A Study on Educational Software Development Ability and Educational Plan of Pre-service Elementary Teachers

Pyung Kim
Dept. of Computer Education
Jeonju National University of Education
Jeonju, Korea
pyung@jnue.kr

***Abstract*—**As SW(software) is used more often and its use is more important in many fields, the Korean government plansSW education as a regular curriculum in the elementary, middle and high school education environment from 2018. This study aims to analyze the SW development competition result of pre-service elementary teachers submitted between 2014 and 2017 to determine the educational plan for connecting their SW development skills to curriculums and suggest an educational plan for training pre-service elementary teachers for future SW education. To this end, 61 educational SW development results submitted for the last 4 years are analyzed about the trend by years in terms of education methods, targeted subjects and school years, and development tools. Moreover, the curriculum for improving SW development skills of the pre-service elementary teachers is suggested. This study can be used to designing curriculums for determining educational plans to connect SW development skills of pre-service elementary teachers to creative curriculum courses and enhancing their problem-solving ability.

Keywords*–Computer Education, SW Development Ability, SW Educational Plan for Pre-service ElementaryTeacher*

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I. INTRODUCTION

Many countries including the US, UK, Japan, China, Israel and Finland run computer education as a compulsory curriculum. The Korean government specified 17 hours for elementary school students and 34 hours for middle school students for SW education applied from 2018 and plans a compulsory course all students should take.

The SW education conducted in elementary school andmiddle school aims to enable students to recognize the big changes happening in the future society and solve problems based on creative and logical methods. In textbooks, SW education is defined as "education for bringing up human resources solving problems through computational thinking." Computational thinking means that logical thinking and diversified creativity is represented, and its result is visibly shown in the process of defining problems and suggesting logical solutions.

The environment surrounding us is composed of sensory motivation, for example, images, colors and sound, and it is natural to live a life, enjoy living and learn something through such diversified senses. Therefore, multimedia used in education is getting more and more important these days.

In elementary schools, it is very important to lead students to be diversified and creative through various activities, which can be restricted because of issues of time, space, expenses and danger. SWeducation can be useful for addressing issues of time, space and expenses safely and fast. For SW education in elementary schools, elementary school teachers should understand SW and must be able to use it in the curriculum courses.

For planning to enhance SW development skills of pre-service elementary teachers and connecting SW to the curriculum courses, JNUE (Jeonju National University of Education) has held a public competition for educational SW development once every year. In this study, the result of public competitions for educational SW development for the latest 4 years is analyzed to plan for determining the educational SW development skills of pre-service elementary teachers and using the SW for curriculum courses to suggest SW curriculums for pre-service elementary teachers.

Chapter 2 of this study describes studies about designing SW curriculums and SW education-related studies of pre-service elementary teachers; Chapter 3 analyzes the educational SW development result; Chapter 4 describes SW curriculums; and Chapter 5 describes future studies and draws conclusion

II. RELATED STUDIES

The effort for enhancing SW programming skills of pre-service elementary teachers in charge of SW education for elementary school students is required. The SW curriculums of most universities of education in Korea include computational thinking, unplugged education, educational programming language, and computer education methodology.

Wing said that CT(Computational Thinking) will influence everyone in every field of endeavor and poses a new educational challenge for our society, especially for our children[1]. Valerie Bar et al. defines CT Concept and capability for the subjects of CS, Math, Science, Social Studies, Language Arts, and suggests a method for introducing computational thinking into the K-12 course[2]. In the study about enhancing SW development skills of elementary

schoolteachers, they examined and suggest the level of SW education knowledge of the elementary school teachers and relation between education categories for successful progress of SW education of elementary school students. Curriculums for introducing SW education into elementary schools in compliance with the curriculum revised in 2015 have been studied[3,4].

III. ANALYSIS OF OF SW DEVELOPMENT

It is compulsory that the students of Department of Computer Education in JNUE develop educational programs used in the curriculum courses through the public SW development competition, and write a thesis based on the result. For the public SW development competition, one team is composed of one or two students, and they can select the program development environment, target school years, and plans for connection to curriculum courses they like. This Chapter describes the process of public SW development competition and details of analyzed result of the public SW development competitions from 2012 to 2017.

