Trends of Utilizing AI in Convergence Education: Cases of Convergence Education Programs in South Korea

Hyuksoo Kwon*

Kongju National University

Professor

Abstract

In preparation for rapid social change and technological innovation, many countries are pursuing policies for educational innovation. Convergence education is one such policy approach. The purpose of this study is to explore key trends and issues identified in research on convergence education policies in Korea, focusing on utilizing AI (Artificial Intelligence). Specifically, we select examples of AI-based education in convergence education programs developed in Korea and explore their implications. The data collected for this study include five outcome reports on the development of government-led convergence education programs implemented from 2021 to 2025, and a total of 32 programs. Furthermore, this study conducted in-depth interviews with four co-researchers who participated in the selected programs. Through document analysis and qualitative analysis of the in-depth interviews, we can identify the following key cases and implications of AI-based education in Korea. First, AI in convergence education provides valuable teaching and learning opportunities for both teachers and students. Second, AI in convergence education is an effective tool that helps students easily solve real-life problems. Third, AI can be used to express or design ideas in convergence education. Fourth, AI in convergence education

* **Corresponding author: Hyuksoo Kwon**, Email: hskwon@kongju.ac.kr
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serves as a tool that facilitates students' self-directed learning. In Korean convergence education programs, AI has played a crucial role in helping students effectively solve real-world problems through student-centered activities. Given the increasing cases of AI use in convergence classes, more attention needs to be paid to educating students on attitudes and values related to the use of AI.

Keywords: STEAM education, research projects, trends, AI utilization, South Korea

Introduction

The advancement and innovation of cutting-edge technologies such as artificial intelligence, big data, and the Internet of Things (IoT) are transforming our society. Intelligent services utilizing AI and machine learning technologies analyze user behavior and preferences to provide personalized information and services. Furthermore, advancements in IoT technology are connecting the physical and virtual worlds, expanding the scope of data collection, analysis, and utilization. Since the advent of the intelligent information society, the amount of information and complexity related to convergence has increased exponentially (Kim, 2022; Richey, 2017).

The OECD 2030 Education emphasizes the role of learners in a complex and uncertain future society, where they can take initiative in their learning and collaborate with others to make positive contributions to society (UNESCO, 2018). It emphasizes that for students' futures, it is crucial to develop the capacity to acquire and generate knowledge, while simultaneously critiquing and utilizing it, and emphasizes the need for a focus on holistic, multicultural, and multidisciplinary learning (UNESCO, 2021). In other words, with the explosive growth of knowledge, there is a need for a shift from a one-sided infusion of fragmented knowledge to an education that fosters integrated competencies that enable learners to solve complex problems through self-directed and collaborative inquiry within the context of their lives.

In Korea, convergence education began as STEAM education and quickly expanded into educational policy as a result of expanded information policy efforts (Ministry of Education, 2020). This convergence education policy strengthens convergence education across subjects by identifying diverse real-world problems within the curriculum and providing opportunities to explore them in connection with subject knowledge. Furthermore, convergence education in Korea contributes to the promotion of project-based education, where students can choose their own learning topics and design their own learning processes.

Despite the government's proactive implementation of convergence education policies, teachers in Korea cited excessive workloads, insufficient support for teacher training and research activities, and a lack of diverse convergence education programs as reasons for their reluctance to embrace convergence education (Kwon et al., 2021). Recognizing these challenges, the government has conducted annual research on the development of convergence education programs and actively promoted their implementation in schools (Kwon et al., 2025).

Accordingly, in response to the shift toward an intelligent information society and societal

demands, Korea revised its curriculum to foster the ability of students to lead their own lives in the future (Ministry of Education, 2022). In particular, this curriculum emphasizes interdisciplinary connections and integration, as well as learning that connect students to their lives, to foster in-depth learning.

Various policy studies on future education emphasize project-based collaborative learning, the integration of curriculum and life, education for fostering higher-order thinking skills, and convergence education (called as STEAM, Science Technology, Engineering, Arts, Mathematics) (Kim et al., 2016; Joo et al., 2016; Hong et al., 2016; Hwang et al., 2019). The direction of future education and the characteristics of the new curriculum can be summarized as strengthening learner autonomy, personalized learning, and practical learning connected to life for in-depth learning. To implement this type of education, convergence education has been implemented as an educational policy in Korea.

