



The Development of STEAM Teaching Model and Program based on Smart Device for Connection of Kindergarten-elementary School

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Abstract. The purpose of this study is to develop the STEAM teaching model and program based on smart device for connection of kindergarten-elementary school. We reviewed literature related to STEAM education and smart devices, developed the teaching model, and verified the validity of experts. This teaching model was applied for 15 weeks to 23 children aged 5-years and 45 children aged 7-years. After modifying and supplementing the application process analysis results, the STEAM teaching model based on smart device was finally developed. On the basis of the result of pilot testing, this teaching model was modified and finalized. The purpose of developing the STEAM teaching model based on smart device for young children aged 5 and 7-years was to increase their interest in and awareness of STEAM, creativity, and convergent thinking ability. As for the operation method, STEAM classes were planned and executed, plans were revised and re-executed according to the STEAM class standards for connection of kindergarten-elementary school. The purpose of developing the STEAM teaching model based on smart device for young children aged from 5-years to 7-years was to increase their interest in and awareness of STEAM, creativity, and convergent thinking ability. The STEAM teaching model based on smart device for connection of kindergarten-elementary school is 3 times of present situation, creative design and emotional experience for content convergent, and conclusion on problem solving. The STEAM program based on smart device for connection of kindergarten-elementary school developed a total of 8 activities. In the early stages of the application of smart device-based STEAM education, the development of a smart device-based STEAM class model can provide implications for connection of kindergarten-elementary school.

Keywords: young children, convergent education, STEAM program, STEAM teaching model, smart device, connection of kindergarten-elementary school

Received: 09.12.2020

Accepted: 13.01.2021

Published: 01.02.2021

INTRODUCTION

In the Republic of Korea, the direction of the education policy in 2016 is 'Education for everyone to be happy, creative talent who opens the future', and a creative convergence type of future talent education is being conducted, and STEAM has been introduced and applied as a national policy of Ministry of Education, Science and Technology in Korea [1]. Therefore, in the field of early childhood education, five areas of integrated education through the Nuri course for each age of 3 to 5 years are already being operated, and various STEAM programs for young children have been developed and applied recently in Korea [2, 3, 4, 5].

The 2015 elementary school curriculum and the 2019 revised Nuri curriculum emphasized the reinforcement of the linkage between the Nuri curriculum for each age group of 3 to 5 years old and the content of elementary school education, and argues that the application of STEAM education through linking the curriculum is necessary. Therefore, STEAM education should be conducted from early childhood to cultivate convergent talents, and development of STEAM programs for young children in connection with elementary school curriculum is also required for linkage education between kindergarten and elementary school. The curriculum currently applied in early childhood education is similar to STEAM education method because it applies integrated, topic-oriented, question-oriented, inquiry-oriented, practice-based learning, and constructivist education [6]. Likewise, despite the progress of STEAM-related research for young children, STEAM studies for early childhood teachers compared to elementary, middle, and high schools are incomplete.

In addition, there are several difficulties when applying steam programs in the field of early childhood education. In other words, in the field of early childhood education, there is no subject such as technology

and engineering, and even in integrated education, the use of technology and engineering, which is the basic purpose of steam education, is remarkably insufficient. Therefore, when developing steam teaching models and programs for young children, it is necessary to use related teaching media in order to properly apply technology and engineering.

Recently, smart infrastructure technologies such as smart phones, tablet PCs, and smart TVs, and smart software technologies such as virtual reality and augmented reality, have rapidly developed '2020 Future of Education Report-Creation of Future Learning' according to the knowledge foundation in 2009 [1]. It is expected that traditional education will be destroyed due to changes in economy and society in 2020. Therefore, there is a need for future STEAM education as an active learner who wants to actively understand and utilize technology in learners who accept passive skills. Despite the government's presentation of the 'Smart Education Policy' in 2010 and the application of various class models using smart devices to elementary school seniors, most smart devices have a user-friendly interface such as a touch screen. As a result, the age group of use is gradually decreasing.

