Analysis of the Current Status of Korea's Informatics Education in 2017

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Abstract: This study analyzed the current status of Korea Informatics education and the results of the SW education effectiveness of SW Education Research School in 2017. As a result of analyzing the current operation status of the SW Education Research School, SW education devices and labs in middle and high schools were extremely poor compared to elementary schools. In the pre-and post-test results of SW education computational thinking-related problem-solving ability, elementary and middle schools showed an overall improvement in the post-test compared to the pre-test, whereas the improvement level in high schools was low even though annual SW training time was the greatest. The purpose of this study is to suggest the implications for the stable settlement of Informatics education through quantitative analysis although this analysis didn't reflect the environment or background of each school.

Keywords: Informatics education, Software education, SW education effectiveness

1. Introduction

Each country is experiencing rapid changes in the fields of education, economics, politics and society as a whole with the advent of intelligent informatization society. This environment gives us an intrinsic worry about what capabilities we need in the future and how we can respond flexibly to a changing society.

Many countries are aware of the need for a new future capacity to prepare for a rapidly changing environment and lead changes. To this end, they are strengthening Informatics education for the purpose of enhancing computational thinking[1][2][3][4]. In other words, they try to improve the techniques to find and solve high-level problems in various situations and environments, on the assumption of problem-solving, by using computing technology rather than acquiring simple knowledge and performing repetitive work.

Before and after 2000, Informatics education changed from using ICT to understanding the principles and concepts of computer science. Korea has also reorganized its primary and secondary school curriculums to provide a variety of experiences that can improve computational thinking in order to cope with the software-oriented society and cultivate talents in the field of Computer Science. The 2015 revised Informatics curriculum is characterized by 'strengthening SW(Software) education' and accordingly put more focus on Informatics education in elementary and secondary schools[5][6].

In higher education institutions, the curriculum and education system are changing with the aim of fostering talents with SW-based problem-solving ability through SW-oriented college education such as the social spread of SW value, the reinforcement of major education, and the SW-integrated education for non-majors. In other words, it is to contribute to improving the supply/demand of manpower through SW educational innovation[7][8].

Recently, various studies have been conducted to measure the effectiveness of Informatics education in accordance with the necessity of Informatics education. Korea has also been running SW Education Research · Leading Schools in elementary and secondary schools from 2015 in order to ensure the successful establishment of Informatics education. This study analyzed the current status of Informatics education in Korea and the SW education effectiveness of the research schools in 2017[9]. In other words, the purpose of this study is to present implications for the stable settlement of Informatics education through the analysis of Informatics education situation.

2. Informatics Education in Korea

In this section, we examine the information education curriculum of Korea, which was revised in 2015. Also, it describes the SW Education Research and Leading School for the settlement of information education field.

2.1 Informatics Curriculum

Korea's K-12 school system is operated as an basic school system of 6·3·3 referring to 6 years of elementary school, 3 years of middle school, and 3 years of high school[10]. Through the revised 2015 curriculum, Korea focused on developing creative and convergent talents with the right personality by cultivating core competencies required by future society, leading to reinforcement of Informatics education in elementary and secondary schools. For the development of competency-centered curriculum, subject competency was first defined, and the sub-factors of each competency factor were presented. In the revised curriculum of 2009, the competencies presented were 'computational thinking' and 'information ethical literacy'. In the revised curriculum of 2015, three core competencies were announced: 'Computing Thinking', 'Information Culture Literacy', and 'Cooperative Problem-Solving Ability'.

The revised content of Informatics curriculum is shown in <Table 1>. In the revised content of the curriculum, elementary school will expand the ICT utilization unit in the 5th to the 6th

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grade Practical Arts Subject to the SW basic literacy unit from 2019 and train the students for more than 17 hours. Middle school will reorganize 'Informatics' Subject into SW-centered education as a required course of minimum 34 hours after 2018.

In high school, 'Informatics' Subject has been revised from 'Advanced Optional' to 'General Optional' since 2018[5][6] and is now in operation.

In the 2015 revised curriculum, there were various changes in content factors compared with the 2009 revision curriculum. In 'Practical Arts' of elementary school, the content of ICT such as computing devices, cyberspace, and multimedia data-making was changed to understanding of software, procedural problem solving, programming elements and the content elements of structure.

