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POSSIBILITY OF IMPROVING COMPUTATIONAL THINKING THROUGH ACTIVITY BASED LEARNING STRATEGY FOR YOUNG CHILDREN

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ABSTRACT

As computational thinking is the basic ability for everyone has to learn, it is the essential preparation for future to educate young children with computational thinking. Activity-based learning strategies are a strategy to help cognitive growth of young children, and it can lead their learning effectively through specific manipulation activities and concrete expressions. Therefore, in this study, we selected a topic called 'Ladybug is going to find a way' that is familiar to young children and appropriate for learning computational thinking. Based on the an activity-based learning strategy for young children, the activity-based program for computational thinking is consisted through the game using ladybug toys, the robot ladybug and concrete expressive activities. The studies progressed with three young children who were 5 years old and nine young children who were 6 years old. As a result, young children who participated in the computational thinking learning program using an activity-based learning strategy learned the subject with high interest in the class, and we found that this class could help improve the young children's computational thinking.

Keywords: *Computational thinking, Activity based learning, Young children, Manipulation, Preschooler*

1. INTRODUCTION

Computational thinking is a fundamental thinking and skill that anyone can learn and use. It is not for making children computer engineers, but it is the core competencies needed by all the people [1]. There are several studies to guide the computational thinking for young children. TangibleK robotics program is a helpful for developing computational thinking for kindergarten children. As young children assemble wooden blocks, they can make robot move [2]. Portelance and Bers(2015) teach fundamental computational thinking concepts of young children using the Scratch Jr and present a technique for assessing the learning of computational thinking [3]. Activity based learning can be an appropriate learning method for young children as a way to teach computational thinking. For example, Bell, Witten, and Fellows(1988) introduced computer science to young children through off-line activities. He introduced computer science for young children through games and off-line activities for all ages [4]. Some unplugged activities can be an activity based learning. Activity-based learning strategies inspire young children to associate with their surroundings [5], and activities can help motivate them [6]. Activity-based teaching is to integrate some types of activity in the planned class, and this activity can range widely from real-life experiences to performing tasks [6]. Developmental cognitive theory that providing specific description to young children can enhance their study suggests the basis for the potential effects of activity-based teaching strategies [5,7,8]. Brunner(1964) states that children's cognitive processes are presented in three stages as they grow and the younger the children are the they depend on perceptual attributes [7]. Brunner(1964) said that when learners cannot get the meaning and understanding in higher levels of representation, they try to get it at lower levels of representation. Specifically, if young children have difficulty in understanding the symbolic explanation, providing a specific description

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expression can improve their understanding [5,7]. Also, according to Piaget's cognitive development theory, children who ages 2 to 7 are in the pre-operational stage and think self-centered [9]. Therefore, it is necessary for young children of this age to directly exercise through concrete objects and to experience directly from their own viewpoints, and this activity-based learning strategy can lead to effective learning of them.

In order to construct a computational thinking education program that is tailored to a learning strategy for young children, we first select a learning topic that can introduce young children to a computational thinking that is familiar in life, construct the topic according to the activity-based learning strategy, and select appropriate learning tools and teaching aids that match learning strategy. Therefore, in this study, a program for learning the computational thinking was constructed through this procedure. In the course of constructing the program, a part of the contents of the British textbooks were applied and modified. By applying this program to the 5, 6 year olds, we explored the possibility of improving interest in computing and computational thinking for young children.

2. LITERATURE REVIEW

2.1 Computational thinking

Although computational thinking is emerging as an important concern, there is little consensus on the definition of computational thinking as to what should be included in computational thinking [10, 11, 12, 13, 14].

Wing [1] says that computational thinking is about designing complex systems or solving difficult problems through abstraction and decompostion. Wing has proposed computing as a core competency that everyone should have, not simply repetitive technologies. Isbell et al. [15] used the term "computationalist thinking" to discuss the thinking of a computationlist. Isbell et al. Focused more on providing sevices, interfaces, and behaviors than finding answers, and wanted to add a modeling approach to phenomena to the discussion of wing. The ITEST Working Group[16] also notes that computational thinking involves thinking about defining and defining the basic ways of thinking in the digital age, and Bundy [17] points out that computational thinking influences almost all disciplines, including science and the humanities And García-Peñalvo [18] emphasized that computatinoal thinking is emphasized as an algorithmic approach to applying high-level abstraction and solving all sorts of problems.