In addition, the use of smart media in the field of early childhood education is universally applied, and despite the negative views or concerns when it was first introduced, it is effectively used in class and has a positive result [7]. Currently, the elementary school curriculum is already implementing smart education, and early childhood education institutions are also using a form that is familiar to young children through teaching media related to smart devices through the computer domain. In other words, the smart device is an effective learning medium that helps young children and elementary school students induce interest and focus attention and enables self-directed learning. According to a recent study, in order to use smart devices in early childhood education, systematic teacher education for the use of educational applications considering regional gaps and teacher age groups and development of early childhood education instructional models considering smart device addiction are necessary in the future [7].

Considering the previous studies of the STEAM program for young children applying the teaching media related to smart devices are as follows. [1] developed a smart device-based educational media model to improve children's steam education. That is, the teaching medium based on smart device for steam education is composed of animal synthesis drawing capable of interworking with smart device by wireless communication, lighting and temperature sensor capable of interlocking and controllable drawing of music invented by sound and sheet music, brightness and temperature and the ability to measure the size of the system. [8] developed the S-STEAM education program using machines for early childhood by reviewing previous studies and literature on science programs, science activities, 3-5 years old Nuri curriculum and S-STEAM education.

Nevertheless, since STEAM education and smart education, which are currently applied to the education field, are in a transitional period, they show a tendency to focus on the use of smart devices rather than applying smart devices as educational contents. In other words, teachers misunderstand the class using digital devices as if it were STEAM education, and teachers who are familiar with the traditional teaching methods show resistance to education using smart devices or complain of difficulties in how to apply digital devices to classes. As a result of analyzing the social perceptions of ICT utilization in early childhood education with big data analysis, it is found that the interest of smart, software application and robot in early childhood education field for the past three years has been high. Implications for the use of ICT media were discussed based on the results of the research [9]. [10] revealed that elementary school students who developed and applied the science and environment convergence human resources education (STEAM) program using smart devices were more effective in enhancing the formation of eco-friendly lifestyle habits of elementary school students than classes applying general theory classes.

Therefore, it is necessary to develop and apply early childhood education programs in which ICT such as smart devices are properly integrated, and teacher training related to ICT education programs must be systematically conducted. If the smart device-based STEAM program is developed and applied as a way to complement the areas where the distinction between technology and engineering is ambiguous due to the characteristics of elementary and elementary education, and activities related to technology and engineering are not diverse, desirable convergence education will be realized.

According to, this study developed a smart device-based STEAM teaching model as one of the methods to compensate for the fact that the distinction between technology and engineering is ambiguous due to the characteristics of early childhood education and elementary education, and activities related to technology and engineering are not diverse. I tried to develop the applied steam program. In other words, for effective preschool-elementary education, the direction of preschool STEAM education should go beyond the existing integrated education to become a convergence between science and technology based on smart devices that combine technology and engineering. There is a need to develop a smart device-based STEAM program that seeks to develop creativity through experience. Due to the nature of early

childhood education, it is necessary to develop a STEAM teaching model using a smart device as one of the ways to compensate for the blurring of technology and engineering and the lack of diverse activities related to technology and engineering.

The research questions set based on the theoretical background and research model of this study are as follows.

Question 1. What is the STEAM teaching model based on smart device for connection of kindergarten-elementary school?

Question 2. What is the STEAM program based on smart device for connection of kindergarten-elementary school?

2. Materials and methods

2.1 Procedure

Figure 1 shows the process for developing the STEAM teaching model and program applied that model based on smart device for connection of kindergarten-elementary school.

