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Influence of Cooking Programs Utilizing Smart Devices on Young Children's Inquiry Ability and Attitude

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Background/Objectives: The purpose of this study is to develop a cooking program utilizing smart devices to facilitate young children's scientific inquiry ability and attitude, and to verify the effect of the program after applying this to 5-year-old young children. This study aims to analyse the influence of the cooking programs utilizing smart devices on young children's inquiry ability and attitude. **Methods/Statistical analysis**: The research participants of this study were 36 young children who were 4 or 6 years old. They were recruited from 'K' preschool located in Busan city (Republic of Korea). The experimental group consists of 18 young children (8 males and 10 females) in class A, while the control group consists of 18 young children (9 males and 9 females) in class B. For the experimental group, 11 sessions of the cooking programs utilizing smart devices. For the control group, 11 sessions of the cooking activities based on the Nuri curriculum were given. As test measures, the scientific inquiry ability test developed by Seo (2003) and the scientific attitude test developed by Lee (2000) were employed. Data analysis was performed using analysis of covariance (ANCOVA), which compares the post-test scores with the pre-test scores as covariates. **Findings**: First, the scientific inquiry ability of the experimental group using the smart device-based cooking program was statistically higher than that of the control group using the cooking activities based on the Nuri curriculum. Second, the scientific inquiry attitude of the experimental group using the smart device-based cooking program was statistically higher than that of the control group using the cooking activities based on the Nuri curriculum. **Improvements/Applications**: The cooking program utilizing smart devices developed in this study has a positive effect on the scientific inquiry ability and inquiry attitude of 5-year-old young children. In particular, this study implies the smart devices employed in the cooking program developed in this study are suitable for 5-year-old young children and of great value as schooling media in the field of early childhood education.

Key words: *Creative Cooking Program, Young Children, Smart Device, Scientific Inquiry Ability, Scientific Inquiry Attitude.*

Introduction

The scientific inquiry ability and inquiry attitude in early childhood are essential thinking functions for science learning. As well as science learning, they are necessary functions to provide thinking skills for everyday life and are essential for casual decision-making (Lind, 1991); (Martin, 2001). Among effective scientific activities to improve the scientific inquiry ability and inquiry attitude, cooking activities that are most likely use all human senses and provide a direct and concrete experience are most suitable. In addition, cooking activities among various activities that can be conducted by early childhood education institutions are effective teaching methods that can be integrated with other educational activities.

The effects of various cooking activities such as exploring the internal contents of ingredients, feeling ingredient’s texture, taste and touch, and experiencing changing processes by physical force or by heat on scientific inquiry ability and scientific inquiry attitude have been studied. A few exemplary studies are the study on the influence of cooking activities on infant’s scientific inquiry ability and attitude (Lee, 2005), the study on the effect of the cooking activity based on the constructivism on preschool children's science process skill and scientific attitudes (Lee, 2005), the study on the effect of cooperative cooking activities on young children's scientific attitudes (Kim, 2015) and the study on the effects of constructivist approach to cooking activities on young children's scientific attitudes. These precedent studies demonstrated that cooking activities have a close relationship with infant’s scientific inquiry ability and inquiry attitude but were limited to show only the effect of the scientific experience that existing cooking program themselves have. Nevertheless, in recent years, it has been imperative to develop a teaching model that adopts new cooking programs beyond the general cooking activities in the existing framework.

Recently, the rapid development of information and communication technology (ICT) has been rapidly changing in all fields of society, in education, the importance of the education utilizing ICT has been emphasized in response to the contemporary changing demands. Utilizing ICT in the 21st century educational field is an indispensable and crucial medium in order to effectively collect, analyse and integrate a variety of information for their own purposes to create new information (Park and Kim, 2011); (Edwards et al., 1996). Especially, young children aged 4 years or older have improved their learning efficiency by using computer software (Lee and Yu, 1998).

The following precedent works were presented: multimedia-based education is effective for developing young children's creativity (Choi, 2000). A group of young children (4-5 years old) who have learned with electronic multimedia devices showed higher attention that a group who learned with pictorial devices or electronic media (Kwon, 2011). A group of young children who have learned with multimedia-based integrated teaching and learning showed a higher learning interest that the group of young children with paper-based pictorial materials (Lee, 2003). Education using a service robot for young children's education improves the sociality of young children (Yoon, 2010). Multimedia-based English lessons are effective in improving young children's English interest and achievement (Kim, 2012).

