

Analysis on the Effectiveness of Online Software Education for Preservice Teachers

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Abstract

Since 2019, elementary schools have been teaching software to students, so pre-service teachers should have the ability to teach software. Also, in the COVID-19 situation, pre-service teachers need the ability to teach software online. The purpose of this study is to investigate the effectiveness of online software education for preservice teachers. After providing online software education to preservice teachers, we analyse the results and examines whether online software education is effective. In this study, we define 55 learning elements by analyzing the achievement standards that can evaluate the software education ability of preservice teachers. We figure out whether pre-service teachers have acquired the ability to provide online software education to elementary school students. As a result of the study, we concluded that pre-service teachers who received this online education could conduct software education online in elementary school.

Keywords: *Software Education, Pre-service Teachers, Elementary School Students, Online Education, Teaching and Learning Materials*

1. Introduction

The hot topics of software education these days are non-face-to-face, that is, online education along with the 4-th industrial revolution. With the development of the Internet, there have been many developments in online education in Korea. There are online courses at general universities, 19 cyber universities, and cyber graduate schools, so college students can easily access online education. While online education in universities is well prepared, elementary schools are not well prepared for online education, and there is not much research on the effectiveness of online education at elementary schools.

The form and development of online education are as follows. A simple definition of online learning is a learning method that transcends time and space. Before the development of the Internet, it was possible to study non-face-to-face anytime, anywhere by sending broadcast materials by mail. However, this was not the online learning and was inconvenient. Next, there was a learning method through broadcasting. This is learning that transcends only space, not time. Examples of such learning methods in Korea are Broadcasting and Communications Colleges and Broadcasting and Communications High Schools. With the development of the Internet, online learning that transcends time and space has attracted attention as a new learning method that has complemented the traditional learning method. In particular, the importance of online education has greatly increased as non-face-to-face education has spread from universities to elementary schools amid the Corona

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Virus Disease 19 (COVID-19) situation.

Online learning overcomes the shortcomings of traditional learning methods in which students gather in a classroom, and has the advantage of being able to directly access desired knowledge online. In elementary education, it is important for students to get together for activities, but it is also important to provide knowledge information in that they complement these activities. There are studies that online education supplements basic education because information of fellow learners or contents of expert intellectuals, that is, knowledge information, can be accessed through a network, that is, the Internet [1]. In this regard, even after the COVID-19 situation is over, online education is necessary for elementary schools.

Even before the pandemic, online education for universities and adults was well developed. Universities are developing and publishing online educational contents under the name of MOOC (Massive Open Online Courses). The representative MOOCs in the United States are Coursera (www.coursera.org), edX (www.edX.org), and Udacity (www.udacity.com). After the learner completes the credits and pays the tuition, this MOOC provides a certificate of course completion [2].

There has been a lot of research on online education. There is a study that students' participation and discussion are effective in online science gifted education. The results of the study showed that discourse promotion and a sense of challenge were effective for learning in online education [3]. Another study is about interactions in online learning. It was found that the active interaction between the learner and the instructor in online learning is a factor that determines the course completion and the learner's course satisfaction [4]. There is a study that qualitatively analyzed students participating in online education, which concluded that conversations and meaningful interactions influence learning [5]. In a study of gifted elementary school students in the COVID-19 environment, it was also concluded that the higher the online education participation, the higher the achievement of elementary school students. [6].

In developed countries, the importance of software education is already highly emphasized. The American teacher group emphasized the importance of software education and created five areas in the software curriculum to create a framework for learning from kindergarten to high school [7, 8, 9]. These five areas are 'Computing Systems', 'Networks and the Internet', 'Algorithms and Programming', 'Data and Analysis' and 'The Impact of Computing'. In the UK, the curriculum is composed of three areas: 'Digital Literacy', 'Computer Science', 'Information Technology' and education is provided from elementary school to high school according to this curriculum [10, 11, 12].

Elementary schools in Korea have been offering software education since 2019 according to the curriculum revised in 2015 [13, 14]. In addition, the need for online education in elementary schools is increasing recently, and so pre-service teachers should be able to provide software education online.

