The Development and Demonstration of Creative Education Programs Focused on Intelligent Information Technology

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Abstract

To appropriately react to the swift development and changes of technologies these days, the need for creative teaching and learning has been increased. Making learners equip digital literacy of intelligent information has become necessary. This paper focused on three promising technologies that artificial intelligence humanities, forensic science, and digital therapeutics from intelligent information technology. We designed educational programs and applied the programs to 596 elementary and secondary school students in Korea. The objective of these programs was to promote the creativity of learners by using numerous techniques in thinking creatively and exploring newly emerging careers in the fields of intelligent information technology. To find out the educational effect, we tested the study's subjects for their satisfaction with education and their creativity. As a result of the study, the scores regarding the satisfaction of students engaged in the programs was high (M=4.18, SD=0.48), and the score on their creativity was also high (M=4.05, SD=0.38). These educational programs also showed high satisfaction and creativity scores regardless of school level. Accordingly, we suggest that the learning contents and concepts of intelligent information technology might be worthy of being applied across elementary and secondary school practices. From the result that the satisfaction, we found that it was necessary to improve quality of the artificial intelligence humanities program. Also, supplementary and advanced related activities are needed toward enhancing learner motivation and satisfaction.

Keywords: creative education, creativity, intelligent information technology, artificial intelligence humanities, forensic science, digital therapeutics

1. Introduction

1.1 Necessity of Research

In the era of the Fourth Industrial Revolution (4IR), the competencies to efficiently acquire and effectively use knowledge is more critical than the amount of knowledge. On this unavoidable wave to the paradigm shift of education, the importance of creative education has been also emerging from day to day in the educational field. Creativity is considered an essential factor that makes learners think flexibly and respond promptly to the rapidly changing trend of modern society (Hwang & Park, 2019). Traditional teaching and learning methods focused on memorizing and withdrawing knowledge. Nowadays, instructional strategies that draw out and express learners' potential creativity as much as possible have expanded. The current 2015 revised Korean national curriculum, which aims to cultivate creative talents, has been applied nationally to elementary and secondary courses since 2018 (Jung & Park, 2021). In this context, the demand for educational programs that promote learners' creativity has been increasing.

At the same time, educational demands for intelligent information technology (IIT), a major driver of development in the era of the 4IR, have also been getting higher. Due to the ascending significance of IT technology and information subjects, studies on various teaching and learning techniques for information education in elementary, middle, and high school levels have been animatedly conducted (Kim et al., 2021). In addition, software (SW) education has become a mandatory course in the national-level curriculum. In elementary schools, about 3.5 hours per achievement standard are allocated for 17 classes. In the case of middle schools, 17 achievement standards are distributed for 34 hours to use 2 hours per achievement standard as class hours (Kim et al., 2020).

Teaching and learning focused on IIT are expected to yield maximal learning motivation and effectiveness when integrated with creative education; the possibility of developing related educational programs has a high potential. Therefore, this paper proposes creative education programs that aimed to teach and learn IIT interestingly and effectively, under the basic premise of respecting and encouraging learners' creativity. Subsequently, we would like to demonstrate the effectiveness by applying the pilot programs for elementary and secondary learners to derive the degree of class satisfaction and creativity.

1.2 Related research

1.2.1 Creativity

Creativity has been defined by numerous researchers. For instance, Guilford presented originality, fluency, flexibility, sensitivity, elaboration, and reconstruction as components of creativity (Guildford, 1950). Regardless of differences in academic views, creativity commonly refers to the ability to produce new and unique outputs based on basic knowledge in each field (Choi & Park, 2021a). Meanwhile, creativity in an educational context allows students to creatively run their lives and properly contribute to society. In creativity education, creativity provides the direction of establishing educational objectives and goals, selecting and constructing contents, devising methods, and evaluating them (Ha & Lee, 2019). Moreover, adding to the competency directly connected to learning, the COVID-19 pandemic raised a need for active research on affective competency (Han, 2021). Therefore, creativity is deemed a steady basis in the development and application of educational programs. The government is also focusing on fostering creative talents in response to the era of the 4IR and is striving to improve national competitiveness in a sharply changing global environment through educational policy strategies (Choi et al., 2021).