In particular, since the mid-2000s, as mobile internet and social network services have been popularized, smart devices have been used for early childhood education. However, there have been few relevant research – a study showing that an inquiry activity program using smart devices revealed positive effects on young children's attitude toward science class and inquiry ability (Yu, 2012). Learning by using smart devices such as tablet PC (personal computer) has raised the curiosity and interest of young children and has been effective in improvement of their scientific problem-solving ability in everyday life (Kim, 2013).

Therefore, in this study, we developed a cooking program using smart devices to improve young children's scientific inquiry ability and scientific inquiry attitude, and then applied it to 5-year-old children. In other words, we aimed to analyse the effect of the cooking program using smart devices on young children's scientific inquiry ability and inquiry attitude.

The research questions to achieve the purpose of this study are as follows.
First, how does the smart device-based cooking program affect young children's scientific inquiry ability?
Second, how does the smart device-based cooking program affect young children's scientific inquiry attitude?

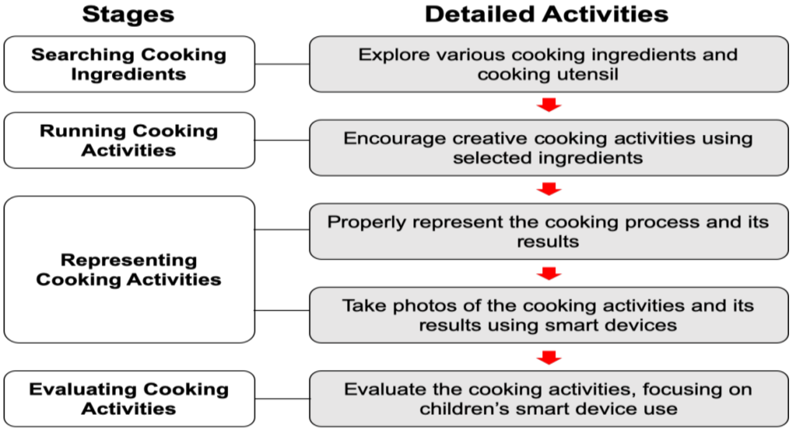
Method

Program

Cooking Program Teaching Model Using Smart Devices

The teaching model of a cooking program using smart devices is shown in [Figure 1].

Figure 1. The teaching model of a cooking program using smart devices



Activities of the cooking program

The actual activities of the cooking program that applied to the experimental group and control group is shown in Table 1.

Table 1: Activities of the cooking program that applied to the experimental group and the control group

Experimental Group				Control Group
#	Smart device	Cooking Contents	Cooking Representations	Cooking Name
1	Making Kimchi Pizza using an NFC smart salinometer	Using an NFC smart salinometer, identify kimchi with different salinity, and then add kimchi and toppings to make kimchi pizza with different salinity and compare the taste and texture.	 	Making Pizza
2	Making Sujebi with a colorimetric thermometer	After checking the temperature of water using a colorimetric thermometer, vary the colour and taste of the dough by	 	Making Sujebi

		making different dough conditions and concentrations.		
3	Making Pumpkin sandwiches with different sugar levels	Measure the sugar level of the pumpkin using a sugar meter and compare and observe the physical and chemical changes of the egg and make a pumpkin sandwich.	 	Making Pumpkin sandwiches
4	Making Origini in different temperature	Using a colorimetric thermometer, make Origini by varying the temperature of roasted ingredients and compare their taste, texture, and colour.	 	Making Origini
5	Making Dimsum in different temperature	Using a colorimetric thermometer, compare the flavour, texture, and colour of the dumplings with different degrees of frying, and then compare the result with the predicted flavour.	 	Making Dimsum
6	Making low-salt well-being Curry	Measure salinity of curry using an NFC smart salinity meter and make physical and chemical changes to make curry with low and high salinity and then compare taste and colour.	 	Making Curry
7	Making Enchiladas with different sugar levels	Using a sugar meter, control the level of sugar, make enchiladas using cheese with different sugar content, predict taste, and compare and explore various enchiladas.	 	Making Enchilada
8	Making Buns using an egg thermometer	Using an egg thermometer, boil eggs in different temperature and observe their changes. Compare the colour, taste, and texture of the bun after making the roll with the thin rolled white bread.	 	Making Buns