A. Process of Educational SW Competiton

It is compulsory that the Year 3 students of Department of Computer Education in JNUE start to prepare for the public SW development competition in March every year, go through the steps shown in Figure 1, complete SW development skillsbetween September and October and write their graduation thesis by May next year. Designing and developing a piece of educational SW takes about 6 to 7 months, and the students should receive professor's feedback through presentations 3 or 4 times during the period to reflect the feedback on the developed SW.

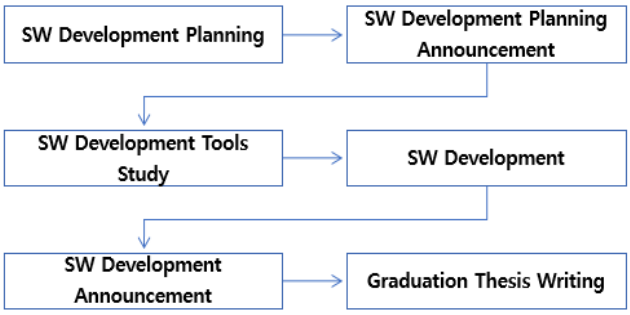

Figure 1. Process for Educational SW Development

Figure 1 shows the steps for preparing for the public SW development competition, composed of 6 steps, and details thereof are described below.

- **SW Development Planning :**this is a step for designing a SW developmentplan to select target subjects, school years, and topic, and state functions to be developed through a story board. In this process, it is required to analyze existing educational SW and services.
- **SW Development Planning Announcement:**this is a step for announcing theSWdevelopment plan to share functions between teams and development plans, change and correct development plans and receive recommendations about development tools through professor's feedback. In this process, mentoring relationship between teams and professors is made depending on development details.
- **SW Development Tool Study :**select SW developmenttoolsand learn how to use the tools and develop programs. Receive mentoring from professors and specify the SW development plan to use the environment and features of the tools effectively in the process of using the selected development tools and developing the functions.
- **SW Development :**this is the SW development process, and it is necessary to use contents not contrary to the copyrights for the resources used to develop the program.
- **SW Development Announcement :**announce the result of SW development, and receive feedback about the result by public competition examiners (how to use the program, correct functions).
- **Graduation Thesis Writing :**plan the thesis for the educational program submitted to the public SW development competition, and describe details of the plan, background theory, related studies, design and development in compliance with the thesis format. Receive feedback twice or 3 times to determine final theses.

B. Subject, Learning Method and Target School Year of Educational SW

In the public educational SW development competition for the latest 4 years, 61 programs have been submitted, implying submission of 15 programs every year. Figure 2 shows the target subjects of the educationalSW, and the legends are about subjects, cases and percentages. In total, 13 programs (21%) were developed for Science, followed by 11programs (18%) for Social Studies, and 8 programs (13%) for Music.

Fiveprograms were developed for the subject Creative Experimental Activities about computers, environmental protection and safety training, and other educational SW was developed for 11 subjects of Art, Practical Course, Physical Exercise, Korean, Math and English.

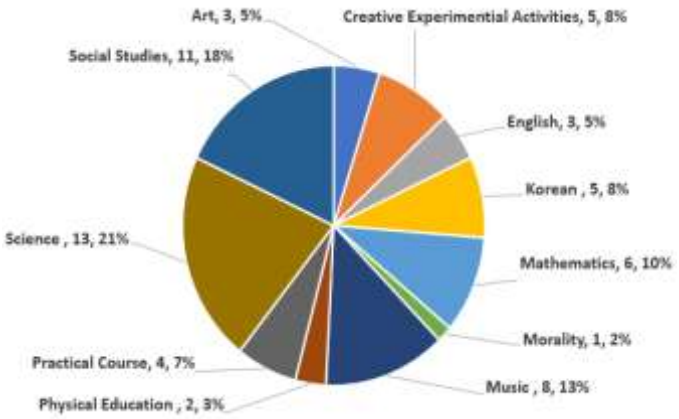

Figure 2. Subject Category of Educational SW Program

The SW was developed as tools for description or observation of scientific experimental contents in Science, games or activities for maps or history education in Social Studies, understanding musical instrument play techniques or rhythms in Music, understanding and using words or sentences in Korean and English, understanding and using polygons or calculation in Math.