In this paper, we study the effectiveness of online software education for preservice teachers. We analyzes whether pre-service teachers who have completed the online software education course provided in this research have the ability to teach software online in elementary school. Chapter 2 explains the software education achievement criteria, which are the basics of lecture content required in this study. Chapter 3 describes the results and analysis of this study for preservice teachers who completed online classes for 15 weeks. Chapter 4 describes the conclusions.

2. Related Studies

2.1 Software Curriculum

In Korea, the 'Guidelines for Information and Communication Technology Education' was announced in 2000 [15], and the 'Revised Guidelines' were announced in 2005 to conduct information education [16]. In 2008, as this guideline was suspended, information education disappeared from public education. Recently, the Korea Information Science Education Association created a curriculum model for next-generation software education [17]. This curriculum presents a system of information education from the first grade of elementary school. However, this curriculum has not yet been implemented.

The software curriculum currently being implemented is the 2015-revised curriculum [13, 14]. In this curriculum, software training for the five software achievement standards is covered in one unit of the Silgwa

(meaning practical) subject textbook. Pre-service teachers must have software education skills according to the 2015-revised curriculum. The purpose of this study is to investigate whether pre-service teachers have the ability to conduct software education online according to the 2015-revised curriculum. The following sections briefly describes the software achievement criteria of the 2015-revised curriculum [13, 14, 18], which is the basis of this study.

2.2 Software Achievement Criteria

There are five software achievement criteria in the 2015-revised curriculum. This is described in Table 1.

Table 1. Five software achievement criteria

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1	Find cases where software is applied and understand its impact on our lives.
2	Think and apply the order of problem solving by procedural thinking.
3	Experience the basic programming process using programming tools.
4	Design a simple program that inputs data, performs necessary processing, and outputs results.
5	Understand the sequence, selection, and repetition structure in the process of making a program to solve a problem.

The detailed description of the criteria in Table 1 is as follows. The first achievement standard is “Find cases where software is applied and understand its impact on our lives.” A detailed explanation of this is as follows. “In addition to software used in computers, we explore software used in various situations, including mobile phones, home appliances, and IoT (Internet of Things) products, and understand the impact it has on our lives.”

The second achievement standard is “Think and apply the order of problem solving by procedural thinking.” A detailed explanation of this is as follows. “Procedural thinking is a thought process that divides a problem into smaller units and processes each problem step by step in order to solve a problem efficiently. Look for examples from everyday life and apply procedural thinking processes for problem solving.”

The third achievement standard is “Experience the basic programming process using programming tools.” A detailed explanation of this is as follows. “Experience the basic programming process using block-based educational programming tools and create your own simple programs.”

The fourth achievement standard is “Design a simple program that inputs data, performs necessary processing, and outputs results.” A detailed explanation of this is as follows. “Understand the input, processing, and output processes of software by inputting numerical values and outputting the results of addition or subtraction, or by inputting multiple strings and creating a program that outputs the result of concatenating two strings.”

Finally, the fifth achievement standard is “Understand the sequence, selection, and repetition structure in the process of making a program to solve a problem.” A detailed explanation of this is as follows. “‘Sequence’ is a process of sequentially executing statements one by one from top to bottom, and ‘Selection’ is a process of selectively executing statements according to a given condition. ‘Repetition’ is the process of repeating a statement a certain number of times or until a given condition is satisfied. Understand the three structures of the above program through the basic process of creating a program that solves everyday problems.” This achievement standard is the stage of coding the procedural thinking of the achievement standard 2.

2.3 Teaching and Learning Materials by Achievement Criteria

In order to enable preservice teachers to have the ability to teach online, we gave pre-service teachers four kinds of teaching and learning materials for each class to learn the learning elements. The four teaching and learning materials are PowerPoint materials, video materials, quizzes and assignments. A detailed explanation

of the teaching and learning content is in Chapter 3.

3. Experiments and Results

3.1 Overview

In this study, we define 55 learning elements to satisfy the five software achievement criteria. After pre-service teachers are educated according to these learning elements, we examine the effectiveness of online education whether the pre-service teachers have the ability to teach these learning elements online at elementary school. Senior students of S. University of Education, who are pre-service teachers, had participated in this online education.

3.2 Teaching and Learning Content

We organized an online class based on five achievement standards that evaluate the ability to teach software according to the 2015-revised curriculum. We defined the learning elements for each of these five achievement standards, and composed the learning contents that can learn these learning elements.