1.2.2 Intelligent Information Technology

Intelligent information technology (IIT) is a technology that implements activities that process high-dimensional information generated by humans through cognition, learning, reasoning, and others based on information and communications technology (Choi & Park, 2021b). IIT that this paper mainly deals with a range of artificial intelligence humanities, forensic science, and digital therapeutics.

Artificial intelligence (AI) humanities take a point of view beyond the acquisition of simple technology. It helps learners who have a lack background knowledge of AI technology explore the principles of AI readily and effectively. Dynamic activities that combined technology and humanities materials such as history, culture, and tales have been suggested. In particular, the use of natural objects, historical figures, specialties, and tourist attractions in certain regions, where is the home of life for the learners, can be expected to promote learning motivation in an intimate atmosphere. It is also effective in improving educational effectiveness by linking or converging with other subjects or learning contents. Thus, AI humanities is a product of creative elements added to the technical aspect of AI.

Forensic Science investigates crimes by applying scientific methods. As a subfield, digital forensics involve scientific procedure and technology that collect, analyze, and secure evidence of a crime. That can be submitted to the court by investigating information stored in information storage media including digital devices (Kim et al., 2021). The popularization of digital devices has made human life dramatically convenient, but at the same time accelerated the occurring and intensifying of newly emerging crimes. Since information stored in digital media is different from evidence in physical crime scenes, a new approach is of investigation needed. Interest in forensic science and digital forensics is growing against this backdrop.

Digital therapeutics is software that can treat diseases and improve health similarly to traditional medicines (Kwon et al., 2021). With the development of information technology, digital therapeutics are expected to become more versatile. The World Economic Forum (WEF) and Scientific American selected digital drugs as one of the top 10 technologies in 2018 (Scientific American, 2020). They were expected to have potential in improving life, changing industries, and protecting the Earth as breakthrough innovations that would have a great impact on global society and the economy. Subsequently, digital medical care was also selected in 2020 top technologies (Scientific American, 2020).

There has been reported that specialized computing skills could visibly reduce students' participation and concentration (Choi et al., 2021). At this point, the necessity and significance of educational programs, teaching and learning methods, and textbooks that integrate creativity elements and IIT has been highlighted.

2. Method

2.1 Study Design and Participants

This study developed the educational programs that can increase students' creativity using IIT as the main content of education. We also aim to provide quantitative implications by analyzing the educational effectiveness of the developed programs. Therefore, we first identified promising future technologies that elementary and secondary learners should know through exploring prior research and selected educational content. Then, education experts and IIT experts gathered to develop creative education programs on the selected content. Next, we applied the developed programs to 596 elementary and secondary school students belonging to 23 schools in Korea. From multiple provinces, study subjects consisted of 55 students from two schools in Seoul, 71 students from two schools in Gyeonggi-do, 262 students from four schools in Gyeongbuk, 30 students from two schools in Gyeongnam, 44 students from two schools in Ulsan, and 146 students from 12 schools in Jeju by region. It comprises 105 students who have experienced the artificial intelligence (AI) humanities program, 230 students in the forensic science program, and 261 students in the digital therapeutics program. As the last step, the educational effect of these educational programs was identified by conducting a satisfaction survey and creativity test on 596 participants. The purpose of this study is to offer quantitative comparisons and implications for further research on educational programs to improve creativity. Furthermore, we applied IIT, a promising future technology, to the creative education program to help students in their future career exploration.

2.2 Instruments

2.2.1 Satisfaction Survey

The instrument for investigating satisfaction used in this study came from the satisfaction survey framework for creative education proposed by the Korea Foundation for Science and Creativity (Korea Foundation for Science and Creativity, 2018). It includes ten items about overall satisfaction, interest, teacher's guidance, opinion sharing, self-reflection, various perspectives, use of convergence knowledge, relevance to real life, and future education hopes. It consists of a 5-point Likert scale. The participants expressed as five if they most agreed and one if they did not agree the most. Cronbach's α for this satisfaction test tool was 0.86. Since this exceeded 0.70, which is judged as the degree of trust in social science research, it can be considered that the reliability of the satisfaction questionnaire was verified.