Recently, efforts are being made to realize personalized education through intelligent learning platforms utilizing AI and digital education, and to share and disseminate educational content and software that incorporate cutting-edge technologies such as AI, big data, AR/VR, and XR(Lee & Jeong, 2023). As these AI and digital education policies become national policies, the need for research and consideration on how to utilize AI in convergence education is emerging.

Therefore, this study aims to explore the key features of convergence education programs already developed in Korea and presents examples of AI-based education. By exploring AI-based education within the context of convergence education practices currently being implemented in Korean schools, this study can serve as valuable foundational data for future educational policy development. Furthermore, the findings from this Korean case study will provide insights into the latest challenges and strategies for convergence education being implemented in various countries.

Background

Korean Convergence Education

With the advent of the Fourth Industrial Revolution and the AI era, science and technology have emerged as key elements of societal innovation and national competitiveness. Consequently, there is a growing demand for education that equips students not only with the fundamental principles of science and technology, but also with convergence thinking and problem-solving skills. Amidst this shift, Korea has implemented convergence education (STEAM) as a national education policy,

aligned with curriculum revisions that promote learner-centered instruction in schools (Ministry of Education, 2020; Ministry of Education, 2025).

Ten years after the introduction of convergence education in Korea, a survey of 871 current teachers nationwide revealed that 51.5% of respondents were implementing convergence education (Kwon et al., 2021). Convergence education is primarily implemented within regular school hours, often in the form of cross-subject integration. Furthermore, to rapidly expand convergence education, the government is developing programs that can serve as examples of convergence classes following the revision of the national curriculum (Kwon et al., 2024). A comprehensive review of these accumulated research findings reveals that Korean convergence education significantly impacts students' cognitive and affective domains (Rho & Yoo, 2016; Kim & Yoo, 2018; Cho, 2018). Specifically, it demonstrates strong positive effects not only in problem-solving skills and creativity, but also in areas such as interest, attitude, and self-efficacy.

According to the 2025 Convergence Education Promotion Plan, convergence classes are learner-centered activities that go beyond simply linking subject matter and foster interdisciplinary thinking and real-world problem-solving skills (Ministry of Education, 2025). Specifically, the plan emphasizes strengthening regional convergence education operations and networks and supporting the development of field-oriented STEAM programs. Specifically, the plan emphasizes the development and dissemination of science and technology-centered convergence programs by operating STEAM clubs at all levels of schools. STEAM student activities, including student-led activities and club activities, are effective in enhancing students' learning motivation and self-directed inquiry skills (Kwon et al., 2025).

Curriculum Revision in South Korea

The 2022 revised curriculum recently revised and currently in effect, is the Korean curriculum. This curriculum strives to systematize competencies to address future society, based on the values that education should pursue and the direction and nature of each subject (Ministry of Education, 2022). Specifically, six core competencies are proposed: self-management, knowledge and information processing, critical thinking, aesthetic and emotional competence, collaborative communication, and community competence. Furthermore, it emphasizes the integration of subject matter learning and real-life issues across the entire elementary and secondary school curriculum, and proposes the application and utilization of knowledge and skills in language, mathematics, and digital literacy.

One of the key features of this curriculum is the introduction of career-related education, which integrates curriculum content across school levels and career planning across student growth continuums. The 2022 revised curriculum emphasizes career education by systematically implementing various career exploration activities, allowing students to tailor their learning to their individual learning levels and methods. All students begin school life adaptation activities focused on understanding the school and emotional support after entering elementary school, and in their final semester, they participate in activities to understand middle school and provide emotional support. Middle school students utilize the free semester system to explore their career paths, and high school students complete elective courses tailored to their career aspirations through the high school credit system.

