim (E-mail: techsakim@duksung.ac.kr Tel: +82-2-901-8611)

Department of Liberal Arts, Duksung Women's University, Seoul 01369, Republic of Korea.

Open Access <https://doi.org/10.6109/jicce.2020.18.4.216>

print ISSN: 2234-8255 online ISSN: 2234-8883

 This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Copyright © The Korea Institute of Information and Communication Engineering

intersections should be emphasized and utilized well [3].

In higher education, AI education, which is currently taking its place in elementary, middle, and high schools, deals with issues related to all areas of society. Therefore, AI education should be integrated with various other fields so that it can proceed with continuity and sequence. The analysis of news articles that convey objective opinions of AI will be a useful basis for determining the direction and content of such education. Therefore, this study identifies the main issues of AI education through newspaper articles, and through big-data analysis, various implications can be presented that can contribute to drafting suitable curriculums for elementary, middle, and high schools in the future.

II. RELATED RESEARCH

The biggest weakness of AI education is that the complexity of the content covered can be overwhelming to students irrespective of their grades.

The results of various efforts were included in a lecture that centered around professors who judged AI to be an aspect of technical literacy that should apply to not only computer majors but also to non-computer majors. The lecture teaches the concepts of AI using games and robots [4]; extracts the social implications of AI through various media, such as movies and videos [5]; carries out discussion topics; and explains AI in connection with animal behavior [3]. This effort led to the design of an introductory AI course.

Recently, computer education has expanded rapidly to the K-12 curriculum worldwide, and curriculum standardization has also been supported by the AP Computer Science Principles curriculum.

The content is not limited to only computer science; therefore, not only consumers but also technology producers [6] such as engineers can acquire technical literacy through various educational activities. Additionally, various software tools, resources, and curricula have been developed to enable younger students to have computer accessibility [7]. Meanwhile, as these efforts have increased, AI has penetrated deeply into life not only in the United States but also worldwide, and China has become the first nation to make AI education mandatory for all high school students [8].

From China, the demand for AI education has spread widely, and to meet this demand, the AAI and CSTA have begun to develop guidelines for teaching AI since 2018 [9]. This effort has been extended to AI4All (<https://ai-4-all.org/>) and ISTE [10].

As a result, the “Five Big Ideas in AI” was suggested for all students, as shown in Fig. 1, based on which AI4K12 was announced [12].

In Korea, the Korean Society for AI Education presented a framework for AI education, as well as educational topics

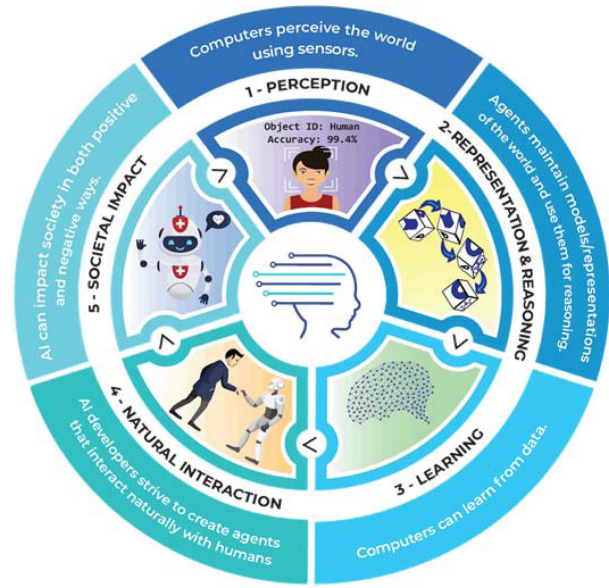


Fig. 1. Five Big ideas in AI: A project to develop an AI curriculum for grades K-12 [11].

