International Journal of Computer Trends and Technology
ISSN: 2231 – 2803 / https://doi.org/10.14445/22312803/IJCTT-V69I1P103

Volume 69 Issue 1, 13-17, January 2021

Review Article

A Study on the Strengthening Method of SW Education Capacity for Pre-elementary School Teachers

Pyung Kim

Dept. of Computer Education, Jeonju National University of Education
50 Seohak-ro, Wansan-gu, Jeonju-si, Jeonbuk, Korea

Received Date: 14 November 2020
Revised Date: 31 December 2020
Accepted Date: 01 January 2021

Abstract *- As AI technology develops, services using artificial intelligence have been developed in various fields and applied to society. Therefore, the education field also needs to improve the curriculum for SW education and AI education and strengthen the SW education capacity through teacher training programs. While SW education was planned and has been operated as a regular subject in elementary, middle, and high school from 2018 in Korea, the curriculum is improved, and training programs are operated for strengthening SW education of teacher trainees and the SW education capacity of incumbent teachers. This study analyses the result of SW contests for the latest 5 years to determine the SW development capability of the elementary school teacher trainees, and conducted a group discussion for planning curriculum improvement by the teachers to make a plan for strengthening the capacity for SW education in elementary school. This study can be used to design curriculums to suggest a direction for the SW development capability of elementary school teacher trainees and the user connected to subjects and enhance creative problem-solving capacity to strengthen elementary school teacher trainees' SW education capacity.*

Keywords *- SW Education, SW Education Strategy, SW Education Capacity, SW Education for Elementary School Teacher Trainees*

I. INTRODUCTION

Korea organized a curriculum revised in 2015 to include SW education for more than 17 hours in Practical Arts for 5th and 6th graders in elementary school. It changed the subject of Information from an elective to a compulsory subject in middle school. The subject of Information in high school changed from an advanced elective to a general elective in high school. The Ministry of Science and Technology specified leading SW schools or central SW education universities to strengthen SW education [1]. Recently, while AI education needs are on the rise, education infrastructure and curriculum development have been studied for artificial intelligence education in elementary, middle, and high school courses. For SW education, curriculums are improved to strengthen teacher trainees' education capacity focusing on national universities of education for the elementary school course, and colleges of education for the middle and high school courses and various SW education training programs are operated for elementary school teachers.

SW education in elementary school and middle school aims to cultivate human resources equipped with problem-solving capacity through computer-based thinking and help students who can do creative, logical problem-solving in the future society. Computer-based thinking refers to logical and creative thinking in defining, dividing problems, making them abstract, and finding logical solutions.

While AI technology develops and AI technology is applied to various services, society and technology are rapidly changing, and the capability of developing and using AI technology is important. An effort has continued to train AI human resources by developing and adapting curriculum programs for AI education in education. To be brief, as AI technology is the center of our daily life and workplaces, our life is changing in all aspects, and it is thus required to enhance students' capacity to understand how to use AI technology. Recently, the Korean government recognized the significance of artificial intelligence and announced the direction of artificial intelligence education policy and key projects for cultivating human resources required in the era of artificial intelligence [2].

Jeonju National University of Education encourages its juniors to join an educational SW development contest held once every year to enhance the SW development capability of elementary school teacher trainees and make a plan connecting SW to subject education. In this study, the results of educational SW development contests for the latest 5 years were analyzed to examine the educational SW education capacity of elementary school teacher trainees. Furthermore, opinions about improving the

curriculum for enhancing the SW capacity were collected from 5 elementary school teachers who experienced the SW curriculum in Jeonju National University of Education through a group discussion. This was used to decide the SW education capacity of elementary school teacher trainees and suggest a strategy for improving the curriculum to enhance the SW education capacity.

Chapter 2 of this study describes SW curriculum design and SW education-related studies of elementary school teacher trainees; Chapter 3 analyses the result of educational SW development; Chapter 4 examines the educational SW contest process and the result of contest results for the latest 5 years; Chapter 5 suggests strategies for improving the SW curriculum and strengthening the capacity through FGI for elementary school teachers, and Chapter 6 describes future studies and conclusion.

