

Creative Problem Solving According to Problem Types Based on Block Type EPL

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Abstract

Background/Objectives: In this Paper, one of the tools in the EPL, Scratch is classifying problem solving ability into four problem types and evaluates them by using them.

Methods/Statistical analysis: In this paper, we conducted a programming lesson using Scratch EPL for our students. Subjects are irrelevant to grade and major. Based on EPL based block programming, we designed 4-problem types and applied them to COS as a way to evaluate creative thinking and problem solving abilities. The scores according to the problem types were analyzed for each major series.

Findings: The target students were divided into four groups based on their major - engineering, social science, the humanities, and science. The problem solving abilities of each major student were tested according to the type of problem they were given.

The Type allows only the block to be addressed as suggested, and the CA Type changes the contents within the block according to the instructions. The C-Type allows the free use of blocks to add blocks or modify existing blocks, and the SA Type directs the order of existing blocks. The scores of students majoring in engineering, natural sciences, social sciences, and humanities were analyzed for the types of problems that changed the blocks.

Improvements/Applications: The ability to solve and implement the problem was found to be higher in the natural sciences than in the majors and male in the sexes.

Keywords: EPL, Creative Programming, Problem-solving ability, Problem Type, Scratch.

1. Introduction

The beginning of SW education is the Fourth Industrial Revolution. The importance of computers and artificial intelligence has increased as the Fourth Industrial Revolution has emerged as a key word throughout the society from a few years ago. It is becoming an age when the way of success we believe has broken down and we have to compete with artificial intelligence and robots[1,2]. Thus, the Fourth Industrial Revolution is an age centering on IT technology.

Looking at the global trend of coding education, the United States is conducting a one-hour-a-week coding class for high-class students from 2013, which improves problem-solving skills and thinking skills. In the UK, programming education has been designated as a regular course since 2014[3], and Sweden has been providing SW education as an essential regular education course since 2017. Finland has also revised its curriculum since 2016 to strengthen its software education. It also features curriculum by grouping elementary and junior high school students ages 7 to 16 into grade-level groups[4]. Universities are also investing heavily in IT education. Singapore promotes smart nations at the government level and focuses on artificial intelligence and big data formation. The United States also invests heavily in training professional programmers. But Korea, the

world's best IT powerhouse, is lagging far behind the world in software. Therefore, the government has started to cultivate creative and convergent talents suitable for this change. In 2014, four ministries, including the Ministry of Education and the Ministry of Trade, Industry and Energy, jointly announced the "Revitalization of SW Education". In the following year, the revised education course was confirmed and announced in 2015, and it became the basis for the SW education at the school[5,6].

EPL (Educational Programming Language) is a language designed to achieve educational purposes, not to develop programs to solve problems. Scratch is a representative tool of EPL[7,8]. Scratch is programmable in block form without having to memorize grammar or function usage, and it is structured so that it can easily understand and acquire the concept, structure and principle related to programming. Scratch is a good tool for learners interested in computer programming, regardless of their major[9-11].

Accordingly, Wonkwang University adopts coding education as a liberal arts course and teaches not only major students but also non-major students. This course supports the programming approach and the technical effects of creating the program. It improves problem solving ability by developing logical, thinking, and creativity[8]. Problem solving ability is classified into four types of problems and evaluated. In particular, these assessments are analyzed by each major and by type of problem.

2. EPL Problem Types

In this paper, we introduce COS (Coding Specialist) as a method to evaluate logical thinking ability and problem solving ability. COS evaluates the Scratch EPL's ability as a coding certification provided by YBM[12]. COS evaluates development tools understanding, sprites usage, sprites control, understanding coordinates, animation effects, multimedia usage, loop and conditional statements, operator usage, random numbers, variables, lists, functions, classes, flowcharts, algorithm, software test, source code verification and debugging, and performance improvement. In other words, Scratch EPL based capability evaluation factors are UI implementation, application implementation and debugging.