9	Making Kimchi using an NFC smart salinometer	Using an NFC smart salinometer, soak cabbage in water with different salinity. Complete Kimchi with various fillings. Compare the conditions of cabbage according to salinity, volume, taste, and texture.		Making Kimchi
10	Popcorn frying with different temperatures.	Use a colorimetric thermometer to compare the shape and volume of the fried corn after frying the corn at different temperatures.		Frying Popcorn
11	Making sugar Cookies with different sugar content using a sugar content meter	Using a sugar content meter, make a mixture of butter, chocolate, sugar, and milk with different sugar content, cook them, and compare the taste, texture and colour of the cookie.		Making Cookies

As shown in Table1, the 11 different kinds of cooking activities were applied to the experimental group. Children experienced the scientific inquiry through the effects of various cooking activities such as exploring the internal contents of ingredients, feeling ingredient's texture, taste, colour and touch, and experiencing changing processes by physical force or by heat. The smart devices for cooking activities were NFC smart salinometer, colorimetric thermometer, egg thermometer and sugar content meter. Children of the experimental group finished cooking as shown in the cooking representations of table 1. And the control group conducted the same cooking activities as the experimental group but without the smart devices.

Activity contents of the cooking program utilizing smart devices

The specific contents of the cooking program utilizing smart devices are shown in Figure 2.

Figure 2. Activity contents of the cooking program utilizing smart devices

Cooking ingredients	Smart device	Representation	Science Inquiry Ability & Attitude
Making pumpkin sandwiches with different sugar levels.	 		Thorough these activities, children can compare and infer the taste of pumpkin with different sugar levels, observe the shapes of eggs depending on different temperatures, and observe the shape, colour, texture and volume of materials changed physically and chemically.
Various kinds of breads, sweet pumpkin, carrot, cucumber, onion, apple, egg, mayonnaise, honey, and various kinds of jam.	 		
Children's cooking knife, chopping board, egg boiling thermometer, electric conductivity salinity meter, and sugar meter.			
Making kimchi using an NFC smart salinometer.	 		Children can cook a variety of kimchi by choosing salted cabbage pickles and anchovy sauce, and can compare, observe, and explore the chemical changes and physical changes of those through slicing, churning, mixing, and cutting. They can compare and deduce the taste of Kimchi set by themselves by sampling various kimchi with
Cabbage, sea salt, red pepper paste, anchovy sauce, garlic and various vegetables.			
Children's cooking knife, chopping board, NFC smart salinometer.			

							different taste and colour.
Popcorn frying with various ranges of temperatures. Corns with different humidity in a dry state, various oils, sugar syrup and chocolate syrup.							Children can choose their own choice of corn and various oils with different dry humidity and observe how they fry depending on the temperature. They can sample various types of popcorn with various sugar syrups. Children can compare and classify the moisture level, friend appearance, and cooking time of corn.
Wok with lid, colorimetric thermometer and sugar meter.							

The Participants

This study is to verify the effectiveness of the cooking program using smart devices. The research participants of this study were 36 young children who were 5-year-old. They were recruited from 'K' preschool located in Busan city (Republic of Korea). The experimental group that learned via the cooking program using smart devices developed in this study consists of 18 young children (8 males and 10 females) in class A, while the control group consists of 18 young children (9 males and 9 females) in class B. The control group learned via scientific activities based on the Nuri curriculum. At the beginning of this study, the experimental group and the control group were 20 and 19, respectively. Three participants were excluded because of the following reasons. One child had been frequently absent in class. One child had suffered from innate disability. The last one's family had moved so that the one didn't have chance to finish the entire 11 classes in class B. A total of 36 participants were selected as the experimental group (18 children) and the control group (18 children).

Instrumentation

Scientific Inquiry Ability

The test employed in this study to measure children's scientific inquiry ability was the 'Scientific Inquiry Ability Test'. This test was based on the scientific inquiry ability evaluation, which was originated from Reference 16, was devised by Reference 17 and was modified and revised by Reference 18. Examination items on young children's scientific inquiry ability consist of 5 subcomponents – 'Prediction', 'Observation', 'Classification', 'Measurement', and 'Discussion'. Each subcomponent has 3 questions so that the total number of questions are 15. Evaluation criterion is described for each question. Based on the evaluation criteria, it was rated on a 5-point scale.

