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The Effects of Nature-Inspired Art Convergence Class On Learning, Problem-Solving Ability of Middle School Students[1)]

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< ABSTRACT >

The purpose of this study was to identify the effects of Nature-Inspired Art Convergence class on self-directed learning and scientific problem-solving ability of middle school students. The study involved 36 middle school students and experimentation was conducted for eight weeks (16 sessions). The participants were randomly assigned to the experimental and control groups, comprising 18 students each. The students in the experimental group participated in the Nature-Inspired Art Convergence class, and those in the control group were assigned to a nature-inspired lecture class. For pre and post-test, PSI-B (Happner & Peterson, 1982) and SDLAT (Yang et al., 2018) were used, while the statistical analysis was conducted using the SPSS 21.0 Program. The study found that Nature-Inspired Art Convergence class was effective in improving the self-directed learning ability and the scientific problem-solving ability of middle school students. In this study, it was found that natural mimicry art fusion class was effective in improving self-directed learning ability and scientific problem solving ability of middle school students. Therefore, it was found that the interest in learning was increased by providing students with pleasure in inquiry activities.It is expected that the natural simulated convergence class, which improves self-directed learning and scientific problem solving ability, will have a positive effect on middle school students, so follow-up research is needed.

Key Words : Nature-Inspired art convergence class, self-directed learning ability, scientific problem-solving ability

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자연모사 미술융복합수업이 중학생의 자기주도학습과 과학적 문제해결능력에 미치는 효과[1)]

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〈 요 약 〉

본 연구의 목적은 자연모사 미술융복합수업이 중학생의 자기주도학습과 과학적 문제해결능력에 미치는 효과를 규명하는데 있다. 연구는 중학생 36명을 대상으로 8주간(16회기) 실험을 진행하였다. 참가자들은 각각 18명의 학생으로 구성된 실험 그룹과 통제 그룹에 무작위로 배정되었다. 실험집단의 학생들은 자연을 모사한 과학예술 융복합 수업에 참여했고, 통제집단의 학생들은 자연모사 강의 수업에 배정되었다. 사전 및 사후 검사는 Huh(2006)가 PSI-B(Happer & Peterson, 1982)를 수정,보완한 검사와 Yang et al.(2018)이 개발하여 타당화 한 중학생의 자기주도학습력검사(SDLAT)를 사용하였고, 통계분석은 SPSS 21.0 Program을 사용하였다. 본 연구에서는 자연모사 미술융복합수업이 중학생의 자기주도적 학습능력과 과학적 문제해결력 향상에 효과적인 것으로 나타났다. 따라서 자연모사 융복합수업은 학생들이 탐구활동을 즐겁게 할 수 있도록 제공되어 실생활의 다양한 문제를 자기주도적으로 문제해결해 나가며 학습에 대한 관심이 높아진 것으로 나타났다. 자기주도학습과 과학적 문제해결력 향상이 되는 자연모사융복합수업은 중학생의 긍정적인 효과를 줄 것으로 기대되므로 후속 연구가 이루어질 필요가 있다.

주요어 : 자연모사 융복합수업, 자기주도학습, 과학적 문제해결력

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Ⅰ. Introduction

Scholars have predicted that the future society will be an era of dreams, and imagination and creativity will be the core of national competitiveness. This highlights the importance of creativity and imagination in all fields, and suggests that a new education system is needed to secure novel perspectives and strategies to prepare for the future (Lhee, 2014).

In particular, Korea emphasizes the importance of education for self-directed learners with humanistic imagination and artistic creativity in order to cultivate human resources in science and technology field and to integrate and integrate society as a whole (Lee et al., 2020). With artificial intelligence (AI)-based technology gaining increasing attention, it is expected that the demand for creative convergence talent development will expand across schools and the society, in order to respond to and adapt to the future society (Ahn, 2017).