Research Design

The primary purpose of this study was to explore key features of utilizing AI education in Korean convergence education programs. Therefore, this study involved a literature-based review of programs developed and implemented in a Korean government-funded convergence education program development project. Furthermore, it involved qualitative research involving in-depth interviews with co-researchers who participated in the development and implementation of the programs. The results of this qualitative analysis can identify various examples of AI utilization in Korea's convergence education plans and provide suggestions for future related research.

Data

The primary data for this study are the results of a research outcome report and development programs for convergence education programs funded by the Korean government from 2021 to 2025, as shown in Table 1. The author participated as the principal researcher in all of these studies, which were completed over a five-year period, from development to field implementation, with financial support from the Korean government. The report analyzed in this study is the result of research aimed at developing various programs to be distributed to schools annually alongside the implementation of Korea's convergence education policy. A total of 32 programs are included in the five outcome reports.

Table 1
List of research projects developing convergence programs led by the Korean government

Year	Report Title	# of Programs
2021	Development of a STEAM program to prepare for the high school credit system	5
2022	Development of a high school career-oriented convergence education program to prepare for the future society	5
2023	Development of a science and technology-focused convergence education program to help middle school students discover their future aspirations	12
2024	Development of a sustainable convergence education (STEAM) program for middle school students to prepare for their dreams and future	6
2025	Development of a school STEAM club program to dream and grow with robots	4

Participants & Instrument

In this study, in-depth interviews were conducted with four co-researchers who had been actively involved in the development and field implementation of the convergence education program, the subject of the literature analysis, for five years. The list of co-researchers who participated in the in-depth interviews is provided in the table. All names presented are pseudonyms (Table 2).

Table 2
Participants for in-depth interview

Name	Role	Major	Teaching Year
Kisul	Program Development & Implementation	Technology	20
Gwahak	Program Development & Implementation	Science	25
Gonghak	Program Development & Implementation	Technology	20
Jungbo	Program Development & Implementation	Information	15

Through in-depth interviews, participants were asked to share exemplary cases of AI education within convergence education programs in program development and implementation research. For a smoother interview, a list of programs and reports was sent in advance, and participants were asked

to record cases of AI usage. This study allowed research participants to have sufficient and comfortable time beforehand to review the programs and organize cases of AI usage based on their experiences in program development and field deployment. They were asked to share their experiences in development and field implementation regarding the utilization of AI-based education within the context of convergence education. Each in-depth interview lasted 30-60 minutes. The interviews were recorded and transcribed using a digital transcription application. After review by the researcher, the participants were asked to review the data themselves for the reliability.

Data Collection & Analysis

In this study, data collection and analysis were divided into two parts: the collection and analysis of literature reviewing the result reports and the programs in the five-years government funded projects and the analysis of in-depth interview results on the utilization of AI in convergence education programs and its implications.

The researcher repeatedly read the in-depth interview data and compared and analyzed similarities and differences across the data to comprehensively understand the use of AI in convergence education programs and their implications as expressed by the research participants. In other words, the collected transcripts were repeatedly read and open-coded. A coding process was conducted, capturing the participants' language, focusing on keywords that recurred or were emphasized in the data. Also, keywords were analyzed and ultimately categorized. The results of the raw data representation, subthemes, and major themes of the collected data, which explore the implications of utilizing AI in the development and application of convergence education programs, are presented in Table 3.

Table 3
Coding Results from Collected Data by In-depth Interview

Raw Data (Interview)	Key Theme
✓ Key Learning Contents in National Curriculum	Learning Contents
✓ Achievement Standards of 'Information' and 'Engineering' subjects	
✓ Students are Learning AI: Machine Learning, Deep Learning	
✓ Ethical Approach of Using AI: Value and Attitude toward AI	
✓ Effective Tool for AI Problem Solving Process	Problem-Solving Tool
✓ Searching Information for Real data, Real-life Problem Situation	
✓ Efficient Method for Students-Centered Activities	
✓ Useful Chance for Expressing the Idea	Visualization Tool
✓ Visualizing the Chosen Idea: Drawing and Design	
✓ Help Students with Insufficient Ability in Drawing Ability	

Validity and Reliability

To ensure the integrity of the study, we strived to ensure the validity and reliability of the data. The results of the program's case selection were reviewed by a professor specializing in science education who has conducted convergence education research for the past five years. This study also conducted a process of selecting exemplary cases for AI education in convergence education programs. Furthermore, To verify the accuracy of the interview content, the transcripts of the in-depth interviews were sent to the research participants for review, and the coding results and interpretations were reviewed by two educational researchers with Ph.D. in Education. Finally, the researcher continuously reflected on the research process and outcomes through research notes from beginning to end.