Based on these various discussions, computational thinking is considered to be a basic idea which is, necessary for future age, and it is requisite to solve the problem that we face in everyday life.

2.2 Computational thinking for young children

As Wing's first definition of computational thinking, we can solve the problems that we face and design the system though computational thinking, and Computational thinking is the way to understand human behavior by using basic concepts of computing [1]. Computational thinking is a type of analytical thinking. It uses mathematical thinking, engineering thinking, and scientific thinking in the general way. Computational thinking is not only for computer scientists, but also for everyone[19]. The study of computational thinking makes it better for all students in the virtual and real world to make a concept of problems and analyze and solve them by selecting and applying proper strategies and tools [20]. Research has been conducted in a variety of ways to facilitate the development of computational thinking for young children. There have been studies showing that 4-year-olds children can understand basic computer programming concepts and can construct simple robots [2, 20, 21]. Bers(2010) tried to cultivate the computational thinking of young children through the process of arranging physical objects in a tangible language and connecting them to computers, rather than relying on pictures and words on the computer screen[2]. Also, using educational robots letting young children predict where the small robots will go and move the robots, it can present interesting problems for young children. Educational robots can also be used for young children. It can be presented interesting problems for young children by allowing young children to predict where the small robots will go and to move the robots. A series of processes that determine what commands to give the robot are introduced as “concrete programming” [22].

2.3 Curriculum Of Computational Thinking For Young Children

According to K-12 Standards, the part of computational thinking consists of problem solving, algorithms, data representation, modeling and simulation, abstraction, and connections to other

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fields. In level 1, students is required be able to use technology resources to solve problems appropriate to their age, to use writing tools and drawing tools, and to show how 1 and 0 can be used to express information [23].

In the United Kingdom, compulsory computing education is mandatory from the age of 5-16 [24,25], and at Key Stage 1, which is the fifth generation of UK computing textbooks, the educational goals are to know what algorithms are, to understand how program execute and to produce simple programs, to predict the execution of simple programs through inference, to use techniques to create, organize, edit, and search digital content, and to understand the use of information technology outside the school [26]. Code.org introduces the term 'algorithm' in Process 1, which is recommended for 4-6 year-old children, and allows children to present a set of directions to reach their goals. Unplugged activities and a set of programming activities provided by code.org are used in combination. The course also introduces sequencing, debugging, a single loops, and events [27].

2.4 Activity based learning strategies

Activity-based learning strategies are learning approaches that inspire students to interact physically with objects related to learning [13]. Activity-based learning strategies can be applied to language, mathematics, and science [5]. For example, you can use a manipulator that calculates money to calculate the amount of money, and Activity-based learning strategies can also be applied in experiments that test the effects of various materials related to objects submerged in water [28].

The use of Manipulation has long been recognized as necessary, enabling students to learn more easily by using manipulators to convey information, using materials to activate real knowledge, and enhancing memory through physical activity [29]. The study of activity-based learning strategies for young children found that it can improve students' listening and reading comprehension. Through activity-based learning strategies, children's recall was more effective through listening strategies [5]. In mathematics, activity-based learning strategies were appropriate for early elementary-age children, albeit through older studies [28]. In addition, activity-based learning strategies for specific probability concepts were more effective than traditional learning methods [30]. In the study of using meta-analysis, manipulation strategies help students achieve their assignments better in science [31]. As a result, activity-based learning strategies, which will contribute to the student achievement, will be possible in the areas of language, mathematics, and science.

Since computational thinking, mathematics, and scientific thinking are interrelated, activity-based learning strategies they are expected to be useful in computational thinking learning, and related research is needed.

3. COMPUTING LESSON PROGRAM USING ACTIVITY BASED LEARNING

3.1 Computing Lesson Program Development Procedure

In order to develop a computational thinking education program, first, appropriate learning topics should be selected to introduce computational thinking, and second, proper teaching and learning strategies to teach the subject should be selected and appropriate learning tools should be selected [32]. Since the activity-based learning strategy was selected first, this program selects the topics that are suitable for the activity-based learning strategy among the learning topics that can teach the computational thinking. After that, we construct the selected topics according to the activity-based learning strategies and selected tools and teaching aids.