Table 1. Content elements of AI Education

Division	Contents
Problem & Explore	Problem Definition and solving, Human and machine intelligence (General AI) Data structure, O(n), Human imitation explore, Heuristic, A*, Optimization (CS & AI Basic), etc.
Knowledge & Reasoning	Knowledge expression, Declarative Knowledge, Logical and proposition, Reasoning, Fuzzy, Scheduling, etc.
Data & Learning	Data clustering, Classification, Recurrence, Supervised learning, Reinforcement, learning, collaborative filtering, Genetic algorithm, SVM
Sensing & Recognition	Sensing, Perception, Pattern recognition, Visual recognition
Language & Communication	Natural Language, Text processing, Speech recognition, Automatic translation, Behavior & interaction
Behavior & Interaction	Sensing, Robotics, Physical reaction, Action, Emotion, Interface, Interaction
AI & Society	AI utilization, Explore application system, AI engineering, AI ethics, Singularity, etc.

and contents from the perspective of universal education, as shown in Table 1 [13].

III. METHODS

The purpose of this study was to collect newspaper articles related to AI education published from January 1990 to August 2020 and to model and analyze the topics. Accordingly, newspaper articles were collected from BIG KINDS, a database of the Korea Press Promotion Foundation, and the search keywords used to find the articles were “AI educa-

tion,” “artificial intelligence convergence education,” “artificial intelligence utilization education,” “artificial intelligence education,” “artificial intelligence convergence education,” and “artificial intelligence utilization education.”

Because articles relating to AI education first appeared in 1990, the collection period was set from January 1990 to August 2020, and a total of 13,378 newspaper articles were analyzed.

The publications that were studied are shown in Table 2. These included 11 central newspapers (e.g., Chosun, Han-kyoreh), 8 economic newspapers (e.g., Maeil Business, Korea Economics Daily), and 2 specialized newspapers (Digital Times, Electronic Times), a total of 21 newspapers; regional papers with many overlapping articles were excluded.

Because the analysis period was approximately 30 years, the period interval was set in units of 10 years, according to previous studies related to AI education. Starting in 2016, when AI-related newspaper articles were rapidly increasing, the years between 2010 and 2020 were divided into five-year increments. Accordingly, the first period was set from 1990 to 1999, the second period from 2000 to 2009, the third period from 2010 to 2015, and the fourth period from 2016 to August 2020, as shown in Table 3.

As for the research procedure, after collecting data as shown in Fig. 2, data preprocessing was performed to convert unstructured data into standardized structured data.

Table 2. Analyzed newspapers

Division	Number (Newspapers)	Number (articles)
Central	11	4,488
Economic	8	6,810
Specialized	2	2,080
Total	21	13,378

Table 3. Number of newspaper articles by period

Periods	Years	Number of collections
I	1990-1999	148
II	2000-2009	441
III	2010-2015	622
IV	2016-2020. 8	12,167

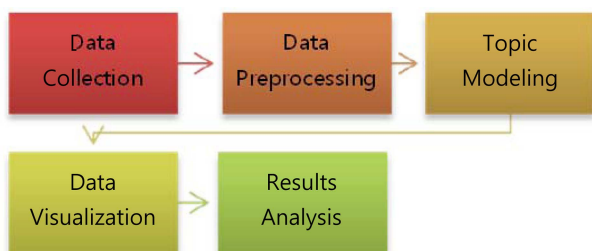


Fig. 2. Research procedure: Topic-modeling approach using LDA technique of unstructured data.

Subsequently, through keyword frequency analysis, important keywords by period were checked along with all remaining keywords, with important keywords being examined through a word cloud that can be viewed intuitively. Additionally, topic-modeling techniques were used to extract information from the text and quickly grasp the connection. This topic-modeling technique used in this study is the latent Dirichlet allocation (LDA) model, a technique most commonly used in text analysis. It is a technique for probabilistically determining the topics present in a document to be analyzed and is used to infer and reduce potential variables in a probabilistically mixed topic so that it can be easily understood and interpreted [14]. The number of topics was determined based on the first point at which topic cohesion was significantly increased. In the case of the news covered in this study, when there were five topics, the topic cohesion was highest; thus, the number of topics was determined as five.

IV. RESULTS

A. Frequency Analysis of Newspaper Articles

Fig. 3 shows a graph relating to the change in the number of newspaper articles by year. After the first article appeared in 1992, articles gradually increased from 2014, but rapidly increased in 2016.