The educational SW programs suggests the process of presenting contents for learning the contents of subjects, and helping students understand and learn the concept through activities or games. Among 61 programs, 13 programs (21%) are a type of delivering the contents, and the remaining 48 programs (78%) were developed to conduct a process of delivering the contents and then doing activities or playing games, or helping students understand and use the contents along with contents delivery through activities or games. Most educational programs were designed to induce elementary school students' interest in the subjects and help them understand the contents through activities and games.

TABLE I. STATISTICS OF LEARNGING METHOD AND SCHOOL YEAR

Item	Learning Method				School Year			
	Activity	Game	Content	Total	1~2	3~4	5~6	Total
2014	8	3	4	15	1	4	10	15
2015	15	0	1	16	1	4	11	16
2016	6	2	7	15	3	0	12	15
2017	12	2	1	15	1	5	9	15
Total	41	7	13	61	6	14	41	61

Six educationalprograms (1%) were developed for year 1 and 2 students (1%); 14 programs (22%) for year 3 and 4 students; and 41 programs (67%) for year 5 and 6 students. Because computers,smartphones or robots are used in the classrooms, it is presumed that the programs were developed for year 3 and 4, year 5 and 6 students who learn computers as a regular subject rather than year 1 and 2 students who are not accustomed used to using computers or smartphones.

C. DevelopmentTool and Examples of Educational SW

The development tools used in SW development are classified into SW coding tools, app development tools, robot coding tools, game programing tools, and contents programming tools.

- SW Coding Tool : Flash, Entry, Scratch
- App Development Tool : App Inventor, M-bizmaker
- Robot Coding Tool : Lego NXT, EV3
- Game Tool : RPG Game Maker, Nekonovel, Minecraft
- Content Authoring Tool: Namo Web Editor, Lectora, KSP(Kerbal Space Program), Power Point, Modoo

TABLE II. STATISTICS OF SW DEVELPOMENT TOOLS

Item	SW	App	Robot	Game	Content	Total
2014	5	2	3	0	5	15
2015	0	5	10	1	0	16
2016	3	5	1	3	3	15
2017	1	0	12	1	1	15
Total	9	12	26	5	9	61

Table 2illustrates current tools used for developing educational SW, and 26 programs (43%) used Lego NXT and EV3 for developing robots, and 12 programs (20%) used App Inventor and M-bizmaker for developing app, and other tools include SW development tools, contents development tools and game programming tools.

TABLE III. EXAMPLES OF DEVELPOED EDUCATIONAL PROGRAM

Item	Image	Subject
Robot		Learn solid figures for robots - Draw polygons - Understand features of polygons
Game		Game for history education by using RPG Game Maker - Understand history of the temporary government of Korea - Reconfigure the history dictionary while playing games
App		App for writing poems by using M-bizmaker - Poem writing - Teacher's feedback - Sharing environment between students

SW		Safety training SW using Scratch - Diseases caused by extreme temperature difference - Activities configured as games to avoid legionnaires' disease
Content		Contents about the position of the earth and the moon written in Power Point - Changes of shapes depending on the earth and the moon positions

Although it is hard to determine SW development skills of students with the used tool type, examination of implemented functions, functional complexity and service configuration shows gradual improvement of SW development skills every year from 2014. Table 3 shows images and subjects of some educational programs developed by using the tools.

IV. SW EDUCATION PLAN FOR PRE-SERVICE ELEMENTARY TEACHERS

As shown in Figure 3, this study proposes a software education stage for pre-service elementary teachers. It is not easy to progress essential coding theory, algorithm and block coding SW, physical computing app, and text coding knowledge step by step during regular courses, becausepre-service elementary teachersdo not have enough time to take compulsory education courses for SW programming education, Therefore, it is necessary to acquire skills required for computer education through various SW training sessions and after-school training courses.