■ Achievement Criteria 1

The lecture on the first achievement standard, “Find cases where software is applied and understand its impact on our lives” consists of 11 learning elements as follows.

- Know and explain the concept of hardware.
- Able to understand and explain software concepts.
- Can find hardware parts on a device and know what software is on that device.
- Be able to describe what hardware and software is in your home.
- Be able to describe what hardware and software the school has.
- Can explain what kind of hardware and software exist in daily life.
- Know what features the software has.
- Can explain the difference between hardware and software.
- Can classify software.
- Know what software is on your smartphone.
- Can talk about the experience of trying the typical software.

■ Achievement Criteria 2

The lecture on the second achievement standard of “Think and apply the order of problem solving by procedural thinking” consists of 11 learning elements as follows.

- Be able to distinguish between procedural thinking and non-procedural thinking, and apply it in your life.
- Know the pros and cons of procedural thinking.
- Recognize types of procedural thinking. Procedural thinking types are sequential, repetitive and selective thinking.
- Experience sequential actions/tasks and find out what strengths and weaknesses there are.
- Experience repetitive behaviors/tasks and find out what strengths and weaknesses there are.
- Experience selective behaviors/tasks and find out what their strengths and weaknesses are.
- Experience certain behaviors/tasks and see if there are any procedural thoughts.
- Can express procedural thinking with virtual code.
- Can express procedural thinking with flow chart.

- Can convert the virtual code to the flow chart and vice versa.
- Can express procedural thinking at home, school, and society with virtual codes and flow charts.

■ Achievement Criteria 3

The lecture on the third achievement standard of “Experience the basic programming process using programming tools” is composed of the following learning elements.

- Know about various software development environments including programming tools.
- Distinguish between programming tools and general application tools.
- Know what the software development environment is and what functions it should have.
- Can create, save, and run files in applications and software development tools.
- Can follow the basic example program step-by-step.
- Know what kind of procedural thinking there is in the basic example program.
- Can modify the basic example program according to the given conditions.
- Can convert the basic example program to a flowchart.
- Can write virtual codes for basic example programs.
- Be able to convert virtual code or flow chart which is slightly modified, to a basic program.
- Figure out what advantages basic example programs have.

■ Achievement Criteria 4

The lecture on the fourth achievement standard, “Design a simple program that inputs data, performs necessary processing, and outputs results” is structured as follows.

- Explain the general process of software receiving data, processing it, and storing the result with an example.
- Know how to receive data from the screen and save it as a file.
- Know how to store input data in variables.
- Know what the variables are, why you need them, and how to name them.
- Know what arithmetic operators are, and know the function of each arithmetic operator.
- Know how to store values in variables and how to get values from variables.
- Can use arithmetic operators to build formulas.
- Distinguish between expressions in mathematics and expressions in programming languages.
- Distinguish between numeric data and string data.
- Can operate using string data.
- Can use arithmetic operators to build formulas.
- Express simple data processing as procedural thinking.

■ Achievement Criteria 5

Finally, the lecture content for the fifth achievement standard of “Understanding the structure of sequence, selection, repetition, etc. in the process of creating a problem-solving program” is structured as follows.

- Can express a task in sequential thinking and simply program it using sequential instructions.
- Know the types of relational operators and the operation results of relational operators, and use them freely.
- Know the types of logical operators and the operation results of logical operators, and use them freely.
- Can express and use a mixture of relational and logical operators.
- Can express a task with repetitive thinking and simply program it using repetitive commands.
- Can express a task with selective thinking and simply program it using optional commands.

- Can program a task by repeatedly using the same command a certain number of times.
- Can program a task by repeatedly using the same command until a specific condition is satisfied.
- Can program a task using conditional statements inside a loop.
- Can program a task using loops inside a selection.
- Can program a task using loops inside a loop.

3.3 Experimental Results and Analysis

3.3.1 Basic Statistics

We conducted this research on the preservice teachers of five classes composed of senior students of S. University of Education in 2021. Basic statistics of participating preservice teachers are in Table 2.