II. RELATED STUDIES

An effort should be made to strengthen the programming capacity of the elementary school teacher trainees who will be responsible for the SW education of elementary school students. The SW curriculum run in most Korean universities of education includes Computational Thinking, Unplugged Education, Educational Programming Language, and Computer Education Methodology. Valerie Bar et al. define CT Concept and Capability for the subjects of CS, math, science, social studies, and language arts and suggest a strategy for introducing computational thinking into the K-12 course [3]. The strategies for enhancing the capacity of elementary school teacher trainees for SW education include the extension of educational contents focusing rather a on subject pedagogy than pedagogical contents in the specialty course; strengthening programming education focusing on educational programming language, for example, Entry, to facilitate connection to the elementary school curriculum in the advanced course; and strengthening subject selection of students by reducing compulsory subjects and extending electives in the advanced course [4].

In the study for strengthening the SW capacity of elementary school teachers [5], a suggestion was made by examining the correlation between the level of SW education knowledge of teachers and education categories for successful SW education in elementary school. An educational model study [6] was made by analyzing the curriculum of the Department of Information in Korea and other countries to extract the key concept and associated concept, and restructure the content system and apply the result to the 3rd and 4th grader group and the 5th and 6th grader group of elementary school.

III. EDUCATIONAL SW CONTEST

In the curriculum of the university of education, SW development education is run as an advanced course, having various curriculums, for example, education for using programming language, algorithm, databases, and robots, using smart devices, an analysis of educational teaching materials, and textbooks, and teaching focuses on the curriculum for teacher training. Therefore, low SW development capacity is inevitable in comparison with the special education curriculum of other universities. However, various contents have been developed and used to strengthen the SW capacity as SW education. AI education is recently strengthened, and SW education capacity is strengthened through programs other than the curriculum.

The students of the department of Educational Computer Education in Jeonju National University of Education develop educational SW that can be used for subject education through a software contest, have the presentation and receive user's feedback for the development result through an SW exhibition to write their thesis including the contents for improving it. One team comprises 1 or 2 members for the SW contest, and students can freely select their program development environment, target grades, and strategies connected to subject education. This Chapter describes the software contest process and results of the analyzed software contest from 2016 to 2020.

A. Process of Educational SW Contest

The juniors majoring in computer education in Jeonju National University of Education start to prepare for the SW contest in March every year, go through the steps shown in Fig. 1, complete SW development in September and October, and hold an exhibition in November to finish their thesis in May next year. Designing and developing a piece of educational SW takes about 6 to 7 months. Students present their work twice or 3 times during this period to have their professor's feedback reflected in their SW development.

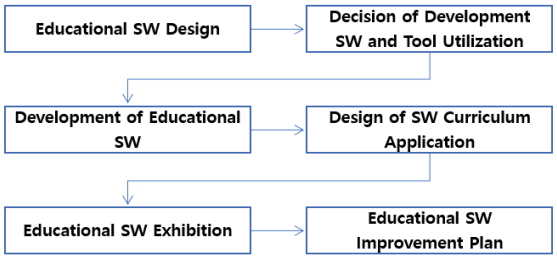

Fig. 1 Steps of educational SW development

Fig. 1 shows the 6 steps of preparing for the software contest, and details are described below.

- Design educational SW: designing SW development goals, development themes, and a storyboard for the service (first feedback through planned presentation).
- Design strategies for developing SW and using tools: reviewing and deciding SW development language and functionality of development tools.
- Develop educational SW program: developing a piece of educational SW to complete connection of designed functions to contents (second feedback through development presentation).
- Design SW curriculum: the step of writing details of teaching about SW education and subject

convergence through teaching design plan corresponding to 5th class.
- Educational SW exhibition: demonstrating developed educational SW to have feedback (3rd feedback for the final program).
- Establish a strategy for improving educational SW establishing strategies for improving and using the SW based on the feedback.

B. Analysis of Educational SW Contest Result

A total of 70 pieces of SW was obtained from the educational SW contests for the latest 5 years, and 12 to 15 pieces were submitted every year. Fig. 2 shows classified target subjects of educational SW, and each legend shows subjects, cases, and percentages to which the SW was applied, respectively.