The Ministry of Education of the Republic of Korea (2022) emphasized the necessity of fostering creative convergence talent through the revised curriculum in 2022. It is a creative fusion talent that creates new knowledge and value by selecting knowledge that can be applied to new environment and situation with self-directed learning ability that can solve various scientific problems of everyday life in future intelligent information society. One of the classes proposed to foster creative convergence talent is the Natural Inspiration Convergence Class (Park & Lee, 2020). Nature-inspired is not an existing consumption purpose, but environment and human beings together properly complement nature to improve scientific problem solving ability environmentally. AI technology is expected to develop further, so the boundary between human and machine can disappear. In addition, human beings are faced with problems such as climate change, energy, food problems, and diseases. Therefore, it is necessary to acquire self-directed knowledge in various ways from various angles in the past and cultivate talented people with scientific problem solving ability (Kim, 2012).

The natural inspire-art convergence class in this study aims to broaden one's experience and recognition area, to learn new perspectives, abilities and skills, and to improve self-directed learning ability by allowing learners to diagnose the necessity of learning independently, to set the goal of learning, and to select human and material resources that can be helpful for learning (Knowles, 1975).

In fostering future talents with creative convergence capabilities, the variables to be considered along with creative problem-solving ability are self-directed learning ability. Since self-directed learning ability is required to pursue student-centered education suitable for students' aptitude, ability, and career, Nature-Inspired Art Convergence class proposed in this study can be regarded as a suitable teaching method to cultivate self-directed learning and creative problem-solving ability (The Ministry of Education, 2022). From this perspective, this study proposes an appropriate Nature-Inspired Art Convergence class education program to cultivate the capacity of creative convergence talents. The activities in this class differ in that they provide the experience of actively designing problem solving by utilizing the knowledge learned and combining the solution process and procedures among the team members to design creatively. Nature-Inspired Art Convergence class is considered to actively promote the idea of self-directed creative expression or problem solving through the creative problem-solving process beyond the level of connecting existing science subjects.

Scientists find new theories through observation of nature, and artists are inspired by new theories and materials of science, which is related to the curriculum that creates new works that they pursue (Kim, 2012). In accordance with this trend of the times, this study aims to explore the possibility and direction of applying the natural inspire-art convergence class, that is, the program that combines art and science subjects, to public education in a new paradigm of education by verifying the effect of the program on the improvement of self-directed learning ability and scientific problem solving ability of middle school students.

In the art convergence class of nature inspired, which is one of the smart learning strategies, various teaching-learning activities can be conducted in the arts, science, and social subjects to learn about the environment. This means that students can develop self-directed learning ability, have flexible and open problem-solving ability, and grow into future creative convergence talents with artistic sensitivity by participating in projects that can be taught in the arts, language, science, and social curriculum (Drake & Burn, 2004; Lee, 2012). The purpose of this study is to examine the effects of Nature-Inspired Art Convergence class, that is, the art and science curriculum, on the improvement of self-directed learning and scientific problem-solving ability of middle school students. Therefore, the following research questions were proposed according to the purpose and confirmed through the experiment.

Research Question 1. Is Nature-Inspired Art Convergence class effective in improving self-directed learning ability of middle school students?

Research Question 2. Is Nature-Inspired Art Convergence class effective in improving the scientific problem-solving ability of middle school students?

Ⅱ. Theoretical background

1. The necessity of Natural Inspired-Art Convergence Education

Yakman (2007, 2011), who first proposed convergence education, said that students can acquire convergent knowledge with interest in each academic field (science, technology, engineering, art, mathematics, etc.). It is argued that convergence classes foster convergent talents capable of responding to future society and foster convergent talents with self-directed learning and scientific problem-solving skills. Therefore, in order to lead the change of the future society in the change of the times, it is necessary to change the teaching and learning system into a convergent curriculum for the cultivation of talented people who can possess flexible and open thinking style and artistic sensitivity (Min & Kim, 2016).