In 2020, because only the data up to August is within the scope of this study, the data appears to decrease compared with the previous year.

Additionally, as shown in Fig. 3, which examines the data status by period, the first period showed only a slight increase in article frequency, which decreased from 1998. In the second period, the average number of articles was 2.4 times that of the previous period, without a significant increase

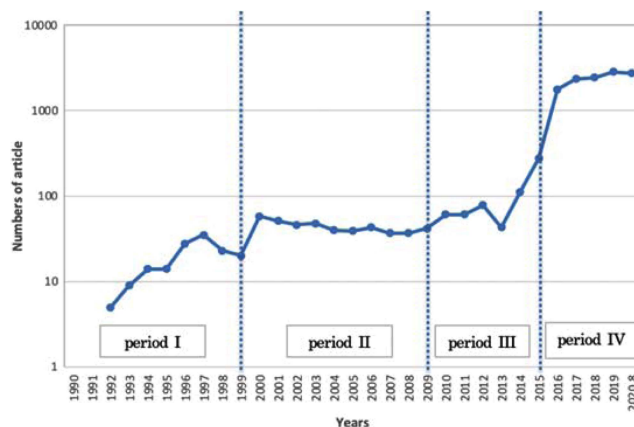


Fig. 3. Frequency of newspaper articles by year and period: Changes in the number of newspaper articles by year and research selection period

Table 4. Top 10 Keywords by periods

I	II	III	IV
Multimedia	Network	Google	AI
PC	Science and Technology	Big Data	Big Data
User	Competitiveness	Job	SW
ICT	Nano Technology	Smartphone	Graduate School
Informatics	User	People	HRD
Automatics	Industry of Robots	IT	ICT
Science and Technology	Intelligent Robots	IoT	IoT
Researcher	China	ICT	Cloud
AR	Real Time	IBM	Drone
Semiconductor	Media Lab	Drone	Deep Learning

or decrease. In the third period, the number of related articles gradually increased, and in 2015, the number of articles in the beginning of the period increased by 4.5 times. However, in 2013, there was a decline. In particular, the decrease in related articles in 2013 is interpreted to be caused by the constant controversy over educational issues, such as history textbooks, university entrance examination system reform, and corruption in the international middle school entrance examination.

The number of articles in the fourth period increased by 23 times compared to the third period, showing a much more rapid increase. The increase in the number of related articles during this period seems to be a combination of the domestic issues requiring SW education in the 2015 revised curriculum and AI education issues.

Table 4 shows the results of the top 10 keywords with the highest frequency during the analysis period.

It is noteworthy that keywords for AI education were limited to related fields until the third period, but from the fourth period, keywords related to people such as “graduate school” and “talent training” were included in the keywords for AI education. Additionally, the inclusion of big data, IoT, cloud, and digital technologies leading the Fourth Industrial Revolution can be said to highlight the connection with AI.

As a result of analyzing the top 20 most frequent keywords, AI, SW, Big Data, Expert, Human Resources Development, Science and Technology, ICT, IoT, and Job were placed in the same order in the word cloud, as shown in Fig. 4.

B. Topic Analysis of Newspaper Articles

The results of the LDA-based topic modeling for newspaper articles related to AI education are shown in Table 5.

In Topic 1, the topic words appearing in the field of AI education included “big data,” “IoT,” “drones,” “intelligent robots,” “blockchain,” “autonomous vehicles,” and “health-