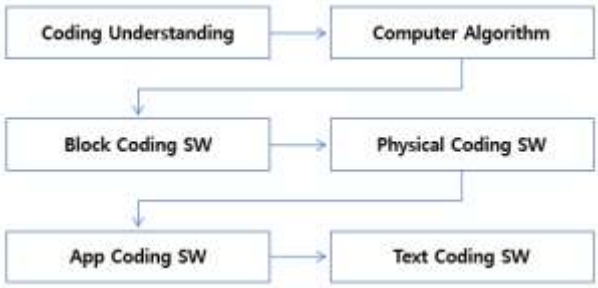

Figure 3. Learning steps of programming SW for pre-service elementary teachers

The SW curriculum for pre-service elementary teachersis different from the SW curriculum designed for students who major in SW in ordinary universities in terms of configuration and steps. Because pre-service elementary teachers should learn coding tools and plans for connection to other subjects used in SW education for elementary school students in elementary schools as well as essential computer theories, it is required to progress unplugged education, block coding and physical computing education step by step.

TABLE IV. CONTENTS AND TOOLS FOR SW EDUCATION

Step	Content	Tool
Coding Understanding	- Sequential, Iteration - Condition, Comparison	- Code.org - Entry Board
Computer Algorithm	- Information Theory - Sort, Search - Tree, Network	- CS Unplugged
Block Coding SW	- Basic SW Coding Skill - Variable, List, Function - Event-Driven Method	- Scratch, Entry - Kodu
Physical Coding SW	- Sensor, Actuator - Communication - Robot Programming - 3D Modelling	- Hamster Robot - LEGO EV3 - Arduino - 3D Printer
App Coding SW	- Mobile Sensor - Web API, Smart Phone API - Visual Component	- App Inventor - M-bizmaker
Text Coding SW	- Text Coding Skill - API, Library	- Blockly - Python, Java

Table 4 illustrates contents of step-by-step education and used tools shown in Figure 3. Pre-service elementary teacherscan learn the steps of essential coding by means of Code.org or Board, computer algorithms and information theories through CS unplugged education. For the block coding education in elementary school, students can learn essential coding skills by using Scratch or Entry, and how to program 3D games by using the game program Kodu focusing on events. The physical coding education to make sensors interwork with motors includes education about sensor and motor control methods and communication by using Lego Robot, Arduino and Hamster Robot. Students can make IoT programs practically by using Arduino and 3D printers. In app development education, students can use development tools including App Inventor and M-bizmaker to develop app by using mobile sensors, web API, smartphone API, and enhance coding skills through text-based coding, for example, Python or Java.

V. CONCLUSION

SWeducation aims to help students understand essential principles and concept of SW, and them equipped with thinking for solving various problems logically and creatively. Through SWeducation, students learn the essential programming concept and logical thinking through activities and playing games in elementary school. In middle school, students can further understand the essential SW concept and principles in the process of defining problems focusing on everyday life, disassembling and connecting the problems step by step. In high school, students can learn how to solve problems in a creative and efficient way in connection with other fields and subjects connected to tertiary education.

It is necessary to enhance SW programming skills of elementary school teachers for SW education inelementary

school. Universities of education in Korea continue to strengthen SW education for pre-service elementary teachers and use SW for various curriculum courses to study creative and efficient learning methods. This study aims to determine SW development skills of pre-service elementary teachers, examine plans to connect SW programming to curriculum courses, and suggest steps of SW education. To this end, the result of public educational SW development competition for the latest 4 years which is conducted once every year for the students of Department of Computer Education in JNUE was analyzed. Subjects and topics, development tools and functions of the educational SW were examined to suggest steps of SW education for pre-service elementary teachers. The SW education for pre-service elementary teachers is composed of 6 steps which include important contents and tools for each step from understanding coding and text coding education. Because it is necessary that they learn the method of using coding tools used by elementary school students in elementary school as well as essential computer theories, and connection thereof to each subject, it is necessary to progress essential coding education, computer algorithm, block coding, physical computing, app coding, and text coding education step by step.

The result of this study can be used for designing curriculums to determine SW development skills of pre-service elementary teachers, and the method of connecting them to curriculum courses, and enhancing creative problem-solving techniques.

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