The future society is called knowledge and information society. Rather than passively acquiring increasing knowledge and information, learners themselves should cooperate with others to create new knowledge through the curriculum. In order to foster convergent talents that are crucial to improving national competitiveness in the 21st century, it is systematically established and promoted for all ages (Kim et al., 2022). Korea's Ministry of Education, Science and Technology (2011) also tried to foster creative science and technology talents through STEAM education. In the STEAM class, students focused on practicing happiness education rather than cramming education by emphasizing the process of experiencing and experiencing themselves, exploring problems themselves, designing and exploring solution (A. Y. Kim, 2014). The Ministry of Education(2015, 2017), Science and Technology aims to increase the interest and understanding of science and technology from the elementary and junior high school level in order to cultivate creative and convergent talents, to apply engineering practices linked to real life based on the basic theory of

science, to increase students' interest and understanding of science and technology, and to cultivate convergent thinking and problem solving ability.

Therefore, the natural inspire-art convergence class, which this study intends to develop and apply, induces students to apply creative ideas when they observe and shape objects or phenomena around them or identify principles.

In order to create a better environment in the future, it is necessary to provide the next generation of young people with the opportunity to cultivate the ability to create new growth engines in the 21st century, leading to the creation of new technologies in the 21st century. In order to solve various problems, it is necessary to acquire and apply fusion knowledge that encompasses engineering, humanities and arts. The learning criterion of the natural inspired-art convergence class focuses on finding various problems in the learner's life and solving them successfully to have interest and motivation in learning and to create a passion to challenge new problems. The natural inspired-art convergence class is related to finding new theories through observation of nature, getting inspiration from new theories and materials of science, and creating new works that they pursue (Park & Lee, 2020). Science and art have a lot of influence on each other. Natural copying can broaden the artistic expression area by observing natural phenomena and combining them with art, and at the same time, it can be the basis of scientific research. For example, it can be an opportunity to observe the list of shapes and patterns in an artwork and to understand the structure of the material (Im, 2012; Jang & Cho, 2019; Lim, 2010).

The concept of natural inspiration art fusion class is considered to have achieved the perfect completion of Renaissance art in the 15th century by Leonardo da Vinci, who showed talent in various fields ranging from sculpture, architecture, civil engineering, mathematics, science and music. In Leonardo da Vinci's famous saying, 'Nature is the best teacher', it was composed based on the content that da Vinci saw the wings of a bird and conceived of an airplane. The emotional experience through class creates interest, passion, and immersion in learning, discovers the meaning of the relationship between individual and community, nature and culture, and equips self-directed learning and scientific solution.

2. Self-directed learning and scientific problem solving

Regarding the components of self-directed learning, Chung (2003) explored the

components of motivation, cognition, and behavior control by studying middle school students. The concept of self-directed learning to be used in this study is self-directed learning in which learners check and manage themselves cognitively, justice, and behaviorally to achieve their learning goals. Therefore, they classified the domain of self-directed learning into three domains of cognitive, affective, and behavioral domains. In the cognitive domain, ‘cognitive thinking, metacognition, and problem solving ability’ were set. In the affective domain, ‘intrinsic motivation, future-oriented motivation, and self-efficacy’ were set. In the behavioral domain, ‘ helping, physical environmental management, and time management’ were set.

The concept of scientific problem solving ability is that everyone faces various problems in daily life, big and small, and tries to think and solve them. In particular, modern society requires the ability to observe, understand and analyze natural phenomena or social phenomena more than ever before, and to solve problems scientifically (Kim, 2012). Choi (2013) said that human life is a process of solving problems because human beings face various problems that must be solved continuously from birth, and this problem solving is a process of finding a combination of various principles already learned to apply and utilize them to new problems.