<Table 1> 2015 Revised Curriculum

Category	Before Revision	Revision (Plan)	Major Goal
Elementary School	12-hrs of Practical Arts Subject ICT Unit	In 2019, More than 17hrs of Practical Arts Subject ICT Unit	Problem solving process, algorithm, programming experience, Informatics ethics cultivation
Middle School	Informatics Subject (Optional)	In 2018, More than 34hrs of Informatics Subject (Required)	Computational thinking based problem solving, simple algorithm, programming development
High School	Informatics Subject (Advanced Optional)	In 2018, Informatics Subject (General Optional)	Algorithm and program design by merging with various fields

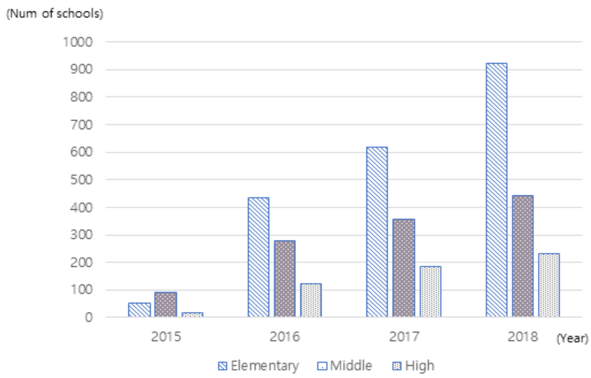
In middle and high schools, higher difficult content such as binary representation of data was deleted, and the content of computing system such as operating system, network, and hardware were included only in the Informatics Subject of high school compared with the 2009 revision curriculum. In addition, it presented abstraction, algorithm, and programming step by step, and added 'Physical computing' that integrated and developed hardware detecting sound, temperature, light, etc. and software controlling operation so as to provide an experience that could directly solve problems in real life.

2.2 Software (SW) Education Research · Leading School

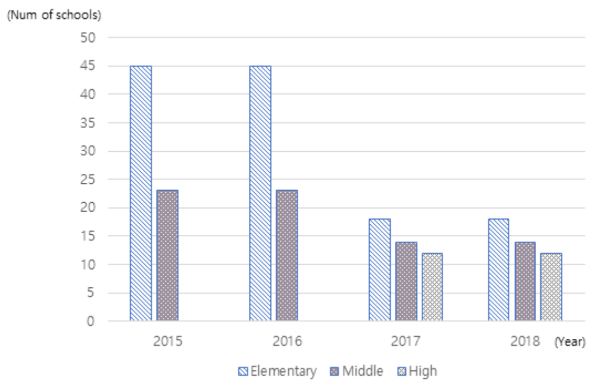
SW Education Research and Leading School was selected to prepare for the required Informatics education of the 2015 revised curriculum and to find a way for the establishment of the curriculum by restructuring the curriculum. Software Education Leading Schools are running, starting with 72 pilot schools in 2014, and the Software Education Research Schools are operating from 2015.

As shown in [Figure 1] and [Figure 2] research schools(68 schools) designated by the Ministry of Education(ME) and leading schools(160 schools) designated by the Ministry of Science and ICT(MSIT) were operated in 2015. In 2016, a total 900 schools were selected and operated by the co-operation of ME and MSIT. In 2017, a total of 1,200 Software Education Research · Leading Schools including 44 research schools were operated, and in 2018, 1,641 schools including 44 research schools are in operation[11] [12].

SW Education Research and Leading School aims to find out how to organize and operate school curriculum and to improve the applicability of Informatics education program to school. SW education research and leading schools are shown in <Table 2>.



[Figure 1] SW Education Leading School



[Figure 2] SW Education Research School

SW Education Research and Leading School aims to find out how to organize and operate school curriculum and to improve the applicability of Informatics education program to school. SW education research and leading schools are shown in <Table 2>.

<Table 2> Comparison of SW Education Research and Leading School

Category	SW Education Research School	SW Education Leading School
Function	- Study education policy task solving - Investigate the content and efficiency of entire education research	- Extract and supplement generalization possibility and application problems
Purpose	- Identify appropriate operating models based on region, school type, and size - Offer students more opportunities to experience SW education through various SW education activities	- Expand SW education best practice and creative education model - Provide the opportunities for teachers to increase SW competency through the operation of SW curriculum
Operation period	-2year based(renewable)	-1year based(renewable)
Support fund	- 10 million won a year	- 9~11 million won a year, depending on the size of school

3. 2017 SW Education Research School Operation Status

SW education research schools operated in 2017 are 46 schools (9 elementary schools, 15 middle schools, and 12 high schools)[9]. The current status of SW Education Research Schools is shown in <Table 3>.