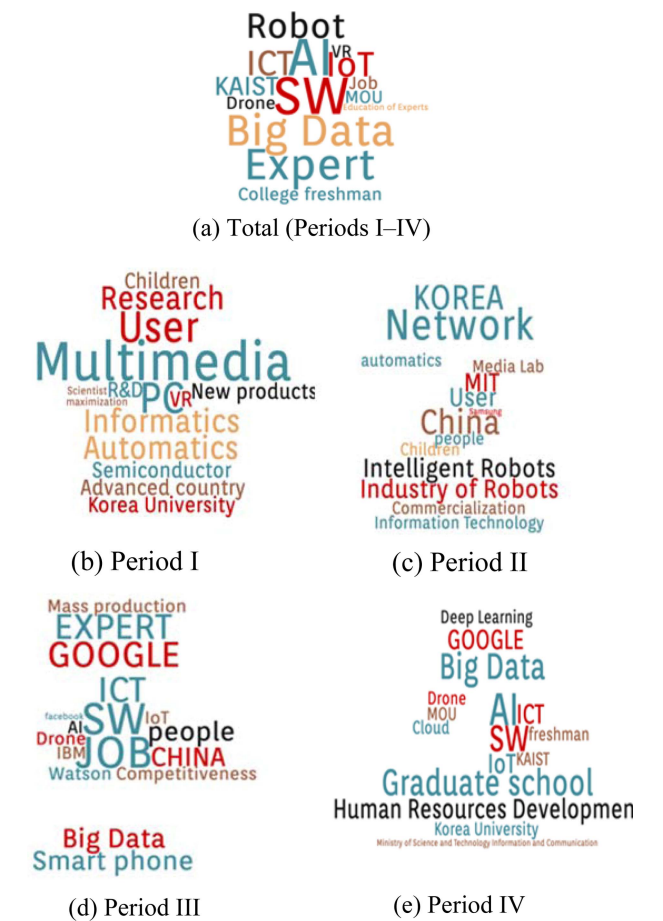


Fig. 4. Visualization of the entire data: Word cloud of the frequency of keywords in newspaper articles to be analyzed

Table 5. Results of topic-modeling approaches

Topic	Proportion	Topic Word
Topic 1	0.297	big data, IoT, drones, intelligent robots, blockchain, autonomous vehicles, and healthcare, Block chain
Topic 2	0.160	Korea University, KAIST, POSTECH, Honam University, Hoseo University, Sungkyunkwan University, Gwangju Institute of Science and Technology
Topic 3	0.178	deep learning, machine learning, speech recognition, cloud, neural networks, big data
Topic 4	0.216	human resource development, experts, activation, acceleration, competitiveness, maximization, commercialization, optimization, and MOU
Topic 5	0.149	MS, KT, LG Electronics, IBM, SK, POSCO, Samsung Electronics, Amazon, Google, Facebook, and the Ministry of Science and Technology

care.” AI is a big focus in the AI education field. Therefore, it can be said that this is a field that should be considered as an advanced course when designing an AI curriculum.

In Topic 2, the topic words appearing in fields representing AI technologies that should be dealt with in AI education

include “deep learning,” “machine learning,” “speech recognition,” “cloud,” and “neural networks.” This reiterates that these basic technologies must be included in AI education, and it can be said that they are essential when designing an AI curriculum.

In Topic 3, the topic words appearing in fields related to strategies for the development of AI education included “human resource development,” “experts,” “activation,” “acceleration,” “competitiveness,” “maximization,” “commercialization,” “optimization,” and “MOU.” This can be said to be related to strategies for achieving sustainable development, rather than the one-off end of AI education, which must be conducted for the development of a future society.

Topic 4 included AI educational institutions such as Korea University, KAIST, POSTECH, Honam University, Hoseo University, Sungkyunkwan University, Gwangju Institute of Science and Technology, high school, and SW Center University Project Group. The reason for this is that the SW-centered university was selected by the Ministry of Science and ICT in Korea, and the newly selected university is characterized by focusing on the AI-related curriculum. Additionally, it can be seen that the topic words for this area included AI graduate schools. Recently, the Ministry of Education in Korea announced that it will provide AI education to elementary, middle, and high schools. By doing so, it is possible to systematically receive AI education.

In Topic 5, the topics consisted of organizations and companies that provide or support AI education, such as MS, KT, LG Electronics, IBM, SK, POSCO, Samsung Electronics, Amazon, Google, Facebook, and the Ministry of Science and Technology. These companies are currently conducting social contribution projects in the field of education. In particular, the IT field is gaining many educational benefits from the social contributions of these companies. This area is composed of companies that are working hard to support AI education and companies that provide AI education platforms.