The nature inspired art convergence class is a curriculum in which learners plan the goal of learning to find scientific problem solving methods on their own initiative, discover human and material resources that can be helpful for learning, and attach importance to curiosity and intellectual desire, internal stimulation, as a suitable learning method. It presents a teaching-learning process so that learners can demonstrate their abilities in future Korean society by equipping them with self-directed learning and scientific problem-solving skills, which are core values of future society. In other words, the goal of school education is to develop competent talents who have self-directed learning ability and can solve problems on their own. In addition, this course aims to utilize the characteristics of teaching-learning interaction as a process of planning, implementing, and evaluating learning by considering adaptability to learning, openness in cognitive aspect, and passion for learning as characteristics of learners (Heppner & Petersen, 1982). The class process of this study is to recognize the given problem situation which is the scientific problem-solving ability correctly and to develop the learner as an active learner through the process of understanding and understanding various phenomena and objects of oneself, others, and the

surrounding world by exploring oneself through the sense with the attitude of inquiry and interest in the process of thinking and science through reasoning, argumentation, observation and experiment (Kang, 2022; Lee et al., 2011).

Knowles (1975) said that self-directed learning ability is one of the core competencies that all students have and are required for learning and achievement. Since human beings inherently have growth potential, these characteristics motivate learners to participate and act proactively. School education is now focused on educating problem solvers who can explore, learn, and solve problems on their own, rather than on educating people who know a lot, such as human databases (Jeon, 2011; Song, 2008).

Ⅲ. Method

1. Subjects

The subjects of this study were 40 middle school students who applied for 5th and 6th classes among the first-grade students of Seoul S middle school who participated in a program implemented as part of the career education of the Ministry of Education. The students who participated in the study were from the same residential area and living environment, and after selection, 20 students were randomly assigned to the experimental and the control groups, respectively. Four students dropped out, and the experimental group (10 males, 8 females) and the control group (8 males, 10 females) had 18 students each. The control group gave a lecture on the theory of nature inspired, and the experimental group provided a teaching-learning method to explore nature, project learning, discussion, art design, and work production.

1) Research instruments

The research instruments used in this study were measurement tools and experimental programs. The measurement tools were self-directed learning ability test (SDLAT) for middle school students developed by Yang et al. (2018) used as pre-post-test, and scientific problem-solving ability test developed by Huh (2006). The experimental tool was the Nature -Inspired art Convergence program. The specific contents are as follows.

2) SDLAT (self-directed learning ability test)

The research self-directed learning ability was measured using SDLAT of middle school students developed and validated by Yang et al. (2018). This test is categorized into three domains: behavior, affection, and cognition. It comprises 58 questions overall consisting of three sub-factors for each domain. Cognitive thinking, metacognition, and scientific problem-solving ability were included in the cognitive domain, while intrinsic motivation, future-oriented motivation, and self-efficacy was included in the affective domain, and helping, physical environment management, and time management were part of the behavioral domain. The Cronbach's reliability of the SDLAT original test was .920 in the behavioral domain; .924, .924 in the affective domain; .939 in the cognitive domain; and .971 in overall reliability. In this study, Cronbach's reliability for cognitive domain was .937, affective domain .921, behavioral domain .919, and overall reliability .970. <Table 1> is the reliability of each sub-factor and the composition of items for SDLAT.

<TABLE 1> SDLAT composition of items & reliability

Domain	Sub-factor	Item number	Number of items	Cronbach α
Cognition	Cognitive thinking	1-8	8	.899
	Meta cognition	9-13	5	.937
	Scientific problem-solving	14-21	8	.878
Affection	Innate motivation	22-26	5	.785
	Future oriented motivation	27-32	6	.825
	Self-efficacy	33-39	7	.867
Behavior	Helping	40-46	7	.839
	Physical environment management	47-51	5	.860
	Time management	52-58	7	.905
	Total		58	.970

3) Scientific problem-solving ability test

The scientific problem solving ability test used only 15 questions extracted by Huh (2006) with the help of a science education specialist (professor of science education) who translated PSI Form B developed by Heppner & Peterson (1982). The highest score in this test was behaviors and attitudes related to positive problem solving, and the reliability of the test items was Cronbach coefficient .840. 15 questions were composed of 5 questions about scientific problem solving confidence, scientific method practice, and scientific problem recognition. The test method was a self-report test with a 5-point Likert scale for middle school students.