Results

Through analysis of Korea's convergence education programs and in-depth interviews with collaborators, this study identified three implications for AI use in convergence education and presented relevant case studies. Each case was explained, and the results of the in-depth interview analysis were presented as a means of understanding the implications of AI use in convergence

education.

Key Learning Contents in Convergence Education Program

AI is a required learning content for all students in the national curriculum (Ministry of Education, 2022). Specifically, the subjects that include AI as a key achievement standard in the revised 2022 national curriculum are information, technology/engineering, mathematics, and so on. Therefore, AI itself was treated as a learning topic that needed to be learned in convergence education programs. Notably, all programs developed in 2025 were robot-related, focusing primarily on learning about AI and robots themselves. Program A, designed for high school engineering classes, was developed as a valuable learning topic that would foster understanding and implementation of AI (Figure 1).

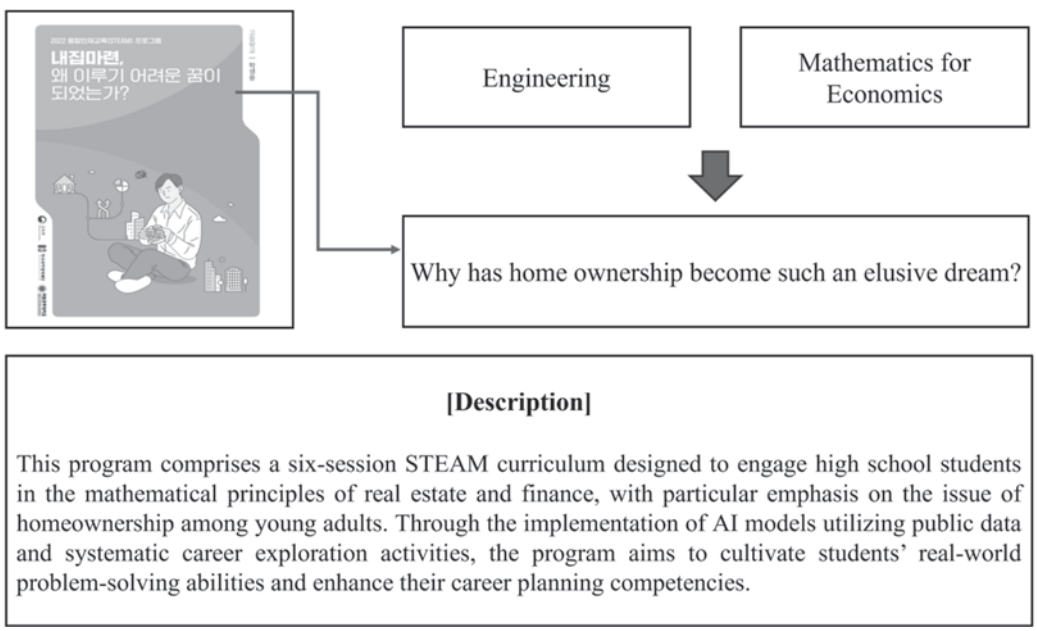

Figure 1 Korean STEAM Education Program A (Kwon et al., 2022)

Gonghak *Artificial intelligence itself is a crucial learning topic. It's covered as a key learning topic in various subjects, including information, technology, and mathematics, in the national curriculum, so it's inevitable that convergence education programs will also include AI-related content.*

Furthermore, AI education, as covered in the revised 2022 curriculum, emphasizes literacy education based on knowledge and understanding of AI, fostering the ability to utilize it and developing positive attitudes. In other words, the convergence education program emphasizes both

knowledge and literacy in AI, while also emphasizing the ability to evaluate both the positive and negative impacts of its use (Figure 2).