3.2 Selecting a learning topic

In this study, 'Find to go to the Way' was selected as a learning topic suitable for activity based learning strategy and introducing computational thinking. At code.org, the 'Flurbs' character finds the fruit in the first unit 'Happy Maps' from 'Course 1', which is recommended for 4-6 year olds [33], and Bee-Bot finds the treasure in Key Stage 1, unit 1.1 of the UK curriculum [26]. In order to solve the problem of 'Finding the way', it is possible to show the process of going to the destination by dividing the step by step using the directions such as right, left, up and down. In this process, young children have algorithmic thinking that they figure out a series of steps to solve the problem. Also, the process of symbolizing right, left, up, and down instructions through consensus with young children may also lead to young children's abstract thinking limitedly. Above all, 'Fining the way' is a learning topic suitable for

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'Activity-based Learning Strategy' as a learning topic that is easy for young children to directly experience activities that are closely related to the daily life experiences of them.

3.3 Activity Based Learning Strategy

As a strategy for activity-based learning in designing a computing lesson for young children, we tried to construct direct activities through concrete and activities that directly experience from their own viewpoints. First, for direct activity through concrete, we selected ladybugs, one of the interesting insects of young children, provided insect toys and construct games using insect toys. In addition, we applied the contents of unit 1.1 'We are treasure hunter' in the UK Computing Curriculum Key Stage 1. We programed the NXT instead of using Bee-bot in unit 1.1 and decorated them with ladybugs. NXT is larger than Bee-bot. And it has the advantage of using other programming in any other way. Second, for the activity to directly experience from the viewpoint of oneself, we applied the contents of unit 1.1 'We are treasure hunters' in Key Stage 1 of the UK curriculum. We tried to improve the effect of learning through the activity that young children become a ladybug and find food themselves.

3.4 Contents Of Program

In order to increase the interest of children on the theme of 'Finding the way', we organized a program called "Ladybugs searching for a way" by choosing "Ladybugs" among the insects that children are interested in. Part of the program composition was applied, and modified the content of unit 1.1 'We are treasure hunters' in Key Stage 1 of UK computing course.

In the first lesson, we prepared boards and little ladybug and aphid's toys. Children played the rock-paper-scissors and let the ladybugs hold fast to eat the aphids toy. In the second lesson, children let their friends know where to go to eat food by telling 'right', 'left', 'forward'. The three periods were agreed with symbols indicating the activity. Children do activity to write down signs of the way that a ladybug catches aphids, and they move ladybugs NXT robot as they wrote symbols. In the fourth lesson, children indicated by the symbol to catch a brief glow aphids and they actually moves the Ladybugs NXT robot using the symbols that they wrote down before. In the fifth lesson, children programed the NXT robot ladybugs to eat the aphids avoiding the predators from catching them by pressing buttons and manipulating NXT robot directly.

4. MATERIALS AND METHODS

4.1 Research Questions

The study investigates the following research question: 1) Are preschool children capable of computational thinking with computing lesson through activity-based learning strategies? 2) Are preschool children enhanced in interest in computing with computing lesson through activity-based learning strategies?

4.2 Participants

12 kindergarten children (eight girls and four boys) who were 5 and 6 years old participated in the study. Two 5-year-old females, one 5-year-old male, six 6-year-old females and three 6-year-old males participated, and the average age was 6 years and a month. It was performed in 5 classes for 5 weeks. Every lesson was progressed for 50 minutes.

4.3 The Lesson Environment

The lesson was in the regular classroom without a computer, children were provided with desks and chairs in order to let the children perform the activity sitting down. In addition, there was a space where all children could sit down and listen to stories, and to play activities and games.

5. RESULTS

5.1 The Interest In Computing

When we surveyed young children's interest in computing in a three-point scale, the result is as table 1. The whole positive answers appeared to be 88.3%, usually 8.3%, negative answers are found to be 3.3%. Through open-ended questions, the most common opinion is that programming their own commands to the robot ladybugs was the most interesting part. Young children were also interested in ladybug toys in ladybug board games, and when one ladybug and one aphid toy were distributed to young children, they were happy to touch and move the toys by themselves.

