Development of Block Assembly Application for Developing Logical Thinking Skills

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Abstract

Programming education is a required subject in elementary school from 2020 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), and the teachers in elementary school must teach programming thinking skills in various subjects. Programming education in elementary school is about improving programming thinking skills of children, not about making programs using programming languages. Researchers and companies have been developing various applications/tools of programming education for elementary school students. We have developing a programming education application called "Kizupuro" which focuses on construction and plays of blocks. This study has developing "Kizupuron" which includes the development of logical thinking skills according to developmental levels such as limitation of the number of colors or color overlap. In an experiment, we conducted four college students use our application to validate it. Results was that this application may be develop logical thinking skills in programing education.

Keywords: *Programming Education, Computational Thinking, Logical thinking, Constructing Plays, Visual Programming*

Introduction

Programming education in elementary schools in Japan started in 2020. [1]. The aim of programming education in elementary schools is developing a programmatic thinking. Programmatic thinking is "the ability to think logically about how to combine symbols [3]." We have been developing "Kizupuro*1," which is based on visual programming that can be used in the early grades of elementary school and can be operated by touch on a tablet device [4]. Furthermore, this study attempted logical thinking by selecting the blocks to be used before assembling them. The difficulty level was adjusted by silhouetting the target object.

Kizupuron: Programming Thinking Application

Figure 1 shows the Kizupuro screen. "Kizupuro" looks at the target object, considers which block to use, and selects the instruction block. The selected instruction block is displayed in the programming area. A user looks at the

target object and considers which block to use. The selected instruction block is displayed in the programming area. The user can check their own assembled blocks' state by pressing the "view" button. Kizupuro's concept employees that the blocks are assembled from the bottom up, similar to the way blocks are assembled in the real world. However, we thought it difficult to develop logical thinking skills by using the “view” button. In this study, we aimed to develop logical thinking skills by selecting the instruction block to be used in advance after confirming the target object as shown in Figure 2.

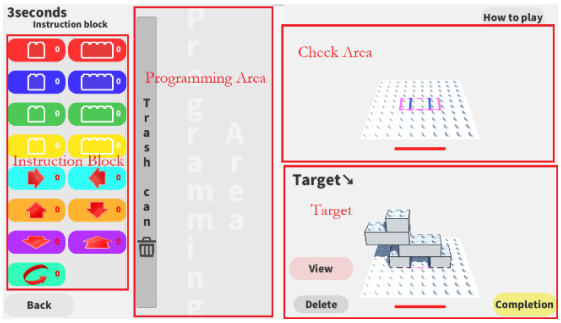

Figure 1 Visual programming screen

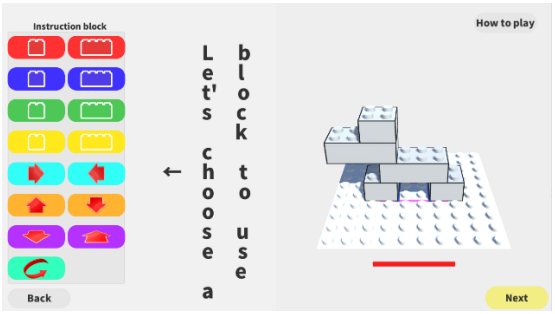

Figure 2 Instruction block selection screen

In addition, Figure 3 shows only a silhouetted target object as a difficulty adjustment. This requires complex thinking about which blocks to use and where.

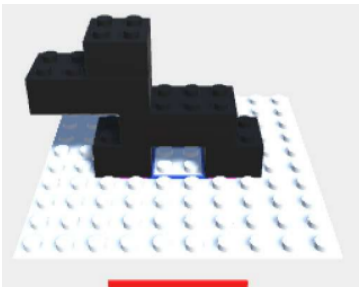

Figure 3 Silhouette target

Experiment

Before having elementary school pupils use the "Kizupuron," this study conducted to verify the effect of "Kizupuron" on five college students on Wednesday, December 8, 2021. The flow of the experiment consisted of explaining the system, having the participants experience each level of "Kizupuron" without a silhouette of the target object, and then having them answer a questionnaire. The questionnaire was administered using a 5-point Ritz-Cart scale, with respondents choosing from the following five responses: "1. very applicable," "2. applicable," "3. undecided," "4. not applicable," and "5. not applicable at all.

1. This system was easy.
2. I wanted to use this system at home.

3. Please tell us what you have learned and what you have been able to accomplish through experience with this system.

3.1 I could anticipate how to proceed for the target.

3.2 The number of instruction blocks was correctly chosen for the target.

3.3 The type of instruction block was correctly selected for the target.

3.4 I've noticed similar instruction block arrangements in several places.

Participants in the experiment responded to the above items on a five-point scale, and answered the reasons they chose in a descriptive manner (item 1 --item 5). In addition, participants were free to write their impressions of the last question (item 6).

Results and Discussion

Table 1 shows the results of the post-experiment questionnaire.

Table 1 Questionnaire Results

question number	question	1	2	3	4	5
1	This system was easy.	0	1	2	1	1
2	I wanted to use this system at home.	0	2	1	1	1
3.1	I could anticipate how to proceed for the target.	0	5	0	0	0
3.2	The number of instruction blocks was correctly chosen for the target.	0	3	1	1	0
3.3	The type of instruction block was correctly selected for the target.	1	2	1	1	0
3.4	I've noticed similar instruction block arrangements in several places.	2	2	1	0	0

Discussion of Difficulty Level

Question No. 1 in Table 2 was item 2 with 1 person, item 3 with 2 people, and items 4 and 5 with 1 person each. In the free description, some participants wrote, "It took a lot of thinking to make it right." and "It takes time to understand the rules, but once I understood them, it was easy." This may be because many students may have found it difficult to understand the exact position of all the blocks at the time of selecting the blocks to be used. It is too difficult for elementary school students to predict, it is necessary to make some adjustments based on the results of this study. One possible adjustment is to use only a silhouette of the target object in the instruction block selection screen and to enter which shape and what color block is to be used. In other words, the system does not select the instruction block that moves the location of the block. Assuming that you are trying to figure out which block to place in which part of the silhouette target object. Further experimentation on this is considered necessary.

Discussion of Interest

Question No. 3 in Table 2 was item 2 was 2 people, and item 3 and items 4 and 5 were 1 person each. In the free description, some respondents wrote, "It was fun once I got used to it." I want to use it at home with children in the future." "I want to use it at home with children in the future." "It is something unconventional but not interesting."

This may be because the system may be effective for extracurricular learning at home for elementary school students, as it can be used with smartphones and tablet terminals.

Discussion of Programming Education

The user confirms the object of the silhouette and selects and inputs the instruction block checked the silhouetted target objects. As the result, first, five participants gave a positive to question No.3.1 of Table 1. This may be because it was necessary to make predictions for all blocks on the instruction block selection screen. Question No.3.2 and 3.3, the goal is clear, and we considered that the correct choice could have been made by the debugging work of the button to try during visual programming. Question No.3.4 could suggest the possibility of noticing repetition, which is one of the most important elements in programming

Conclusion

This study focused on block assembly play and developed an application that aims to develop logical thinking and programming thinking by predicting how to assemble the overall rough blocks before visual programming. The results of the student experiments suggest that the system may be effective in programming education and developing logical thinking. Future assignments include the introduction of a system to select the instruction block of the block to be used by looking at the silhouettes, adjusting the level, and making the operation of the instruction block easier to understand. We would also like to incorporate a system that uses actual blocks. In the future, we plan to conduct experiments with actual elementary school students and evaluate “Kizupuron”.

Acknowledgment

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