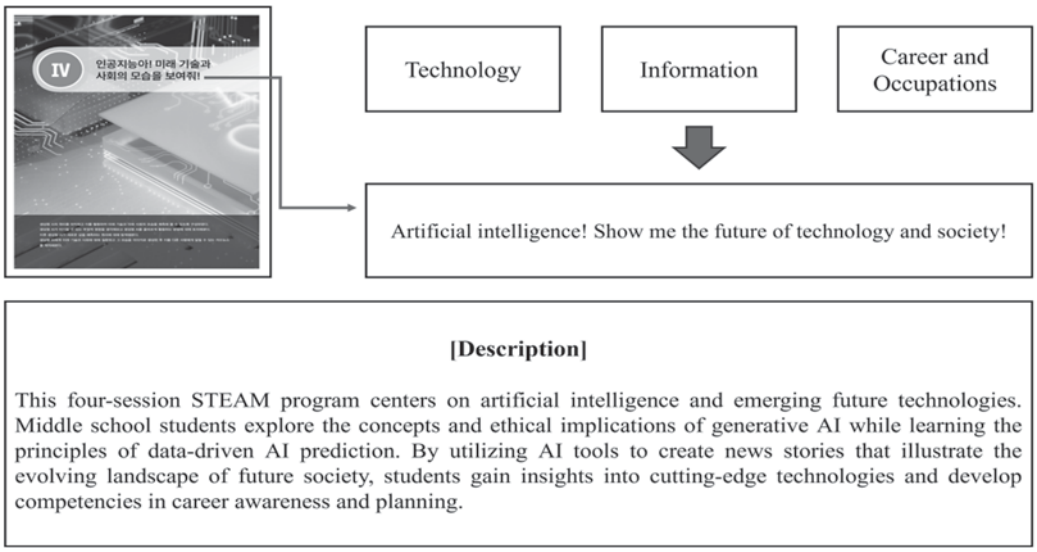

Figure 2 Korean STEAM Program B (Kwon et al., 2023)

Kisul *Developing a knowledge of artificial intelligence is also emphasized in convergence education these days. A balanced perspective on technology utilization is crucial, and I covered examples of AI utilization while covering technology assessments.*

An Effective Tool for Real-life Problem Solving

In convergence education programs, AI has been used as an effective problem-solving tool. Most convergence programs consist of student-centered activities where students present problem situations and work to solve them. These programs provide students with opportunities to actively utilize AI to solve real-world problems. Specifically, AI has been used to collect data for problem-solving or as a direct tool for actual problem-solving.

Science

Information

Careers and Occupations

My daily life 30 years later

[Description]

This four-session STEAM program encourages students to explore the impact of scientific and technological advancements on human civilization and to anticipate future social changes, focusing on cutting-edge science, technology, and artificial intelligence. Using generative AI and digital visualization tools, students create videos envisioning their lives 30 years in the future while developing insights into emerging technologies and career planning skills.

Figure 3 Korean STEAM Program C (Kwon et al., 2023)

Gwahak *I've used generative AI to identify and summarize the latest trends in scientific advancements and social changes. Of course, I do this after providing sufficient guidance. I believe it's ideal because it allows students to research and summarize materials tailored to their level through questions tailored to their learning needs.*

Jungbo *While we encourage the use of generative AI throughout our programs, we always provide guidelines for its use. Leveraging AI allows for summaries and question-and-answer sessions tailored to students' skill levels, and facilitates effective data collection and information gathering in problem-solving learning.*

In Program D, AI is both a valuable tool and a significant chance of the overall problem-solving process. Through activities such as implementing AI apps, AI was utilized in the problem-solving process. Program E also included activities utilizing the IoT and AI within the design thinking process.

Technology | Information | Career and Occupations

No bad language, only kind words! An AI app that allows you to use only kind words.

[Description]

This five-session STEAM program addresses cyberbullying prevention and AI ethics. Students collect and process positive and negative online comments to train an AI model and use App Inventor to develop a messenger application capable of filtering abusive language. Through exploring career pathways in app development and entrepreneurship, students cultivate digital ethics awareness and enhance their career planning competencies.