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Table 1: The interest in computing

Questions	No	Usually	Yes	Total (persons)
Can you input algorithm ?			12 (100)	12
Can you make algorithm ?		1 (8.3)	11 (91.6)	12
Do you want to join the lesson again?		2 (16.6)	10 (83.3)	12
Did you enjoy studying?	2 (16.6)	1 (8.3)	9 (75.0)	12
Do you want to try a different study associated with it?		1 (8.3)	11 (91.6)	12
	2 (3.3)	3 (8.3)	53 (88.3)	60 (100)

They were also very interested in seeing the NXT ladybug moving by pushing its button as they thought, and they liked to manipulate the NXT ladybug in their team activities. At first, the young children who was in charge of the robot in her own activities was unfamiliar with walking depending on her friend's words, but was delighted to finally arrive at the place where the food was.

5.2 Computational thinking

As a result of observing the appearance of young children in classes, when they are at each step of the process, some of them can do themselves, others were performed with the help of a teacher. Evaluation of the entire activity was used to translate the assessment presented in unit 1.1 of the UK Computing textbooks Key Stage 1. For providing a more fundamental data, we observed the children who attend classes and described what they performed. It was difficult for the children to understand the meaning of programing, but they could perform a given instruction from their point of view. In addition, whenever children who were difficult to distinguish between right and left, when making algorithms, they asked which is right, and which is left. However, children took positive attitude to enter the algorithm to the robot ladybugs. Although some children who did not do very well in the first class, were observed to be successful in the next attempt.

Table 2: Self-evaluation after class

Questions	No	Usually	Yes	Total (persons)
I can follow the command.	1 (8.3)		11 (91.6)	12
I can write command.		1 (8.3)	11 (91.6)	12
I can move the ladybug by command.		1 (8.3)	11 (91.6)	12
I can tell my friends about the command.		4 (33.3)	8 (66.6)	12

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I know what the inputs are and how to program them and what the output is.	5 (41.6)	1 (8.3)	6 (50.0)	12
I can say, for example, what the input, the program, and the output are.	4 (33.3)	1 (8.3)	7 (58.3)	12
I can create programs		3 (25.0)	9 (75.0)	12
I can fix mistakes in the program.	2 (16.6)	2 (16.6)	8 (66.6)	12
After entering the command, I can see where the ladybug will go.	1 (8.3)	1 (8.3)	10 (83.3)	12
I can find a way to program the ladybug to work well.	1 (8.3)		11 (91.6)	12
	14 (11.6)	14 (11.6)	92 (76.6)	120 (100)

When playing a board game with ladybug toys, the ladybug is moved by hand toward the destination of young children's choice, moving their way to capture aphids in a single step. Being asked 'How do you go about eating aphids quickly?' And Sohi painted a way to go with her fingers while she was going, and she thought about the question "Is there a faster way?" In the activity of placing the obstacles on the way to find aphids, and directly entering the up, down, left, and right as a sequence of NXT ladybugs, Minwoo enters command to NXT ladybug with his command arrow shapes. He did not get to where he wanted to be at first attempt, but after several attempts, he was able to get to where he wanted to go.

6. DISCUSSION

In this study, we have constructed a computing class based on activity-based learning strategies that directly interact with concrete objects and experiences from the perspective of young children who are more dependent on perceptual thinking. In addition, three 5-year-old and 6-9 young children were taught. Appropriate objects lead to the young children's interest, and specific manipulation activities help with their thinking. Also, by acting as a robot by themselves, they get the chance to experience and think of problems at their own disposal, not at the other aspects. And children learned algorithms and algorithmic thinking and abstract thinking with this progress. In first periods, children think how to get to their destination and manipulative materials by hand and think algorithmic thinking through ladybug game. In second periods, children move themselves, and expressed the orderly steps of the body. In third periods, children make their symbols to express, to simplify the language, and to simply manipulate the NXT ladybug robot. In fourth and fifth periods, we provided an opportunity for algorithm thinking through progressing that should a ladybug go to any path to symbolize a way to avoid the enemies, to your destination in order and enter the algorithm ladybug robot. After the lessons, a positive reaction in computing of the children appeared to be 88.3%, "I can do it" in self-evaluation of the activities appeared to be 76.6%. As the results of the observations we found that the children were in different levels of ability in study and performance of the tasks. And it did not have a problem with the performance of all children in the games and activities, but some children have difficulties in writing down algorithm process with language and symbol. However, when children connect it to the input of the robot

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activity, they seemed to enjoy the process, and to symbol them.