2.2.2 Creativity Test

The creativity test tool adds a component of sensitivity among the elements of creativity suggested by Guilford(1950) to fluency, flexibility, originality, and elaboration, which are the elements of creativity suggested by Torrance(1974) (Guilford, 1950; Torrance, 1974). It consists of two sub-factors per factor, designed with ten questions and composed of a 5-point Likert scale. In the same way as the satisfaction survey tool, it is designed to indicate five if participants most agree with the question and one if they do not agree the most.

2.3 Data Analysis

We conducted the survey of learner satisfaction of the class involving and the creativity for all study participants after the education programs were finished. To analyze the satisfaction survey results, we calculated the mean and standard deviation through descriptive statistics. Then, we conducted a one-way ANOVA analysis to compare the satisfaction results by school levels and program contents.

We also calculated the mean and standard deviation through descriptive statistics for the creativity survey data as in the analysis of the satisfaction survey results. The program used for all analyses was IBM SPSS 24.0. The internal consistency of the research tool was evaluated by the alpha value of the Cronbach coefficient. Reliability was judged to be significant at the level of $p < .05$.

3. Results

3.1 Development of Creative Programs Focused on IIT

The programs proposed in this study were developed to cultivate students' creativity by using various creative techniques. Then, we designed the programs to understand promising technologies and have the necessary

competencies for the future. In addition, the programs did not cover simply temporary solutions but educational methods whose necessity will naturally expand according to changes in the technological and social environments. Therefore, we have composed various future cutting-edge technologies as educational content for improving students' creativity.

The educational content deals with digital medical technology in the healthcare field and AI technology in the computing field among the top 10 promising technologies for 2020 selected by the World Economic Forum (WEF, 2020). Additionally, forensic science was selected as an educational content because skills for forensics, which can protect oneself from the threat of unpredictable disasters and crimes, are emerging as a promising future industry (Wilson-Wilde, 2017). Therefore, in this paper, the programs' content was composed of forensic science, digital therapeutics, and AI humanities by reflecting these promising IITs in the future.

Forensic science includes sub-topics such as fingerprint detection, anti-forensics, hacking and digital footprints. Digital therapeutics include Attention Deficit Hyperactivity Disorder (ADHD), corona blue, and digital drama digital therapeutics. AI humanities combine AI with humanities elements such as mythology, history, and culture and include Support Vector Machines (SVM) and Convolutional Neural Networks (CNN) that combine historic sites and mythological elements. The targets of the programs are elementary and secondary school students, and the creative thinking techniques used in the programs are Plus-Minus-Interesting (PMI), Six thinking hats method, educational game, discussion, role-playing, using AI, coding, etc. Further, we developed textbooks that can be used for 2-4 classes, including various class materials so that teachers can easily use the programs. Table 1 shows the fields, themes, creative techniques, and characteristics of the IIT-focused creativity cultivation programs proposed in this study.

Table 1. Creative Education Programs Focused on IIT

Program	Field	Creative Technique	Main Subject
Forensic Science	· Mathematics	· Educational Games	· Scientific investigation
	· Natural Science	· Role Playing	· Fingerprinting detection
	· Engineering	· Discussion	· Digital footprint
			· Anti-forensics
Digital Therapeutics	· Natural Science	· Using AI	· ADHD digital therapeutics
	· Biology	· Coding	· Corona blue digital therapeutics
	· Scienc		· Digital drama digital therapeutics
AI Humanities	· Engineering	· PMI	· Support Vector Machine
	· Philosophy	· Six Thinking Hats Method	· Convolutional Neural Network
			· AI ethics

3.2 Practical Application

To examine the practical educational effect of the educational programs for enhancing creativity developed in this study, we applied the planned learning content with designated instructional strategies to 596 elementary and secondary school students in Korea. The application period of the educational interventions was two months, from September to November 2021. The instruction was conducted in 2-4 sessions depending on the program. As can be seen in Figure 1, students were actively engaged in the classes. In addition, we used a variety of digital devices to increase students' concentration and class participation.

Figure 1. Students Taking Classes to Improve Their Creativity

After applying the educational programs to the students, we investigated and analyzed the students' satisfaction with the classes. An analysis was conducted based on the response results of 591 students, excluding five insincere responses among 596 students who received the education.