<Table 3> Number of SW Classes, Classes and Students

Category	Average Number of Classes	Average Number of Participating Students	Average Time of Annual SW Education
Elementary School	3.88	93.51	19.35
Middle School	5.45	139.0	38.77
High School	8.08	198.08	45.70

<Table 4> shows the current status of the curriculum for the teachers of SW education research schools. In elementary school, 12 of the total 19 teachers in charge of operation were in charge of all subjects, and 5 of the teachers in charge of Practical Arts Subject were the second highest. In addition, there were 1 physical education teacher and 1 creative activity education teacher. The middle school had 3 Informatics teachers and 3 science teachers among the total 15 operation teachers. In addition, there were not only 2 teachers in technology and mathematics, respectively and 1 teacher in charge of humanities curriculums such as Korean language, morals, and arts, respectively.

<Table 4> Status of School Teachers by School Grade

Category	Subject	Number(%)	Total
Elementary School	All subjects	12(63.2)	19
	Practical Arts	5(26.3)	
	Physical Education	1(5.3)	
	Creative Experience Activity	1(5.3)	
Middle School	Informatics	3(20.0)	15
	Science	3(20.0)	
	Technology	2(13.3)	
	Mathematics	2(13.3)	
	Korean Language	1(6.7)	
	Ethics	1(6.7)	
	Art	1(6.7)	
	Technology, Art, Chinese Language	1(6.7)	
	Home Economics	1(6.7)	
High School	Informatics	8(66.7)	12
	Bioscience	1(8.3)	
	Earth Science	1(8.3)	
	Physics	1(8.3)	
	English	1(8.3)	

In the high school, 8 teachers responsible for the Informatics subject among a total of 12 schools were the most in charge of the operation of SW education research school. In addition, there were 3 teachers, one in each of science subjects, including bioscience, earth science and physics subjects, and one English teacher.

<Table 5> shows EPL(Education Programming. Language) used for SW education in elementary to high schools. Elementary, middle, and high schools commonly used Block Programming Languages including SCRATCH, Entry, and App Inventor, as well as Texture Programming Languages including C Language. Besides, the elementary school used LightBot, Roboid, Tinkercad, and Kodu as well.

<Table 5> EPL Used for SW Education

Category	Types
Elementary School	SCRATCH, Entry, App Inventor, C Language, LightBot, Roboid, Tinkercad, and Kodu
Middle School	SCRATCH, Entry, App Inventor, C Language
High School	SCRATCH, Entry, App Inventor, C Language, C++, Python

<Table 6> shows the current average of labs and devices needed for SW education by school grade. In the case of computer rooms, elementary schools had 1.37 the most. High schools had an average of more than one computer lab. In the case of smart classroom, elementary schools had the most at 1.58, and the number of group learning classrooms at the school was 0.89, which was the highest among the three schools.

<Table 6> Status of SW Education Labs and Devices

Category			Elementary School	Middle School	High School
Labs	Computer Room		1.37	0.94	1.34
	Smart Classroom		1.58	0.4	0.25
	Group Learning Classroom		0.89	0.2	0
SW Education Devices	Desktop		42.16	34.47	41.67
	Laptop		12.21	5.27	32.67
	Window Tablet		8.37	6.93	0
	Smart Pad	Android	26.16	16.33	9.83
		IOS	1.58	0.27	0

On the other hand, middle schools showed the lowest number of computer rooms, smart classrooms, and group learning rooms on average among the three schools. The average number of desktops was 44.17 in high schools, 42.16 in elementary school, and 34.47 in middle schools. The average number of students with laptops was 5.27, which was the lowest among the other schools. It was confirmed that high schools had no window tablet and IOS smart pad in high schools.

4. Analysis of the Effectiveness of SW Education Research School

‘A Study on the Effectiveness of SW Education in 2017' was conducted to measure the effect and awareness of SW education among students. The survey on the opinions of teachers and parents about SW education was carried out as well, but it was excluded from the analysis of this paper.

4.1 Development of Computational Thinking-Related Test Tool

A computational thinking-based problem-solving process test tool consists of 4 SW competencies with 17 questions for elementary school students, 20 for middle school students, and 20 for high school students. Each competency includes a sub-computational thinking-based problem-solving process[10]. Analysis competency consists of data collection, data analysis, and data representation. Design capability consists of problem division, abstraction, algorithm and process; implementation capability is automation and testing; and generalization capability consists of application and generalization, and the definitions of sub-levels by competency are shown in Table 7[13].