Scientific Inquiry Attitude

In this study, a scientific attitude test tool was the 'scientific attitude test', which was modified and supplemented by Reference 17 based on the scientific attitude assessment criteria presented in Reference 19. The scientific attitude test consists of 9 components including curiosity, confidence, gumption, honesty, openness, criticism, judgement suspension, cooperation and perseverance. Each component has 3 subcomponents so that it consists of 27 questions. Evaluation criterion is described for each question. Based on the evaluation criteria, it was rated on a 5-point scale.

Experimental Procedure
Pretest

A pretest was conducted on the first week of September 2018 before the application of our program. The homeroom teacher directly conducted the scientific inquiry ability and inquiry attitude tests in the experimental group and the control group. The tests were carried out by the homeroom teacher, who directly gave the individual children a detailed explanation of the test and then checked their responses. The time required for the both tests was about 40 minutes.

Main Experiment

We had presented 11 sessions of the cooking program utilizing smart devices to the experimental group from October 10, 2018 to December 23, 2018. For the control group, general cooking activities based on the Nuri curriculum were applied according to the designated weekly plan.

Post-test

The post-test had been conducted in the experimental group and the control group for three days between December 27 and December 29 in 2018. The progress of the post-test, the location, and the execution duration and the examiners were the same as those in the pre-test.

Data Analysis

For reliability analysis of the two test tools, Cronbach α coefficients were calculated using the data collected in this study. In order to verify the effectiveness of the program, analysis of covariance was used by using pretest scores as covariates.

Result

The effect of a cooking program utilizing smart devices on young children's scientific inquiry ability.

The results of analysing the means and the standard deviations of the post-test scores and the adjusted scores are shown in Table 2.

Table 2: The means and standard deviations of post-test scores and adjusted post-test scores regarding scientific inquiry ability

Distribution			Post-test Scores		Adjusted Post-test Scores	
		N	***M***	***SD***	***M***	***SD***
Expectation	Experimental	19	12.00	1.76	11.07	0.32
	Control	17	7.24	2.33	8.28	0.34
Observation	Experimental	19	11.11	1.73	10.67	0.28
	Control	17	8.65	2.45	9.13	0.30
Classification	Experimental	19	10.16	1.98	9.65	0.32
	Control	17	6.88	2.00	7.45	0.34
Measurement	Experimental	19	10.00	1.91	9.11	0.30
	Control	17	5.76	1.60	6.76	0.32
Discussion	Experimental	19	10.58	2.43	9.73	0.41
	Control	17	6.29	2.14	7.24	0.44
Total Inquiry Ability	Experimental	19	53.84	8.71	50.22	1.08
	Control	17	34.82	7.16	38.87	1.15

As shown in Table 2, after applying the cooking program using smart devices, the post-test score of the experimental group's scientific inquiry ability was somewhat higher than that of the control group. Table 3 demonstrates the results of analysing post-test scores that uses pre-test scores as covariates for the scientific inquiry ability.

Table 3: ANCOVA analysis of scientific inquiry ability on post-test score

Classification	**Variables**	**Sum of Square**	**df**	**Mean Square**	***F***
Expectation	Pre-test Score (Covariate)	89.93	1	89.93	55.85***
	Group (Main Effect)	50.42	1	50.42	31.32***
	Error	53.13	33	1.61	
	Adjusted Sum	346.75	35		
Observation	Pre-test Score (Covariate)	102.71	1	102.71	72.17***
	Group (Main Effect)	19.85	1	19.85	13.95**
	Error	46.96	33	13.95	
	Adjusted Sum	203.89	35		
Classification	Pre-test Score (Covariate)	72.94	1	72.94	39.23***
	Group (Main Effect)	38.17	1	38.17	20.53***
	Error	61.36	33	1.86	
	Adjusted Sum	230.56	35		
Measurement	Pre-test Score (Covariate)	60.85	1	60.85	43.46***
	Group (Main Effect)	32.38	1	32.38	23.12***
	Error	46.21	33	1.40	
	Adjusted Sum	268.00	35		
Discussion	Pre-test Score (Covariate)	89.11	1	89.11	32.29***
	Group (Main Effect)	42.17	1	42.17	15.28***
	Error	91.05	33	2.76	
	Adjusted Sum	344.89	35		
Overall Inquiry Ability	Pre-test Score (Covariate)	1561.23	1	1561.23	82.33***
	Group (Main Effect)	863.12	1	863.12	45.52***
	Error	625.78	33	18.96	
	Adjusted Sum	5432.31	35		