Therefore, in this study, it was confirmed that young children were very interested in computing lessons constructed through an activity-based learning strategy and gave high scores in self-evaluation.

7. CONCLUSION

If we agree that computational thinking is the basic skill necessary for everyday life, the education of computational thinking for young children is needed to be universalized like language education, mathematics education and science education for young children. Education of computational thinking using an activity-based learning strategy can be a good alternative for this. The education of computational thinking using the activity-based learning strategy has the following advantages. First, it provides young children with direct experiences through concrete materials, so that the contents necessary for computing education can be presented according to the developmental level of young children. Second, it can provide more concrete and solid learning through the activities in the young children's point of view. Third, by helping young children to directly touch and manipulate and expand their thoughts, it can induce interest and positive response to young children and provide a sense of accomplishment through direct manipulation. In effect, although a case study, the answers of question investigation of the young children showed a high degree of interest and achievement, and it was observed that the young children, who was not good at the first time in manipulating the object, gradually improved in the next attempt and the next.

Therefore, noting that computational thinking is the core skill in life, constructing a computing program based on an activity-based learning strategy using topics related to computing thinking can be effective in expanding interest and improving computational thinking.

8. LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

This study is a case study, and a study involving more young children will be needed in future studies. We suggest that future research consider the following points. First, it is necessary to develop various program contents using an activity-based learning strategy. In other words, it is necessary to study about specific objects (useful robots, board games, etc.) suitable for children's developmental stages and to study specific programs that children use specific objects in. Second, it is necessary to develop a program that meets the characteristics of young children and is linked to the program of the next age. Designing a teacher program for this is also required. Third, it is necessary to design a specific evaluation plan suitable for the characteristics of young children, and more detailed observation and research on the activities of young children are needed. These researches using an activity-based learning strategy for young children will be able to provide a more beneficial program for young children. Also It is expected to make various studies to improve computational thinking and interest in computing.

REFRENCES:

[1] Wing, J. M., "Computational thinking", *Communications of the ACM*, Vol. 49, No. 3, 2006, pp. 33-35.

[2] Bers, M. U., "The TangibleK Robotics program: Applied computational thinking for young children", *Early Childhood Research and Practice*, Vol. 12, No. 2, 2010, pp. 1-19.

[3] Portelance, D. J., and Bers, M. U., "Code and Tell: Assessing Young Children's Learning of Computational Thinking Using Peer Video Interviews with ScratchJr", *Proceedings of the14th International Conference on Interaction Design and Children*, 2015, pp. 271-274.

[4] Bell, T. C., Witten, I. H., and Fellows, M. R., "Computer Science Unplugged: Off-line activities and games for all ages", 1998, Computer Science Unplugged.

[5] Biazak, J. E., Marley, S. C., and Levin, J. R., "Does an activity-based learning strategy improve preschool children's memory for narrative passages?", *Early Childhood Research Quarterly*,Vol 25, No. 4, 2010, pp. 515-526.

[6] Suydam, M. N., and Higgins, J. L. "Activity-Based Learning in Elementary School Mathematics: Recommendations from Research", 1977.

[7] Bruner, J. S., "The course of cognitive growth", American psychologist, Vol 19, No 1, 1964, pp. 1-15.

[8] Piaget, J., "Play, dreams, and imitation in childhood", New York: Norton, 1962.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[9] Ginsburg, H. P., and Opper, S., "Piaget's Theory of Intellectual Development", Englewood Cliffs, N.J.: Prentice-Hall, 1998.

[10] Allan, W., Coulter, B., Denner, J., Erickson, J., Lee, I., Malyn-Smith, J., and Martin, F., "Computational thinking for youth", *White Paper for the ITEST Small Working Group on Computational Thinking (CT)*, 2010.

[11] Barr, V., and Stephenson, C., "Bringing computational thinking to K-12: What is involved and what is the role of the computer science education community?", *ACM Inroads*, Vol. 2, No. 1, 2011, pp. 48- 54.