2. Research procedure

This study was conducted during the fall semester of 2019, and the preliminary test was carried out on November 5, 2019. According to the results of the pre-test, the difference between the two groups was not statistically significant in self-directed learning and scientific problem solving between the experimental group and the control group (p>.05), so the experiment was conducted after identifying the homogeneity between the groups.

The purpose of this study is to identify the effects of Nature-Inspired Art Convergence class on the self-directed learning and scientific problem-solving ability of middle school students. Therefore, the experimental group participated in the Nature-Inspired Art Convergence class, and the control group attended a lecture-oriented class. The experiment was conducted 16 times, once a week, for 8 weeks with each session lasting 45 minutes. The program composition system including the procedures and contents of the Nature-Inspired Art Convergence class applied in this study is the same as shown in [Figure 1], <Table 2> and the teaching and learning process.

Purpose and goal	Purpose	Self-directed Learning and Scientific Problem-Solving Ability of Middle School Students through Nature-Inspired Art Convergence program	
	Goal	Understanding the definition of nature-inspired and recognizing the diversity of nature-inspired inquiry method, understanding the basic principles of nature-inspired, improving self-directed learning, and nature-inspired - Promoting scientific problem-solving ability through Nature-Inspired Art Convergence program	
Educational Contents	Nature-Inspired	Why are you trying to learn nature? Imitate nature. Appreciating the beauty of nature	
	Nature-Inspired Art Convergence	The photosynthesis principle of plants can solve the air pollution problem through imitation. Nature has simple materials and processes, and eco-friendly manufacturing methods that consider nature. Learn basic knowledge of clouds and learn scientific observation and artistic observation. Understanding the world climate and drawing it info graphically.	
Teaching-Learning method	Teaching Learning step	Brainstorming to increase interest in the subject Sharing prior experience in nature-inspired	Understanding and imitating nature
		Understanding and imitating nature	A Study on the science theory of nature-inspired A Study on the inventions of nature-inspired
		Appreciation of abstract art	Abstraction method is scientific principle of light and color
		Eco-friendly manufacturing	Nature is a simple material and process, and also thinking about nature
		Smart fashion resembling nature	I designed a natural dye
		Evaluation and finishing	Consulting on works made from natural simulation-art convergence themes. Evaluation of completed products discussion through a convening team

〔Figure 1〕 Composition of Nature-Inspired Art Convergence program

<Table 2> The Nature-Inspired Art Convergence program sample

Activity name	session	Instruction step	Program	Student's activity
Orientation	1	Brainstorming to raise interest in the subject	Why are they trying to learn from nature?	Theme network composition
Understanding and imitating nature	2	Learning from the photosynthesis of plant.	The photosynthesis principle of plants can solve the air pollution problem through imitation.	Photosynthetic experiment,chlorophyll extraction
Understanding and imitating Nature	3	What secrets does a person's fingerprint have?	Search for fingerprints on hands, check for other fingerprints on Friends	Fingerprint collaboration
Appreciation of abstract art	4	Mondrian, Kandinsky, Jackson Pollock Appreciation of the Secrets of Abstract Art	The abstraction is based on the scientific principles of light and color. We learn about abstraction.	Drawing of abstraction method imitating nature
Eco-friendly manufacturing	5	Why would he try to mimic the climate of nature?	Understanding the world climate and drawing it info graphically	Pictogram, infographic drawing
Smart fashion resembling nature	6	Is there a smart fashion that resembles nature?	Making my own fashion features with nature	Making natural dyed clothes, bags
Smart fashion resembling nature	7	Appreciating a beautiful cloud	We gain basic knowledge of clouds from scientific and artistic observation.	Clouds in famous paintings (Monet, Picasso)Clouds in the mountains (Cloud Generation Test)
Smart fashion resembling nature	8	Making my own light	The color that can be obtained from nature,Peacock LED	LED Tree-based recycling village decoration
		Evaluation and finishing	Consulting on works made from natural simulation-art convergence themes Evaluation of completed products discussion through a convening team	