Figure 4 Korean STEAM Program D (Kwon et al., 2023)

Society | Technology | Careers and Jobs

Sustainable AI Smart City

[Description]

This six-session STEAM program explores the concept of sustainable AI smart cities. Students analyze urban inequality faced by disadvantaged groups and explore IoT- and AI-based technological solutions. Using Arduino and AI tools, they build smart city prototypes, investigate related careers, and create digital card news stories, fostering creative problem-solving and career planning skills.

Figure 5 Korean STEAM Program E (Kwon et al., 2024)

Kisul *When developing programs, I believe it's crucial to provide students with experiences of success. Students need to be able to create solutions to real-world problems through activities. In these situations, the Internet of Things, artificial intelligence, and big data can be meaningful problem-solving tools to learners.*

Gonghak *When teaching AI itself, students found it too difficult. However, I think the class was much more effective when it was taught in the context of convergence education, along with real-life problems.*

An Easy Tool of Designing or Expressing Ideas

AI was used to present final products or results, or as a way to express ideas. According to Convergence Education Program F, AI helped students more easily and comfortably accept design and drawing activities, such as expressing or visualizing ideas.

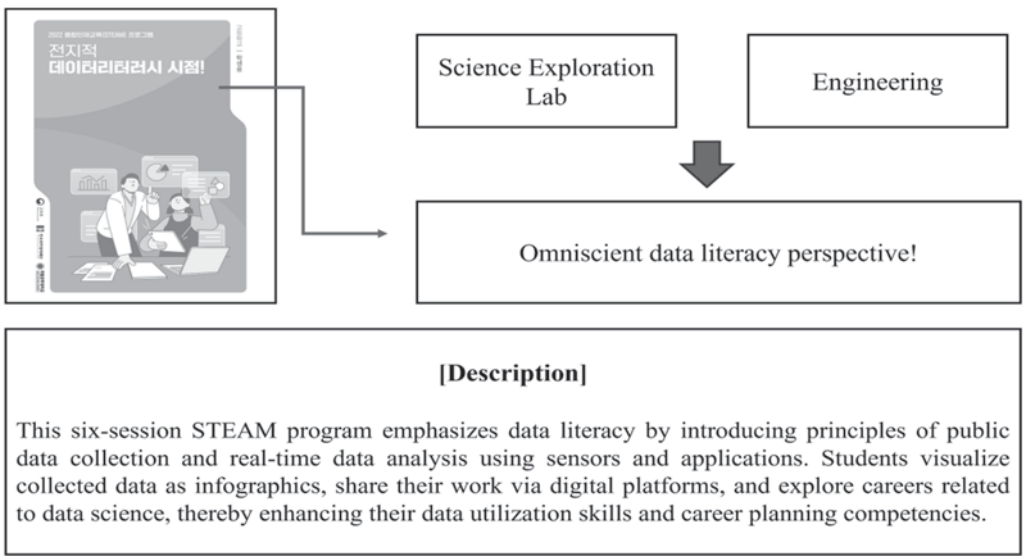

Figure 6 Korean STEAM Program F (Kwon et al., 2024)

Gwahak *In science classes, students often find it difficult to create final data and diagrams. In the integrated learning environment, students truly appreciate the ability to use AI and digital technologies from data collection to analysis and presentation.*

Furthermore, AI is a powerful tool for drawing shapes and creating pictograms, making shape learning and design activities easier. Program G provides an opportunity to easily create various pictograms by combining coding activities with the drawing of basic shapes, which were previously difficult in math classes.