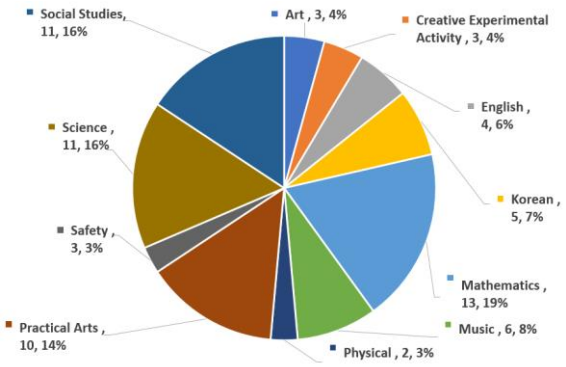

Fig. 2 Steps of SW Programming Education

About the target subjects of developed SW, 13 cases (19%) were for math, followed by 11 cases (16%) for science, 11 cases (16%) for social studies, and 10 cases (14%) for practical arts. For creative, experimental activities, 4 cases were developed to have computers, environmental protection, and safety education. Educational SW was also developed for 11 fine arts subjects, practical arts, physical education, Korean, math, and English. SW application for each subject is illustrated in Table 1 below.

Table 1. Strategy for integrating SW with each subject

Subject	SW application case
Math	Educational contents for mathematical principles using programs, principle application strategies through games, activities using figures and graphs, finding rules, and computation.
Science	Educational contents for principles about scientific phenomena, experiments, and activities using robots, changes by steps.
Social studies	Contents for apps or activities to connect history, maps, and locations to explain them through games or historical locations and events to apps or activities.
Practical arts	Contents for activities using physical computi technology to support activities experienced actual life, e.g., diet or growing plants.
English, Korean	Language education contents supporting storytelling-based English speaking or creation.
Music, Arts, Physical education	Contents support creative activities based on the principle of music, fine arts, physical education, the principle, and physical computing.
Others	Educational contents for safety education, environmental education and SW education, and activities.

Educational SW suggests content for application to subject education and helping students understand and learn the concept through activities or games. Among 70 cases, 24 cases (34%) were developed to suggest contents for effectively delivering the contents, and the remaining 46 cases (66%) to proceed the process of helping understanding and use along with delivering the contents through activities grams after delivering the contents. Most educational program SW was designed to inspire elementary school students to be interested in the subjects and facilitate their understanding.

Table 2. Types and characteristics of EPL

Year	Learning Method				School Grade			
	Activity	Game	Content	Total	1~2	3~4	5~6	Total
2016	6	7	2	15	3	0	12	15
2017	12	2	1	15	1	5	9	15
2018	5	4	5	14	2	0	12	14
2019	1	1	10	12	1	2	9	12
2020	6	2	6	14	0	8	6	14
Total	30	16	24	70	7	15	48	70

The target grades of educational SW include 7 cases (10%) for the 1st and 2nd graders, 15 cases (21%) for the 3rd and 4th graders, and 48 cases (69%) for the 5th and 6th graders. It is seen that the SW was developed rather for the 5th and 6th graders who learn computer education as a regular subject in their practical arts course than the 1st and 2nd graders who are not used to using computers or smartphone because computers, smartphone, and robots are generally used for the subject.

The development tools used for SW development include SW coding tools, app development tools, robot coding tools, game development tools, and contents editing tools. General development language includes Entry and Scratch, the block programming language, RPG Maker for game development, and Appinvento.

Most used SW teaching aids include Lego EV3, followed by Hamster Robot and Arduino. It was revealed that developing SW operating in the activity, game, and app environment was slightly more difficult than creating content.

IV. STRATEGY FOR STRENGTHENING SW CAPACITY OF ELEMENTARY SCHOOL TEACHER TRAINEES

Five elementary school teachers who completed the advanced course of computer education in the university of education joined a group discussion to collect opinions about a strategy for improving the SW curriculum to

improve the SW curriculum of the University of Education for elementary school teacher trainees.

Contents for improving the curriculum were created, focusing on the SW education capacity required for conducting SW education in the practical part for the 5th and 6th graders in elementary school. After dividing the curriculum into basics and advanced for SW education, the SW education basics were divided into block programming, algorithm basics, physical computing basics, and basics for using computers. The advanced SW education was composed of a strategy for using SW in connection with subjects and a strategy for increasing education connected with the configuration of storytelling-based contents and various teaching aids.

Table 3. SW curriculum of Jeonju University of Education

Category	Subject
ICT	Basic computer principle, using ICT, production of multimedia, searching Internet and information, using smart devices, information and communication ethics
EPL	Block programming, Python
Robot	NeoBot, Lego EV3
Computer theory	Computer algorithm, data structure, database, computer network

The opinions collected through the group discussion for improving the SW curriculum are described below.