The UI implementation evaluates the following capabilities:

- ① Place the sprite at the specified position on the stage
- ② Change stage and sprite according to given conditions
- ③ Show / hide / change sprite or variable on stage
- ④ Understand UI scenarios and connect sprites to events that perform their functions
- ⑤ Follow the instructions to check the behavior of the sprite and modify the script

Application implementations evaluate the following capabilities:

- ① Create and use variables or random numbers according to the instructions
- ② Create and use list according to instructions
- ③ Combine use block palette such as motion, shape, sound, pen, observation etc.
- ④ Writing script using loops
- ⑤ Writing script using conditional statements
- ⑥ Writing script using operators
- ⑦ Writing script by Flowchart
- ⑧ Writing script using deduct algorithms

Debugging evaluate the following capabilities:

- ① Correct invalid data values for the script to work properly
- ② Add the necessary blocks for the script to work properly
- ③ Delete unnecessary blocks for the script to work properly
- ④ Change the block for the script to work properly
- ⑤ Change the block placement where the script errors
- ⑥ Algorithm-based program error correction

The problem types according to Scratch EPL based capability evaluation factors are classified into block addition type, block contents modification type, block addition / content modification mixing type, and block order modification type as in [Table 1]. The block usage view is created in accordance with the execution behavior and the result of the instruction in the case where the arbitrary block cannot be used other than the proposed block for the instruction and the free block use. However, since most of the problems present algorithms and flowcharts through the instructions, we did not deviate from the proposed operation procedures, algorithms, and flowcharts.

Table 1: The problem types according to Scratch EPL based capability evaluation factors

Problem Types	Description
G-type(Given type)	Using blocks with a given block
CA Type(Contents Alteration Type)	Changing the contents of a block Change the contents of a block according to instructions
C-Type(Complex Type)	Adding blocks and changing existing blocks
SA Type(Sequence Alteration Type)	Changing the order of existing blocks according to instructions

2.1. G-Type

The G-type (Given Type) is a form of adding blocks according to the instructions in the problem, adding blocks within one or two sprites. It is important to note that you must use the correct blocks to perform the actions that are consistent with the instructions in the problem. This type is a type of program implementation-related problem that analyzes the problem and then evaluates the ability to place blocks and complete the program to the instructions as shown in figure 1.

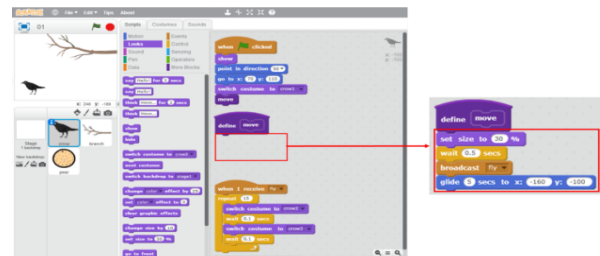


Figure 1: GivenType

2.2. CA-Type

The CA Type(Contents Alteration Type) is a form in which the contents are not inputted or blocks in which contents other than the correct answer are inputted in advance, and the examinee inputs the contents or corrects the contents. This type is a type of problem that analyzes and understands content and evaluates the ability to examine and debug already coded source code as shown in figure 2.

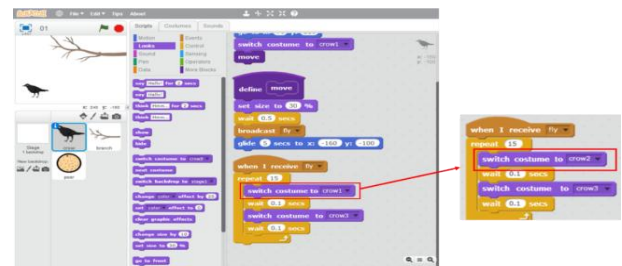


Figure 2:Contents Alteration Type

2.3. C-Type

The C-Type(Complex Type) is a type of problem that changes the contents of an existing block with the addition of a new block. This type is a type of problem that program implementation, source code examination and debugging as shown in figure 3.

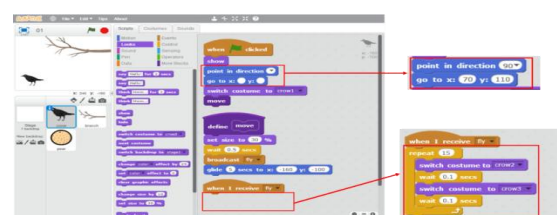


Figure 3:Complex Type

2.4. SA-Type

The SA-Type(Sequence Alteration Type) is a problem of changing the order of the blocks so that the coded source code is correctly changed to the order of the blocks according to the instructions. This type is a type of problem that source code examination and debugging as shown in figure 4.