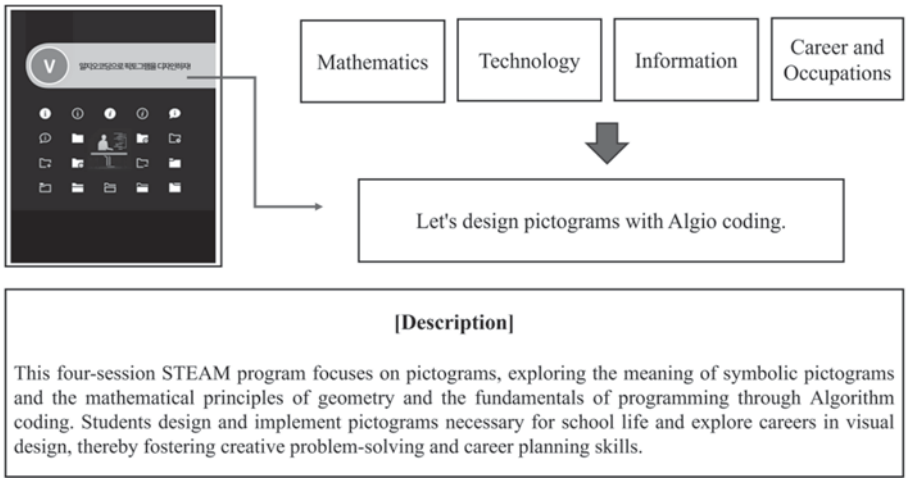

Figure 7 Korean STEAM Program G (Kwon et al., 2024)

Kisul *I'm not a math teacher. In my technology classes, I've always insisted on hand-drawing pictograms. But after using a program called Algiomath, which my math teacher uses, I started teaching students the principles of geometric drawing and creating pictograms. It's great that even students who lack drawing skills can participate with such confidence.*

Conclusion & Recommendation

This study aimed to explore key features of AI utilization in convergence education in Korea and understand its implications. Therefore, this study analyzed convergence education programs developed from 2021 to 2025 with financial support from the Korean government and analyzed in-depth interviews with developers who participated in the study. The implications of AI utilization in convergence education programs can be concluded as follows.

First, AI was utilized as a key learning component in convergence education programs. Korea's national curriculum includes key learning content and achievement standards related to AI in subjects such as practical arts for elementary school, technology and home economics for secondary school, mathematics, information, and engineering (Ministry of Education, 2022). Therefore, AI can be one of the key learning contents or topics of convergence education programs in cross-disciplinary efforts.

Second, AI was utilized as a key problem-solving tool in convergence education programs. With the demand for educational innovation, learner-centered education is gaining attention, and various methods such as design activities, problem-solving activities, and design thinking are being

utilized in convergence education. Convergence education focuses on learner-centered education (Kwon et al., 2025), and in this sense, AI is being utilized as a valuable tool in the problem-solving process. Generative AI can be utilized to collect information for problem-solving or as a valuable tool for problem-solving. Furthermore, AI-based instruction is effective in developing students' intellectual, affective, and psychomotor development. The primary goal of AI is to foster students' interest and curiosity in STEM subjects, as well as their digital literacy, and to foster the development of psychological skills such as problem-solving and creativity. Therefore, AI education can be actively utilized in contexts such as STEM education and maker education (Asunda et al., 2023; Vansconcelos & Santos, 2023). Furthermore, in Korea, AI-based education is being utilized as a valuable tool to enhance the effectiveness and efficiency of instruction in many subjects (Lee & Kwon, 2024). In other words, AI education can be actively utilized not only in computer science (information) but also in other school subjects (How & Hung, 2019).

Third, AI was utilized as a design and visualization tool for students in convergence education programs. Convergence education programs, by their very nature, often involve students expressing their ideas and visualizing them. By utilizing AI, students can create high-quality works through the process of visualizing and expressing data, and gain experience in accurately expressing their thoughts.

The following recommendations are based on the results of this study. First, while this study analyzed programs developed in recent convergence education projects in Korea, it did not explore various aspects related to the actual implementation of these programs. In particular, further research is needed beyond program analysis to address the needs of teachers who will teach these programs. To implement convergence education programs, teachers need opportunities to develop their AI education skills (Pedro et al., 2019). Second, this study was limited to programs from the past five years, and further research is needed to explore the diverse applications of AI. AI tools available in education are continually evolving and diversifying, and ongoing research is being conducted to ensure their usefulness and safety. In addition, in the context of convergence education, AI-based education will become more diverse, and the specific student effects related to this also need to be verified (Xu & Quyang, 2022).

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