As Table 4 shows, the weights of the topics indicate the importance of each topic, and as a result of the analysis, the following topics are set out in order: (1) the field of AI education, (2) AI-based technologies, (3) AI education institutions, (4) strategies for the development of AI education, and (5) AI related companies.

A visualization of topics by period is shown in Fig. 5 to analyze their flow. The field related to AI shows a steady increase from the 1st to 4th periods, and in particular, shows a rapid increase in the 3rd period. AI-related companies have been steadily appearing since the second period, and AI educational institutions have been shown to be increasing significantly in the third and fourth periods.

Strategies for the development of AI education showed steady values overall, with a slight increase in the fourth

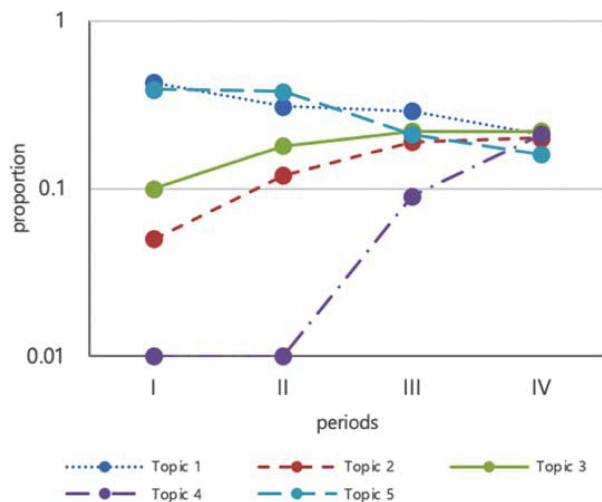


Fig. 5. Change in topic according to period: Trend of topics according to periods divided by year.

period. It is noteworthy that AI-based technologies show an increasing trend overall and that different topics appear in each period.

V. DISCUSSION AND CONCLUSIONS

In this study, 13,378 newspaper articles from January 1991 to August 2020 were gathered and analyzed to examine the trends of newspaper articles relating to AI education. AI is already being actively taught in universities, and elementary, middle, and high schools are currently preparing to incorporate it into their curricula. Therefore, by analyzing the trend of newspaper articles related to AI education, it was possible to confirm the trend of changes in AI education and to estimate the flow of related topics. The results of this study are as follows:

First, according to the results of the frequency analysis of topics, it can be seen that the trend toward AI education has increased since 2014 but has increased exponentially since 2016. Additionally, as a result of analyzing the top 10 keywords by period, it was confirmed that the third and fourth analysis periods were more specific to AI education than the first and second periods. This reflects the fact that the Ministry of Science and Technology and ICT in Korea launched the SW-centered university project in 2015 and selected an AI-centered university in 2019, laying the foundation for AI education in higher education. This result indicates that AI education is receiving significant attention in Korea.

Second, as a result of conducting the LDA-based topic analysis, five topics were extracted: “artificial intelligence education field,” “artificial intelligence education institution,” “strategy for artificial intelligence education development,” “artificial intelligence-related companies,” and “artificial

intelligence-based technology.” Among them, topics related to the field of application of AI showed the highest proportion. As also shown in the frequency analysis, this topics can be said to be an area to be dealt with in AI education. Additionally, it can be confirmed that this area has a connection with digital technologies that are leading the Fourth Industrial Revolution. In this way, it was possible to confirm the progress of AI education through the flow of topic analysis by period. As such, it was confirmed that AI education was covered throughout various topics in newspaper articles.

AI technology is key to the future society, and we have reached a situation wherein one cannot live without its understanding it. Therefore, curriculum design and educational activities should be conducted with sensitivity to social issues ranging from education on AI-based technologies to education using AI. AI technology, which is the technology leading the Fourth Industrial Revolution, and is also used to analyze the present, future, and past educational activities to cultivate future talents, will provide important basic data for strategies regarding AI education.