3. Data processing

In this study, to verify the effects of the Nature-Inspired Art Convergence class, the homogeneity between the experimental and the control groups was confirmed by two independent group t-test using the pre-test scores. Effects of the experiment were compared by two independent groups t-test using the post-test scores. SPSS 21.0 program was used for statistical processing.

Ⅳ. Results

1. Effects of self-directed learning ability of middle school students

To identify whether Nature-Inspired Art Convergence class is effective in improving the self-directed learning ability (SDLA) of middle school students, two independent group t-tests were conducted with the average difference between the two groups using post-test scores after the experiment. The results are demonstrated in <Table 3>.

<TABLE 3> Comparison of SDLA: post-test

Sub-variable	Group	*N*	*M*	*SD*	*t*	*p*
Cognitive-thinking	Experiment	18	32.61	4.881	-9.124	.001
	Control	18	26.94	3.192		
Meta-cognition	Experiment	18	20.08	3.184	-5.896	.000
	Control	18	27.72	2.812		
Scientific problem-solving	Experiment	18	31.86	3.539	-7.289	.000
	Control	18	17.252	3.223		
Intrinsic motivation	Experiment	18	20.03	2.324	-8.315	.003
	Control	18	17.03	2.274		
Future-oriented motivation	Experiment	18	24.81	3.031	-6.485	.001
	Control	18	21.31	2.745		
Self-efficacy	Experiment	18	28.50	2.929	-8.650	.002
	Control	18	24.14	2.699		

Seeking help	Experiment	18	25.08	2.776	-6.893	.000
	Control	18	21.69	2.750		
Physical environment management	Experiment	18	20.78	2.404	-9.761	.003
	Control	18	17.33	2.354		
Time management	Experiment	18	24.17	4.292	-3.341	.002
	Control	18	22.25	2.710		
Total	Experiment	18	460.03	6.897	-14.068	.000
	Control	18	391.33	6.153		

As shown in <Table 3>, there was a statistically significant difference ($p<.05$) between the experimental group that participated in the Nature-Inspired Art Convergence class and the control group that received a lecture on nature. Specifically, the mean score of the experimental group students was high in all variables such as cognitive thinking, metacognition, scientific problem-solving ability, intrinsic motivation, future-oriented motivation, self-efficacy, seeking help, physical environment management, and time management, which are sub-variables of self-directed learning ability, and the difference between the groups was statistically significant at the level of $p<.01$, $p<.001$). These findings indicate that the Nature-Inspired Art Convergence class is a class that helps middle school students improve their self-directed learning ability. Middle school students were more interested in expressing their own thoughts or observing natural objects and natural phenomena than listening to lectures, and were more interested in expressing their contents artistically.

2. Effects of scientific problem-solving ability of middle school students

To identify whether Nature-Inspired Art Convergence class is effective in improving the scientific problem-solving ability of middle school students, two independent group t-tests were conducted by verifying the difference between the two groups using the post-test scores that were conducted after the experiment. The results are as follows:

<TABLE 4> scientific problem-solving ability: post-test

Sub-variable	Group	*N*	*M*	*SD*	*t*	*p*
science problem solving confidence	Experiment	18	20.33	2.191	-8.072	.000
	Control	18	16.67	2.138		
practice of scientific method	Experiment	18	19.64	2.602	-7.804	.000
	Control	18	15.83	2.307		
scientific problem recognition	Experiment	18	19.58	2.699	-9.473	.000
	Control	18	14.97	2.395		
Total	Experiment	18	119.11	11.23	-12.246	.000
	Control	18	94.94	9.77		