As a result of the analysis, the overall satisfaction average was high, indicating that students were generally satisfied with the training programs (M=4.18, SD=0.48). On the other hand, looking at the satisfaction results by school level, the elementary school showed the highest (M=4.30, SD=0.34), and middle school showed the lowest (M=4.15, SD=0.15). Meanwhile, as a result of performing One-Way ANOVA to verify whether there is a significant difference in the average of satisfaction scores according to the school level, it was revealed that the variable of school level was found to be statistically insignificant. Table 2 shows the analysis of satisfaction results by school level.

Table 2. Survey Results on Satisfaction by School Level

	M	SD	*F*	*p*
E.S.[1]	4.30	0.34		
M.S.[2]	4.15	0.13	4.691	.632
H.S.[3]	4.16	0.49		

[1] E.S.= Elementary School, [2] M.S. = Middle School, [3] H.S.=High School

Meanwhile, developed creative education programs are not directly related with learning elements in the national curriculum. Therefore, there are few restrictions on school levels and grades. The programs can be used for a wide range of learners by appropriate difficulty adjustment and learning scaffold. Nevertheless, for effective application in the educational field, each program was mainly designed for certain school level. Among 10 education programs, 6 programs are more appropriately constructed for elementary school students, and 4 are for middle or high school students. It can be assumed that this is the causal factor of a slight difference in satisfaction by school level.

As a result of analyzing the student satisfaction results for each applied program, the program with the theme of digital therapeutics showed the highest satisfaction (M=4.45, SD=0.12), whereas the program that recorded the lowest satisfaction was the artificial intelligence humanities program (M=3.95, SD=0.40). Furthermore, as a result of performing One-Way ANOVA to find out the difference in program satisfaction, the program's satisfaction result was found to be statistically significant ($p < .05$). Table 3 shows the analysis of satisfaction results according to the program.

Table 3. Creative Education Programs Focused on IIT

	M	SD	*F*	*p*
F.S.[1]	4.14	0.39		
D.T.[2]	4.45	0.12	4.783*	.019
A.I.H.[3]	3.95	0.40		

[1] F.S. = Forensic Science, [2] D.T.=Digital Therapeutics, [3] A.I.H.= AI Humanities

*p<.05

In addition, as a result of creativity evaluation, a high average was recorded overall (M=4.05, SD=0.38). The One-Way ANOVA was used to verify whether the mean of the creativity factors showed a significant difference according to the school level. The factors of creativity did not show a significant difference according to the school level. Table 4 shows the result on students' creativity tests by school level according to the creativity factor, the dependent variable.

Table 4. Creativity Test Results by Factor

		M	SD	*F*	*p*
Sensitivity	E.S.[1]	4.08	0.23	.485	.019
	M.S.[2]	4.03	0.0		
	H.S.[3]	4.27	0.84		
Elaboration	E.S.[1]	4.12	0.29	1.067	.380
	M.S.[2]	4.02	0.18		
	H.S.[3]	4.48	0.77		
Originality	E.S.[1]	4.02	0.28	.595	.570
	M.S.[2]	3.95	0.38		
	H.S.[3]	4.40	0.30		
Flexibility	E.S.[1]	4.07	0.34	1.780	.218
	M.S.[2]	3.87	0.26		
	H.S.[3]	4.58	0.62		
Fluency	E.S.[1]	4.04	0.28	.620	.557
	M.S.[2]	3.88	0.27		
	H.S.[3]	3.80	0.52		

[1] E.S.= Elementary School, [2] M.S. = Middle School, [3] H.S.=High School

4. Discussion

Creativity is a competency that humans need to cultivate in the age of AI (Korea Foundation for Science and Creativity, 2018). This study proposed IIT-focused educational programs for improving learners' creativity by reflecting the current educational needs. The proposed programs have the themes of intelligent information technology, including forensic science, digital therapeutics, and AI humanities. The target learners are elementary and secondary school students. As a result of applying the programs to the students in Korea, the programs' satisfaction and the creativity test result were counted high.

However, in the case of AI humanities, satisfaction is calculated to be lower than that of other programs. It is necessary to improve its learning content to increase the students' satisfaction. Moreover, there was a difference in satisfaction based on school levels. This was caused by existence of main target learning group. Additional advanced and compensatory teaching-learning materials for each school level should be considered for enhancing overall satisfaction for every student. We will develop programs to strengthen creativity that can be used internationally in the future and research programs by level.

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