- Configuration of the curriculum for enhancing SW education capacity, including contents suggested in textbooks for the 5th and 6th graders in elementary school, is required to use procedural thinking and Nanobot.
- A curriculum is required to describe the educational infrastructure for artificial intelligence education following artificial intelligence education, education using artificial intelligence services, and understanding and using artificial intelligence technology.
- It is necessary to strengthen the classes using teaching aids to enhance SW education and converge education by using various teaching aids.
- It is necessary to suggest a strategy for connection to other subjects and a strategy for strengthening teacher's education capacity by sharing SW converged education cases and cases of desired SW education classes.
- It is necessary to suggest a strategy for analyzing educational contents and teaching aids used in SW education and increasing education.
- Education is required to suggest and evaluate classes' goals, for example, teaching plans for SW education, goals in classes, design of contents of classes, and class evaluation.

Students should know the necessity of SW education, the method for SW education, and the method for designing and evaluating classes with reference to converged SW education cases.

It is necessary to understand the algorithm principle of concatenation, selection, and repetition through unplugged classes considering the education environment and have various experiences about the basic principle and procedural thinking of computer science. Programming language education requires teaching to find more efficient ways to convert the unplugged activity to a computer language that can understand and divide problems and solve the problems in a logical resolution way. It is necessary to strengthen SW education capacity while designing various ways of converged education through verification of effectiveness in the class design and SW convergence process in SW convergence classes.

V. CONCLUSION

SW education aims to help the student understand the basic principle and concept of SW and solve various problems logically and creatively. Students can learn the basic concept of programming and logical thinking through experiences and play in the class of SW education in elementary school. In middle school, students can further understand the basic concept and principle of SW in defining, decomposing, and concatenating problems step by step in their real life. In high school, the required education is to solve problems creatively and efficiently connected to learning in various fields and other subjects related to their future career.

Recently, AI used in various ways across society is changing the pattern of acquiring, analyzing, using, and consuming information. As a result, basic training and education are required to understand and use AI technology in elementary, middle, and high school. Elementary school teacher trainees should strengthen their capacity for SW education and be equipped with AI education capacity. While universities of education have improved their curriculum and adapt programs and the curriculum to gradually strengthen SW education for elementary school teacher trainees, more time for the curriculum is required, and flexible response to the rapidly changing education environment is limited.

This study decides the SW development capability of elementary school teacher trainees, designs a strategy for connecting SW to other subjects and suggests a strategy for improving the curriculum to strengthen elementary school teacher trainees' SW capacity. To this end, an analysis was made of the result of educational SW contests for the latest 5 years while the contest is held once every year for the students majoring in computer education in the universities of education. An examination was made of target subjects, themes, development tools, and functions of educational SW. An analysis was made of the SW development capacity and the current SW convergence education. In a group discussion with the elementary school teachers, improving the SW curriculum required in the elementary school education environment was suggested for the teacher trainees in the universities of education. This study includes the strategy for designing and evaluating classes applied to the actual elementary

education environment, the computer theory focusing on the effect of SW convergence education, a necessity for computer education and improved understanding of the principle of computers, unplugged computing, programming language, SW convergence education, and curriculums.

This study can be used to examine the current SW development capability of elementary school teacher trainees and connection to other subject education and improve the curriculum for strengthening SW education capacity.

ACKNOWLEDGMENT

This work was supported by the cost of education, research, and student guidance at Jeonju National University of Education in 2019.

REFERENCE

[1] H. Jo, Analysis of Elementary Pre-service Teachers' Experiences and Understanding of Software Education, Journal of The Korean Association of Information Education, 22(1)(2018), 81-89.

[2] Ministry of Education Education Policy Direction and Core Tasks in the Age of Artificial Intelligence. (2020).

[3] M. Binkley, O. Erstad, J. Herman, S. Raizen, M. Ripley, Miller-Ricci, M. Rumble, Defining twenty-first-century skills, Assessment, and teaching of 21st-century skills, Springer Netherlands, (2016) 17-66.

[4] C. Kim, Needs of Improving the Curriculum of the National University of Education for Strengthening SW Education, Journal of The Korean Association of Information Education, 23(1) (2019) 1-8,

[5] Y. S. Jung, K.S. Kim, I. K. Jeong, H.B. Kim, C. Kim, J, S, Yu, C, W, Kim, M. H. Hong, A Development of the Software Education Curriculum Model for Elementary Students, Journal of The Korean Association of Information Education .,19(4)(2015) 467-480.

[6] Y. H. Sung, N, J, Park, A Study of the Direction for Developing KAIE Computing System Curriculum in Elementary Education, Journal of The Korean Association of Information Education, 21(6) (2017) 701-710.