Table 2. Basic statistics of participating preservice teachers

Class	Number of students	Number of respondents	Semester
Class-1	29	25	Spring
Class-2	32	28	Spring
Class-3	33	29	Spring
Class-4	39	27	Fall
Class-5	29	15	Fall
Total	162	124	

As shown in Table 2, a total of 162 students participated in the online education on the five software achievement criteria. Of these, 124 students participated in the lecture evaluation after 15 weeks of lectures. The students answered the questions whether the online software education they had taken was effective and whether they had achieved the ability to conduct online software education in the elementary school field. The survey response rate was 77%. The response rate of spring semester students was higher than that of fall semester students. We can infer that the response rate was low in the fall semester due to the teacher recruitment examination.

3.3.2 Analysis of Effectiveness of Online Software Education

After the students completed the online class, we conducted a survey on the students according to the five achievement criteria. For each of the five achievement criteria, the survey asked the following questions to find out the effectiveness of online software education. The answer to the question was selected from level 1 (strongly not), level 2 (no), level 3 (moderately), level 4 (yes), and level 5 (very much).

- Q1. Are online lectures effective to learn the five achievement standards?
- Q2. Did you understand 100% of the five achievement criteria?
- Q3. Can you create online course materials for use in elementary schools?
- Q4. Can you teach online classes in elementary school?
- Q5. Can you teach online classes for low-achieving students in elementary school?

The experimental result is in Table 3 below.

Table 3. Effectiveness of online software education by achievement criteria

Question	Answer	Achievement Criteria 1	Achievement Criteria 2	Achievement Criteria 3	Achievement Criteria 4	Achievement Criteria 5
Q1	Level 1	1 (# of students answered)	0	0	0	0
	Level 2	1	1	1	3	0
	Level 3	11	14	21	15	14
	Level 4	51	52	48	56	50
	Level 5	60	57	54	50	60
	Average level	4.35 (level)	4.33	4.25	4.23	4.37
Q2	Level 1	0	0	0	0	0
	Level 2	1	2	2	1	0
	Level 3	12	13	15	15	11
	Level 4	52	55	54	55	59
	Level 5	59	54	53	53	64
	Average level	4.36	4.30	4.27	4.29	4.35
Q3	Level 1	0	0	0	0	0
	Level 2	0	2	1	2	0
	Level 3	14	16	15	12	11
	Level 4	63	58	64	65	63
	Level 5	47	48	44	45	50
	Average level	4.27	4.23	4.22	4.23	4.31
Q4	Level 1	0	0	0	0	0
	Level 2	0	1	3	1	1
	Level 3	16	15	19	20	15
	Level 4	60	61	63	64	63
	Level 5	48	47	39	39	45
	Average level	4.26	4.24	4.11	4.14	4.23
Q5	Level 1	0	0	0	0	0
	Level 2	1	2	2	0	1
	Level 3	17	18	26	24	21
	Level 4	62	59	53	59	61
	Level 5	44	45	43	41	41
	Average level	4.20	4.19	4.10	4.14	4.15

The following is a detailed description of Table 3. Analyzing the results of question Q1, all of the achievement criteria 1 to 5 scored an average of 4.23 or higher, so pre-service teachers recognize that it is effective to teach software online. Analyzing the level for the question Q2 of whether you understood 100% of the five achievement criteria, most of them understood 100% with an average of 4.27 or higher. Analyzing the results for Q3, the average level is 4.22 or higher. We can see that students have the ability to create online lecture materials. For all the five achievement criteria, students think that they can make good online lecture materials but the third achievement criterion, the software experience part, is relatively low. Analyzing the results for Q4, the average level of students is 4.11 or higher, which indicates that pre-service teachers can do online lectures well enough. Analyzing the results of Q5, the average level is 4.10 or higher, indicating that pre-service teachers are able to give online lectures well enough for elementary school students with low academic achievement.

3.3.3 Correlation Analysis

In this study, we performed Pearson correlation analysis on the three main questions to figure out the correlation between five achievement criteria.

Table 4 below shows the correlation between achievement criteria for Q1, regarding whether online software lectures are appropriate. We can see that the correlation between achievement standards for Q1 is very high with the Pearson correlation. The correlation between achievement standard 3 and achievement standard 4 is relatively high, and achievement standard 1 and achievement standard 4 are relatively low.