REFERENCES

- [1] Ministry of Education, *2020 Ministry of Education work report*, Ministry of Education, Sejong, 2020.
- [2] B. J. Grosz, “Collaborative Systems (AAAI-94 Presidential Address). *AI Magazine*, vol. 17, no. 2, p. 67, DOI: <http://doi.org/10.1609/aimag.v17i2.1223>.
- [3] S. Lee, “Artificial intelligence as the liberal arts of computer science,” *ACM SIGART Bulletin*, vol. 6, no. 2, pp. 8-10, 1995. DOI: 10.1145/201977.201981.
- [4] D. Wong, R. Zink, and S. Koenig, “Teaching artificial intelligence and robotics via games,” in *The Twenty-Fourth AAAI Conference on Artificial Intelligence*, Atlanta, 2010, [Online] Available: https://www.researchgate.net/profile/Daniel_Wong31/publication/228986664_Teaching_Artificial_Intelligence_and_Robotics_Via_Games_Abstract/links/56272fad08aeabddac936b67.pdf.
- [5] V. A. Cicirello, “An Interdisciplinary course on artificial intelligence designed for a liberal arts curriculum,” *Journal of Computing Sciences in Colleges*, vol. 23, pp. 120-127, 2008, [Online] Available: <https://www.cicirello.org/publications/p120-cicirello.pdf>.
- [6] M. Resnick, Amy Bruckman, and F. Martin, “Pianos not stereos: Creating computational construction kits,” *Interactions*, vol. 3, no. 5, pp. 40-50, 1996. DOI: 10.1145/234757.234762.
- [7] D. Touretzky, C. Gardner-McCune, F. Martin, and D. Seehorn, “Envisioning AI for K-12: What should every child know about AI?,” in *The Thirty-Third AAAI Conference on Artificial Intelligence (AAAI-19)*, Hawaii, 2019. DOI: <https://doi.org/10.1609/aaai.v33i01.33019795>.
- [8] H. You, “China’s AI ambition... ‘I teach from elementary, middle and high school.’” *Zdnet Korea Websites*, 1 Sep 2017, [Online] Available: https://zdnet.co.kr/view/?no=20170901105106&re=R_20191108091606.
- [9] M. Park, “AI for K-12 initiative in collaboration with the Computer Science Teachers Association (CSTA) and AI4All,” in *The AAAI-18 Conference*, Louisiana, 2018, [Online] Available: <https://aaai.org/Pressroom/Releases/release-18-0515.php>.
- [10] ISTE, “Artificial intelligence goes to school,” in *International Society for Technology in Education (ISTE) 2018*, Chicago, 2018, [Online] Available: https://conference.iste.org/2018/program/search/detail_session.php?id=110888525.
- [11] B. Spice, “Five big ideas in AI featured. In NSF video showcase,” *Carnegie Mellon University School of Computer Science*, May, 2020, [Online] Available: <https://www.scs.cmu.edu/news/five-big-ideas-ai-featured-nsf-video-showcase>.
- [12] D. Touretzky, F. Martin, D. Seehorn, and C. Breazeal, “Special session: AI for K-12 guidelines initiative,” in *The 50th ACM Technical Symposium on Computer Science Education*, New York, 2019. DOI: 10.1145/3287324.3287525.
- [13] T. Kim, M. Ryu, and S. Han, “Framework research for AI education for elementary and middle school students,” *Korean Association of Artificial Intelligence Education Transactions*, vol. 1, no. 4, pp. 31-42, 2020, [Online] Available: http://www.aied.or.kr/html/web/papersearch_view.html?no=7.
- [14] D. M. Blei, “Probabilistic topic models,” *Communications of the ACM*, vol. 55, no. 4, pp. 77-84, 2012. DOI: 10.1145/2133806.2133826.



Sung-ae Kim

received her B.S. degree in Bio-Mechatronics Engineering from Sungkyunkwan University, Korea, in 2000, and her M.S. and Ph.D. degrees in Technology Education from Korea National University of Education, Korea, in 2002 and 2015, respectively. From 2002 to October 2020, she was a technology teacher at the secondary schools in Gyeonggi Provincial Office of Education, Korea. Since September 2020, she is an assistant Professor in the Chamirisa college of liberal arts, Duksung Women’s University. Her research interests include Technology and Engineering education, IT convergence education (focused on robotics education, Artificial Intelligence convergence education), Maker education.