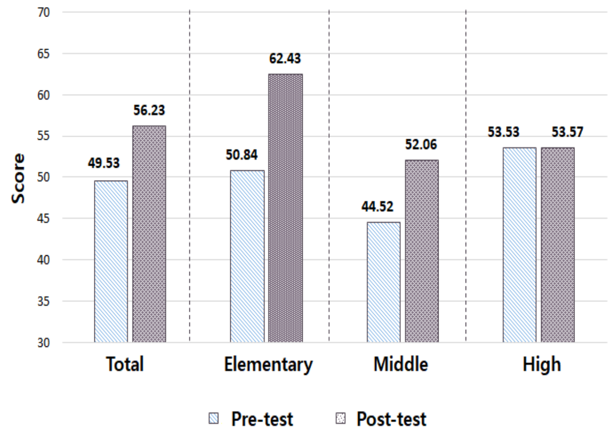
<Table 7> Computational Thinking based Problem Solving Process

Capabilities	Computational Thinking	
	CT-based problem solving process	Content
Analysis	Data Collection	Gathering what you need to solve problems
	Data Analysis	Checking data stability, and finding data conclusions from what you need for finding patterns of data and solving a problem
	Data Representation	Presenting and organizing data using graphs, charts, words or images
Modeling	Problem division	Dividing tasks into smaller unit so that the processing is easy to solve a problem
	Abstraction	Reducing complexity by leaving only the key elements needed for problem solving and eliminating unnecessary elements around
	Algorithm	Setting things to do to solve a problem and a series of steps
Implementation	Automation	Performing tasks that require repetitive tasks to move or act on their own, using computers or electronic devices
	Testing	Modeling for the representation of data or procedures, and model-based testing
Generalization	Application and generalization	Using or utilizing a structured model designed to solve individual or specific issues in larger scale at the same time or appropriately in a more comprehensive or generic way

Analysis capability refers to the ability to present various types of data in order to use the necessary information. As a process to express in a form that is easy to use to fit the purpose, modeling capability is the ability to divide work into small tasks that can be easily handled, reduce complexity and represent a series of procedures. Implementation capability refers to the ability to plan and operate the modeled items in real-time through the system. Generalization capability is the ability to extend the scope of a structured model to include more examples. In other words, it is the ability to expand to a wider range like the transition in learning based on already completed models.

4.2 Results

The average score of the pre-test of all students was 49.53, and that of post-test was 56.23. 6.7 points increased after SW education. The results of the pre-and post-tests are shown in [Figure 3].



[Figure 3] Pre and Post Test Results

The mean scores of the pre-and post-tests were 50.84 and 62.43, respectively in elementary schools, and 44.52 and 52.06, respectively in middle schools. The average of elementary school students increased by 11.59 points, showing the greatest increase compared to middle and high schools. The average score increase in high school students was mere 53.53 on the pre-test and 53.57 on the post-test. In the case of high school, there was a school that participated in the third grade students who were going to take the university entrance examination. In addition, there was an opinion from teachers that they did not concentrate because the test results did not affect the entrance examination.

5. Conclusion

This study analyzed the current status of Informatics education in Korea and the results of the SW education effectiveness of SW Education Research School in 2017. As a result of analyzing the current status of the SW Education School, the number of students participating in the Informatics Education increased as the school level increased, but the infrastructure was poor. In particular, middle and high schools will need to expand the labs and device needed for Informatics education.

In addition, the teacher who runs the SW education research school was a teacher who was not directly related to the SW education. If the operation teacher have expertise in SW education, they will be helpful in various aspects of Informatics education.

The results of pre-and post-tests on the problem-solving capability for computational thinking showed that the scores of post-test were improved in elementary and middle schools than in the pre-test, but the scores in high schools were not improved even though the annual SW training time was the highest.

In this study, quantitative analysis was carried out in order to grasp the SW education effectiveness of students and operation status. Therefore, we should not overlook that the way, in which the school operates, is different during the course of the study and that the measurement results of the effectiveness vary depending on the timing and subjects of the study. Therefore, in the future, it is necessary to provide a more diverse interpretation of the study results through qualitative analysis such as in-depth interviews.

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