As shown in <Table 4>, the overall score of scientific problem-solving ability and the sub-variables of the experimental group that participated in the Nature-Inspired Art Convergence class was higher, and the difference in the average score between the two groups was statistically significant (p<.001). Problem-solving ability means the ability to solve problems by combining existing principles to form new principles. Therefore, the scientific problem-solving ability highlighted in this study is the ability to learn and apply the scientific principles of natural simulation and to identify solutions to problems in various new situations. And the program was organized based on the theory of nature, considering the interest of the learner in every class, and the scientific problem was solved through observation of natural objects, and the results were redefined and expressed. It is judged that these activities have improved students' scientific problem-solving ability.

Ⅴ. Discussion & Conclusion

Through this study, it was confirmed that the Convergence of science and art of nature-inspired can improve the learner's self-directed learning ability and scientific problem solving ability. In this process, students were able to exchange various ideas and related expertise, find scientific principles, and gain confidence in art expression, thereby

improving self-directed learning and scientific problem-solving abilities.

First, a Nature-Inspired Art Convergence education program improved the self-directed learning ability of middle school students. This is because the contents and themes of the program were selected based on the 2022 revised curriculum, and classes were organized so that students could be self-directed by utilizing teaching-learning methods through nature exploration, project learning, discussion, art design, and production. The nature-motivated art convergence education program provided a self-directed learning experience by creating works through team activities, inducing students' interest, and creating works to motivate middle school students. This is consistent with the findings of Maeda (2006) that education that combines science and art can maximize self-directed learning ability by allowing students to easily access scientific knowledge. In the study of Park & Son (2017) and H. J. Kim (2014), it was confirmed that students can plan, check, and evaluate their studies, which are effective virtues of learners. In addition, this is the same as the results of the study in which the learner recognizes his or her self-efficacy by determining the whole process with intrinsic motivation, as Kwag & Woo (2018) showed in previous studies on self-directed learning ability.

Second, the Nature-Inspired Art Convergence education program could improve the scientific problem solving ability of middle school students. This is because each class is planned and organized so that students can acquire basic knowledge about phenomena related to nature, observe nature, apply scientific principles, and produce results. The scientific theories on environment and energy and the activities to find scientific solutions to pending issues such as environmental pollution and energy conservation are consistent with previous studies that promote scientific problem-solving skills in real life (Im, 2012; Lee et al., 2011). It is also related to the research result that students improve their scientific problem solving ability by exchanging various ideas and related expertise through team activities and finding scientific principles and making them confident in art expression (Bredo, 2000; Kim, 2011; Korea Foundation for the Advancement of Science & Creativity, 2012).

Based on the results of this study, I would like to discuss the following.

First, it is necessary to refine the Nature-Inspired Art Convergence education program in school because it is difficult to reflect individual characteristics of learners by providing self-directed learning method centered on team activities tailored to the average

characteristics of learners. It is necessary to find a way to diversify the natural mimic art convergence education program in school education, to study the changes of learners in the process of program activities, and to reflect these individual characteristics in the the Nature-Inspired Art Convergence education program.

Second, in that it has a positive effect on self-directed learning ability and scientific problem solving, it is necessary to develop and provide textbooks and activities that enable them to do so. Through this, teachers will be able to cultivate self-directed learning and scientific problem-solving skills, which are core competencies to prepare for the future era, if they use them in various topics and activities in the field.

In the follow-up study, it is necessary to carry out a wide range of studies targeting schools and grades in various regions so that the program for each grade can be planned and systemized to confirm which grade is most effective. Therefore, it is necessary to conduct follow-up research considering various variables as well as self-directed learning and scientific problem-solving ability in order to prepare for the future age by expanding the area in the Ai curriculum as well as the middle school free grade class.

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