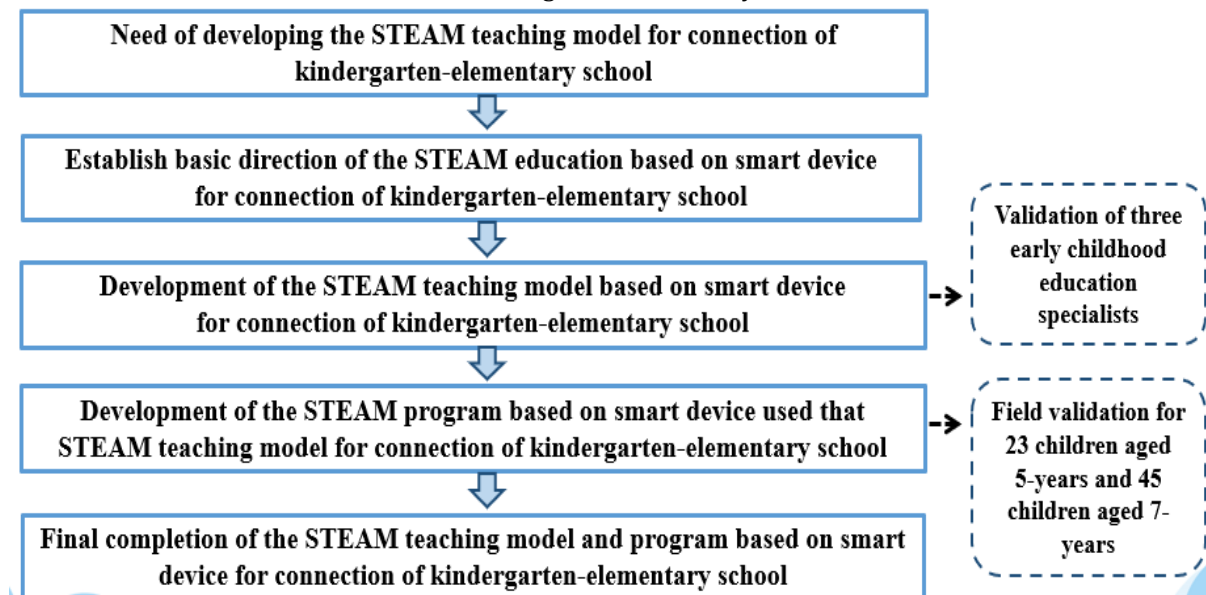


Figure 1 The process for developing the STEAM teaching model and program based on smart device for connection of kindergarten-elementary school

Figure 2 shows the process of development stage for the STEAM teaching model based on smart device

[1: Preparation stage]

Review of literature

Analyzing detailed elements of the STEAM class design framework and deriving common elements through literature review on smart device's utilization plan and activity standards of STEAM education

Case analysis

Analysis of application examples of the STEAM academic conference and performance presentation meeting of the Korea Science and Technology Foundation and the Ministry of Education to develop a smart device-based STEAM convergence model

[2: Development stage]

Developing of STEAM teaching model and derivation of components

After synthesizing the literature review and case analysis results, STEAM teaching model will be developed with reference to Cho(2013)'s STEAM integrated education model

Validation by expert group

9. After in order to secure the feasibility of the developed STEAM teaching model, the feasibility of experts is verified for 5 STEAM experts and PhDs in early childhood education and elementary education












for connection of kindergarten-elementary school.

Figure 2 The process of development stage for the STEAM teaching model based on smart device for connection of kindergarten-elementary school

2.2 Smart device used on STEAM program

Table 1 shows the sample of smart device used on the STEAM program based on STEAM teaching model.

Table 1 The sample of smart device used on the STEAM program

		
smart magnifying glass web	smart heart rate monitor web	smart camera web
		
moisture meter web	smart metal detector web	salinity meter web
		
electronic scale	electronic thermometer	fruit dryer
		
mask pack maker	metal detector	sugar content meter

3. Results

3.1 The smart teaching model based on smart device

On the basis of the result of pilot testing, this teaching model was modified and finalized. The purpose

of developing the STEAM teaching model based on smart device for young children aged from 5-years to 7-years was to increase their interest in and awareness of STEAM, creativity, and convergent thinking ability. The development principles and emphasis are on applying science-based convergence education that links other subjects, based on constructivist theory, and applying smart devices to emphasize technology and engineering. As for the operation method, STEAM classes were planned and executed, plans were revised and re-executed according to the STEAM class standards for young children.

Figure 3 shows the STEAM teaching model based on smart device for connection of kindergarten-elementary school.