*** $p < 0.001$

As shown in [Table 3], after experiencing the cooking program utilizing, the total scientific inquiry score in the experimental group was significantly higher than that of the control group (F = 45.52, p < 0.001). Specifically, even when the differences in the scores of subcomponents of scientific inquiry ability before applying the cooking program utilizing smart devices, after applying the cooking program utilizing smart devices, the scores of the experimental group was significantly higher than those of the control group. The statistics of the scores are 1) prediction ($F = 31.32$, $p < 0.001$), 2) observation ($F = 13.95$, $p < 0.01$), 3) classification ($F = 20.52$, $p < 0.002$), 4) measurement ($F = 23.12$, $p < 0.001$) and 5) discussion ($F = 15.28$, $p < 0.001$).

The effect of a cooking program utilizing smart devices on young children's scientific inquiry attitude.

The results of analysing the means and the standard deviations of the post-test scores and the adjusted scores are shown in Table 4.

Table 4: The means and standard deviations of post-test scores and adjusted post-test scores for scientific inquiry attitudes

Classification			**Pre-test Scores**		**Post-test Scores**	
		N	***M***	***SD***	***M***	***SD***
Curiosity	Exp	19	9.63	3.00	9.64	0.60
	Control	17	7.65	2.00	7.64	0.63
Gumption	Exp	19	10.32	2.16	10.31	0.52
	Control	17	7.65	2.32	7.66	0.55
Honesty	Exp	19	9.16	1.17	9.15	0.47
	Control	17	7.06	2.64	7.71	0.49
Objectiveness	Exp	19	9.16	1.86	9.07	0.39
	Control	17	7.76	1.82	7.87	0.41
Openness	Exp	19	9.16	1.42	9.16	0.37
	Control	17	7.00	1.84	7.00	0.40
Criticism	Exp	19	8.16	0.83	8.16	0.32
	Control	17	7.76	1.82	7.76	0.33
Judgement Suspension	Exp	19	7.53	1.47	7.53	0.44
	Control	17	6.65	2.32	6.64	0.47
Cooperation	Exp	19	10.37	1.77	10.32	0.38
	Control	17	8.24	1.75	8.29	0.40
Perseverance	Exp	19	8.53	1.58	8.47	0.36
	Control	17	6.12	1.90	6.18	0.38
Overall inquiry Attitude	Exp	19	82.00	8.81	82.04	2.67
	Control	17	66.53	13.91	66.49	2.82

Table 4 shows the results of analysing the means and the standard deviations of post-test and adjusted post-test scores for scientific inquiry attitudes. As demonstrated in Table 4, after experiencing the cooking program utilizing smart devices, the post-test scores of the experimental group was somewhat higher than that of the control group. The results of analysing the post-test scores for the scientific inquiry attitude, which regards the pre-test scores as covariates are demonstrated in Table 5.

Table 5: ANCOVA analysis of post-scoring scores (N = 36).

Classification	**Variables**	**Sum of Square**	***df***	**Mean Square**	***F***
Curiosity	Pre-test Score (Covariate)	1.21	1	1.21	0.18
	Group (Main Effect)	35.78	1	35.78	5.25*
	Error	225.09	33	6.82	
	Adjusted Sum	216.64	35		
Gumption	Pre-test Score (Covariate)	0.19	1	0.19	0.04
	Group (Main Effect)	62.63	1	62.63	12.17**
	Error	169.80	33	5.15	
	Adjusted Sum	233.89	35		
Honesty	Pre-test Score (Covariate)	0.60	1	0.60	0.15
	Group (Main Effect)	18.54	1	18.54	4.52*
	Error	135.45	33	4.11	
	Adjusted Sum	154.97	35		
Objectiveness	Pre-test Score (Covariate)	22.61	1	22.61	8.02**
	Group (Main Effect)	12.76	1	12.76	4.53*
	Error	92.98	33	2.82	
	Adjusted Sum	133.00	35		
Openness	Pre-test Score (Covariate)	2.92	1	2.92	1.10
	Group (Main Effect)	41.92	1	41.92	15.64***
	Error	87.61	33	2.66	
	Adjusted Sum	132.31	35		
Criticism	Pre-test Score (Covariate)	2.98	1	2.98	1.57