Table 4. Correlation between achievement criteria for Q1

Question		Achievement Criteria 1	Achievement Criteria 2	Achievement Criteria 3	Achievement Criteria 4	Achievement Criteria 5
Achievement Criteria 1	Pearson	1	0.655**	0.559**	0.544**	0.604**
	Significance level		0.000	0.000	0.000	0.000
Achievement Criteria 2	Pearson	0.655**	1	0.812**	0.783**	0.791**
	Significance level	0.000		0.000	0.000	0.000
Achievement Criteria 3	Pearson	0.559**	0.812**	1	0.873**	0.777**
	Significance level	0.000	0.000		0.000	0.000
Achievement Criteria 4	Pearson	0.544**	0.783**	0.873**	1	0.810**
	Significance level	0.000	0.000	0.000		0.000
Achievement Criteria 5	Pearson	0.604**	0.791**	0.777**	0.810**	1
	Significance level	0.000	0.000	0.000	0.000	

Table 5 below shows the correlation between achievement criteria for Q3, regarding whether students can teach software online in elementary school. By analyzing the correlation in Table 5, we can see that the correlation between all achievement standards is high. Among them, the correlation with achievement standard 1 is relatively low, because it consists of learning elements without practice. However, there is relatively high correlation between achievement standards that have learning elements that require practical programming.

Table 5. Correlation between achievement criteria for Q3

Question		Achievement Criteria 1	Achievement Criteria 2	Achievement Criteria 3	Achievement Criteria 4	Achievement Criteria 5
Achievement Criteria 1	Pearson	1	0.738**	0.686**	0.767**	0.701**
	Significance level		0.000	0.000	0.000	0.000
Achievement Criteria 2	Pearson	0.738**	1	0.767**	0.819**	0.846**
	Significance level	0.000		0.000	0.000	0.000
Achievement Criteria 3	Pearson	0.686**	0.767**	1	0.901**	0.857**
	Significance level	0.000	0.000		0.000	0.000
Achievement Criteria 4	Pearson	0.767**	0.819**	0.901**	1	0.848**
	Significance level	0.000	0.000	0.000		0.000
Achievement Criteria 5	Pearson	0.701**	0.846**	0.857**	0.848**	1
	Significance level	0.000	0.000	0.000	0.000	

Table 6 below shows the correlation between achievement criteria for Q5, which is the question of whether online software education is possible for elementary school students with low academic performance. We can see that the correlation between the five achievement criteria is very high. Just as the correlation among the five criteria for whether online classes are possible for general students was high, the correlation results for students with lower achievement standards were also high. Among them, achievement standards 3 and 4

have the highest correlation, which means that there is a high correlation between the practical programming elements.

Table 6. Correlation between achievement criteria for Q5

Question		Achievement Criteria 1	Achievement Criteria 2	Achievement Criteria 3	Achievement Criteria 4	Achievement Criteria 5
Achievement Criteria 1	Pearson	1	0.812**	0.733**	0.743**	0.768**
	Significance level		0.000	0.000	0.000	0.000
Achievement Criteria 2	Pearson	0.812**	1	0.782**	0.786**	0.794**
	Significance level	0.000		0.000	0.000	0.000
Achievement Criteria 3	Pearson	0.733**	0.782**	1	0.860**	0.810**
	Significance level	0.000	0.000		0.000	0.000
Achievement Criteria 4	Pearson	0.743**	0.786**	0.860**	1	0.818**
	Significance level	0.000	0.000	0.000		0.000
Achievement Criteria 5	Pearson	0.768**	0.794**	0.810**	0.818**	1
	Significance level	0.000	0.000	0.000	0.000	

4. Conclusion

In this study, we investigated the effectiveness of online software education for elementary school pre-service teachers. After pre-service teachers took online software education of the 2015-revised curriculum, we conducted a survey to analyze whether pre-service teachers can teach software online in elementary schools. We defined eleven learning elements for each of five software achievement criteria. We gave educational materials, concept explanation materials via online, practice materials, quizzes and assignments to the pre-service teachers for these 55 learning elements, and operated an online classroom using them. In the lecture evaluation, the preservice teachers were very positive about the online lecture. After completing these classes, preservice teachers answered that they could give online software lectures to all students in the elementary school as well as students with low academic achievement. They replied that they could create online lecture content as well. As the result of analyzing the correlation between achievement criteria, the correlation between satisfaction with online lectures and the ability to teach online lectures at the elementary school was also very high.

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