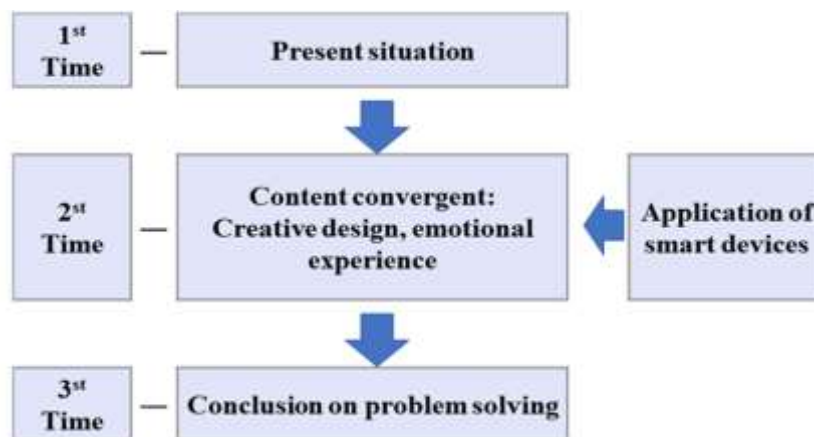


Figure 3 The STEAM teaching model based on smart device for young children

[Step 1] Situation presentation: This is the step of presenting a comprehensive situation or task to be solved that encompasses the overall learning. In this stage, the learner recognizes the activity as a self-problem, presents the situation, recognizes the problem, presents the limitations of the design, and presents the key contents that can be challenged.

[2nd stage] Creative design: This is the stage of the creative problem-solving process in which systems, elements, and processes are devised to create what is needed within given constraints. In this stage, the definition of the problem, planning of the design, selection of ideas, and production are actually constructed.


[Step 2] Emotional experience: This is a step in which you feel interest and get motivation for new challenges through experiences of immersion and success in the process of solving problems yourself. This stage includes appropriate rewards and encouragement, such as learner's experience of success, interest in learning, sense of achievement, and confidence, and feedback from teachers.


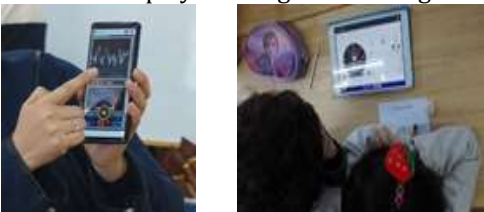


[Step 3] Conclusion on problem solving: This is the step to draw the final conclusion on problem solving. In this stage, learners evaluate their own activities and share their findings with friends.




3.2 The STEAM program based on smart device

Table 2 shows the STEAM program applied that model based on smart device for connection of kindergarten-elementary school.

Table 2 The STEAM program based on smart device

	Name of Activity	Smart Device	Activity Goal & Picture
1	I'm Dr. Fruit, I'm also making art with fruits - Giuseppe Akimboldo	Moisture/Sugar/Salt Measurement Smart Device	<ul style="list-style-type: none"> You can observe and change fruit and dried fruit. You can measure the moisture, sugar content, and salinity of fruits using a smart device that measures moisture, sugar content, and salinity. You can dry fruits using a dryer and fruit dryer. You can create creative Giuseppe recipes using dried fruit. 

2	Make a custom natural mask pack!	Face analysis smart device, moisture measurement smart device, U-CK (mask pack making machine)	<ul style="list-style-type: none"> • You can observe mask sheets and natural materials and change their condition. • You can analyze the facial structure using a face recognition smart device. • You can make a natural mask pack using a mask pack making machine. • You can measure and compare moisture using a smart device. • You can make a variety of colors by mixing natural ingredients. 
3	I'm a sound designer!	Sound of nature app smart device, bird sound app smart device, stethoscope, sound level meter app smart device, voice modulator app smart device	<ul style="list-style-type: none"> • You can understand the process by which sound is made. • You can create sounds in a variety of ways. • You can use sound by using smart devices such as sounds of nature, sound level meters, and voice modulator apps. • You can display the height according to the sound change. 
4	The secret story in my fingers!	Smart Magnifier, Smart Microscope, Smart Camera	<ul style="list-style-type: none"> • You know that each person has different fingerprints and understand the characteristics of fingerprints. • You can observe fingerprints using a smart magnifying glass or a smart microscope. • You can create your own password using your fingerprint. • You can write a secret letter to a friend by using a password. 
5	A necklace made of iridescent water towers!	on Color Measure App Smart Device, Real Color Mixer App Smart Device	<ul style="list-style-type: none"> • You know about the various colors, locations and spaces in Mondrian's work. • You can use the color measurement app smart device to understand color mixing. • You can create various colors by mixing colors using the color mixing app smart device. • You can creatively create mandala artwork by using color mixing. • You and your friends appreciate Mondrian works and mandala works you have made. 