[12] Brennan, K., and Resnick, M., "New frameworks for studying and assessing the development of computational thinking", *In Proceedings of the 2012 annual meeting of the American Educational Research Association*, Vancouver, Canada, 2012, pp. 1-25.

[13] Gouws, L. A., Bradshaw, K., and Wentworth, P., "Computational thinking in educational activities: An evaluation of the educational game light-bot", *In Proceedings of the 18th ACM conference on Innovation and technology in computer science education*, ACM, 2013, pp. 10-15.

[14] National Academies of Science, "Report of a workshop on the scope and nature of computational thinking", Washington DC: National Academies Press, 2010.

[15] Isbell, C. L., Stein, L. A., Cutler, R., Forbes, J., Fraser, L., Impagliazzo, J., Proulx, V., Russ, S., Thomas, R., and Xu, Y., "(Re) defining computing curricula by (re) defining computing". ACM SIGCSE Bulletin, Vol. 41, No. 4, 2010, pp. 195-207.

[16] Allan, W., Coulter, B., Denner, J., Erickson, J., Lee, I., Malyn-Smith, J., and Martin, F., "Computational Thinking for Youth", Technical report, Education Development Center, 2010.

[17] Bundy, A., "Computational thinking is pervasive", *journal of scientific and practical computing, noted reviews*, Vol. 1, No. 2, 2007, pp. 67-69.

[18] García-Peñalvo, F. J., "What computational thinking is", 2016.

[19] Wing, J. M., "Computational thinking and thinking about computing", *Philosophical transactions of the royal society of London A: mathematical, physical and engineering sciences,* Vol. 366. No. 1881, 2008, pp. 3717-3725.

[20] Bers, M. U., Ponte, I., Juelich, C., Viera, A., and Schenker, J., "Teachers as designers: Integrating robotics in early childhood education", *Information technology in childhood education annual*, Vol. 2002, No. 1, 2002, pp. 123-145.

[21] Cejka, E., Rogers, C., and Portsmore, M., "Kindergarten robotics: Using robotics to motivate math, science, and engineering literacy in elementary school", *International Journal of Engineering Education*, Vol. 22, No. 4, 2006, pp. 711-722.

[22] Mannila, L., Dagiene, V., Demo, B., Grgurina, N., Mirolo, C., Rolandsson, L., and Settle, A., "Computational thinking in K-9 education", *In Proceedings of the working group reports of the 2014 on innovation & technology in computer science education conference*, 2014, pp. 1-29.

[23] International Society for Technology in Education & Computer Science Teachers Association, "CSTA K-12 Computer Science Standards Revised 2011", 2011.

[24] Cetin, I. "Preservice Teachers' Introduction to Computing: Exploring Utilization of Scratch", *Journal of Educational Computing Research*, Vol. 54, No. 7, 2016, pp. 997-1021.

[25] Department for Education, "National curriculum in England: Framework for key stages 1 to 4", Retrieved from, 2013.

[26] Naace, Havering education service, and Computing At School, "Switched on Computing Year1", Rising Star UK Ltd, 2014.

[27] Course 1 , Available :< https://studio.code.org/s/course1>, (Accessed: 15-Feb-2017).

[28] John Hattie and Eric M. Anderman, "International guide to student achievement (educational psychology handbook)", Routledge, 2012

[29] McNeil, N., and Linda J., "When theories don't add up: disentangling he manipulatives debate", *Theory into Practice* Vol. 46, No. 4, 2007, pp. 309-316.

[30] Gürbüz, R., "The effect of activity-based instruction on conceptual development of seventh grade students in probability", *International Journal of Mathematical Education in Science and Technology*, Vol. 41, No. 6, 2010, pp. 743-767.

[31] Schroeder, C. M., Scott, T. P., Tolson, H., Huang, T. Y., and Lee, Y. H., "A meta□analysis of national research: Effects of teaching strategies on student achievement in

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

science in the United States", *Journal of research in science teaching*, Vol. 44, No. 10, 2007, pp. 1436-1460.

[32] Korea foundation for the advancement of science & Creativity, "Research for introducing Computational Thinking into primary and secondary education", 2014.

[33] Unplugged happy maps, Available :< https://code.org/curriculum/course1/1/Teacher >, (Accessed: 17-Feb-2017).