	Group (Main Effect)	1.47	1	1.47	0.78
	Error	62.60	33		
	Adjusted Sum	66.97	35		
Judgement Suspension	Pre-test Score (Covariate)	1.27	1	1.27	0.34
	Group (Main Effect)	7.13	1	7.13	1.91
	Error	123.35	33	3.74	
	Adjusted Sum	131.56	35		
Cooperation	Pre-test Score (Covariate)	16.00	1	16.00	5.90*
	Group (Main Effect)	36.80	1	36.80	13.57**
	Error	89.48	33	2.71	
	Adjusted Sum	146.31	35		
Perseverance	Pre-test Score (Covariate)	20.60	1	20.60	8.30**
	Group (Main Effect)	46.46	1	46.46	18.72***
	Error	81.91	33	2.48	
	Adjusted Sum	154.56	35		
Overall Inquiry Attitude	Pre-test Score (Covariate)	27.92	1	27.92	0.21
	Group (Main Effect)	3264.26	1	3264.26	16.00***
	Error	4464.16	33	135.28	
	Adjusted Sum	6639.64	35		
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$					

As shown in Table 5, after experiencing the cooking program utilizing smart devices, the experimental group showed a significantly higher scientific inquiry attitude score than that of the control group ($F = 16.00$, $p < 0.001$). Specifically, after the cooking program using smart devices, the following scores were higher in the experimental group than the control group: curiosity ($F = 5.25$, $p < 0.05$), gumption ($F = 4.52$, $p < 0.05$), honesty ($F = 4.52$, $p < 0.05$), objectiveness ($F = 4.53$, $p < 0.05$), openness ($F = 15.64$, $p < 0.001$), cooperation ($F = 13.57$, $p < 0.01$) and perseverance ($F = 18.72$, $p < 0.001$). However, criticism and judgment suspension didn't have significant difference between the two groups.

Conclusion

In this study, the differences of scientific inquiry ability and scientific inquiry attitude were analysed between the experimental group that experienced the cooking program utilizing smart devices and the control group that underwent the cooking activities based on the Nuri curriculum. Based on the analysis, we intended to investigate the effect of the cooking program utilizing smart devices on young children's scientific inquiry ability and scientific inquiry attitude. Focusing on research questions, the results are summarized as follows. First, it was found that the cooking program utilizing smart devices positively affected all subcomponents of the scientific inquiry ability including the scientific inquiry ability itself. This result is in the same context as the previous research that the inquiry activities utilizing smart devices had a positive effect on young children's inquiry ability in science class. It also supports the research findings that young children's learning with smart devices such as tablet PCs, increased their curiosity and interest and thus improved the ability of scientific problem solving in everyday life. In addition, this study is in line with the previous studies, which suggested that cooking practices have a positive effect on young children's scientific inquiry ability, and described that the cooking activities, based on the constructivism, have a positive effect on young children's scientific inquiry ability.

Second, the cooking program using smart devices positively affected each sub-component including the whole scientific inquiry attitude, except for criticism and judgment suspension. This result complies the former finding that an inquiry activity class program using smart devices showed a positive effect on young children's attitude toward science class. Additionally, this study supports the results that cooking activity approaches, cooking activities based on the Constructivism, cooperative cooking activities, and a Constructivist approach to cooking activities demonstrated positive effects on young children's scientific inquiry attitude.

Therefore, this study implies that a cooking program utilizing smart devices is a useful learning tool, which motivates and stimulates the learning activities of young children. The active employment of smart devices suggests that it is effective not only as a medium to facilitate children's understanding of cooking activities, but also to improve scientific inquiry skills and inquiry attitudes. It is worth noting that the use of ICTs such as smart devices will be an indispensable and important education medium in the future, as demonstrated in the study, in which young children aged 4 years or older had improved learning efficiency when learning with computer software. In the future, researches should be conducted and verified with various smart devices on diverse activity areas such as science, art, and language as well as cooking activities to

The limitations of this study are as follows: this study was limited to 5-year-old young children only as participants. Therefore, future studies shall expand the range of research participants with various ages to vary and adjust the complexity and difficulty of a cooking method. Second, since the smart devices employed in this study are limited to cooking programs, it is necessary to specify how to develop and apply smart devices applicable to the fields of physical education, music, mathematics, and language activities. Third, despite the encouraging effect of the class program using the smart device, there have not been many studies on educational programs utilizing smart devices. Therefore, the development of various teaching methods using smart devices must precede. Convergence education research that applies desirable ICT education in early childhood education should be encouraged.

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