6	Water and white powder meet!	Magnifying Glass Smart Device, My Lab Smart Device, Silent Camera Smart Device, Kitchen Scale/Paper Cup Weighing Device Smart Device	<ul style="list-style-type: none"> • You can predict the results of different experiments with different powders. • You can express the process of change of the powder you met with water through creative movements. • You can measure quantities using the Kitchen Scale smart device. • You can use a variety of materials to complete the elastic ball. 
7	My only shining image in the world	Face analysis smart device, magnifying glass smart device, future face smart device, Art & Culture smart device	<ul style="list-style-type: none"> • You can understand that living things grow and change. • You can use Art & Culture smart devices to compare various aspects of masterpieces. • You can creatively design your own future shape. • You can analyze masterpieces by using any smart devices. 
8	My various expressions on my face!	Heart rate measurement app smart device, Facial expression app smart device, Emocon app smart device	<ul style="list-style-type: none"> • You understand a variety of emotions and know how to cope with your emotions. • You can create a variety of facial expressions using the emoticon app smart device. • You can creatively design facial expressions according to your emotions. • You can measure and compare your body changes according to your emotional changes. 

4. Discussion

In this study, in the early stages of the application of smart device-based STEAM education, the development of a smart device-based STEAM class model can provide implications for early childhood education. This study has high implications that a smart device-based STEAM teaching model and program were developed after applying the smart device teaching media of elementary and elementary school students. In addition, by applying this program to the field of education, it provided fusion-type academic and educational basic materials not only in the fields of early childhood education and elementary education, but also in the fields of teacher education, technical education, and computer engineering.

In addition, it will be able to contribute to activation STEAM education in the field of early childhood education in that it has developed a new teaching method using smart devices with ict technology. In particular, as in this study, through the use of various smart device teaching media, learners can maximize educational effects such as fusion thinking ability and creativity development. Young children and elementary school students voluntarily select and utilize the smart device teaching media to express their thoughts and feelings, and creatively create their own results, resulting in a positive interaction between the learner and the smart device, and the learner's self-directed Leads to a positive effect of learning.

In the early stages of the application of smart device-based STEAM education, the development of a

smart device-based STEAM class model can provide implications for connection of kindergarten-elementary school. Including the smart device teaching media applied through this study, the steam class model, the activity plan of the steam program, etc. can be directly used as educational teaching materials for pre-school teachers. In addition, the results of this study will function as a reference frame for STEAM education, indirectly, in terms of linkage education between early childhood education and elementary education.

5. Conclusions

The purpose of this study was to develop the STEAM teaching model and program based on smart device for connection of kindergarten-elementary school. The purpose of developing the STEAM teaching model based on smart device for young children aged 5 and 7-years was to increase their interest in and awareness of STEAM, creativity, and convergent thinking ability. The development principles and emphasis are on applying science-based convergence education that links other subjects, based on constructivist theory, and applying smart devices to emphasize technology and engineering. As for the operation method, STEAM classes were planned and executed, plans were revised and re-executed according to the STEAM class standards for connection of kindergarten-elementary school. The STEAM teaching model based on smart device for connection of kindergarten-elementary school is 3 times of present situation, creative design and emotional experience for content convergent, and conclusion on problem solving. That is, the step 1 are the course of situation presentation and creative design, step 2 is the course of emotional experience, and step 3 is the course of conclusion on problem solving.

6. Acknowledgements

This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2019S1A5A8033541).

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