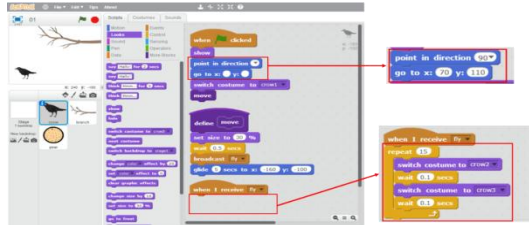


Figure 4: Sequence Alteration Type

3. Result Analysis of Problem Type

The materials used SPSS/PCWIN (ver. 23.0) programs to analyze the COS scores applied by students. The ability to solve problems and to implement them was divided into the departments of engineering, natural sciences, humanities, social sciences, and gender. In order to determine if there are significant differences between gender and department depending on the type of problem presented, divide it into four groups using the average and standard deviations of the problem type values. Duncan-test was carried out with a member distribution analysis (One-Way ANOVA) and a post-validation. The results showed significant differences between department and gender depending on the type of problem[Table 2, Table 3].

Table 2: A result analysis1 of Problem Type

	Engineering	Natural Science	Humanities	Social Sciences	Total	p-value
G-type	67.20±33.10	67.60±32.51	54.44±32.29	57.53±31.79	62.10±32.82	0.01
CA Type	80.45±24.11	77.66±28.85	67.06±33.0	72.87±25.80	75.14±27.83	0.00
C-Type	66.52±23.76	60.54±25.05	48.73±23.59	57.53±22.89	59.28±24.48	<0.001
SA Type	73.42±20.95	70.32±25.08	58.74±25.14	65.62±21.03	67.73±23.28	<0.001

The average score for the Given type in all department was 62.10±32.82, while the average score for Block Contents Alterations Type was 75.14±27.83 and Complex Type was 59.28±24.48. In addition, the average score for Sequence Alteration Type was 67.73±23.28.

Table 3: A result analysis2 of Problem Type

	N	G-type		CA-type			C-type		SA-type		
		1	2	1	2	1	2	3	1	2	3
Humanities	82	54.44		67.06		48.73			117.49		
Social Sciences	125	57.53		72.87	72.87		57.53			131.23	
Engineering	133		67.20		77.66		60.54	60.54		140.63	140.63
Natural Science	95		67.60		80.45			66.52			146.85
p-value		0.491	0.928	0.127	0.059	1.000	0.360	0.069	1.000	0.136	0.324

For the Given Block Type, Complex-Type, and Block Sequence Alteration Types, the score was higher in engineering and natural sciences than in the humanities. The humanities scored lower than the engineering and natural sciences in the Block Contents category. Overall, male were better at solving problems than female in all Block Types[Table 4].

Table 4: A result analysis3 of Problem Type

	N	G-type	CA Type	C-Type	SA Type
Male	221	67.10±30.63	80.81±25.43	64.03±24.27	72.97±24.52
Female	214	56.94±34.25	69.29±29.02	54.37±23.78	62.33±27.01
p-value	-	0.001	<0.001	<0.001	<0.001

4. Conclusion

In this paper, WonKwang University students taught programming using Scratch, one of the tools of EPL. Based on EPL-based block programming, four problem types were designed to evaluate creative thinking and problem solving abilities. The G-type solves the problem only with the proposed block, and the CA Type changes contents in the block according to the instructions. C-Type allows the block to be added or change the existing block freely, and the SA type changes the order of the existing block according to the instructions. Through this, we divided into four groups of engineering, natural science, social science, and humanities of each major.

The problem-solving ability of each major was tested by the type of problem. In other words, the scores of students majoring engineering, natural sciences, social sciences, and humanities were analyzed by type of problem that changed the block.

In the case of G-type, C-Type, and SA type, the scores of engineering and natural sciences were higher than those of human sciences. In case of CA type, scores of human sciences were lower than those of engineering sciences and natural sciences. Overall,

male's ability to solve problems was higher than that of females.

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