DEVELOPMENT OF NEW PROGRAMMING WITH STICKERS FOR ELEMENTARY SCHOOL PROGRAMMING EDUCATION

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Abstract

Programming education will be compulsory at elementary schools from fiscal 2020 in Japan. Programming education in elementary school does not learn programming language coding, but computational thinking. This paper describes a new programming education using stickers that combine the features of unplugged programming and physical programming.

Keywords: programming education, elementary school, programming with stickers.

1 INTRODUCTION

In Japan, programming education will be compulsory at elementary schools from fiscal 2020. Programming education in elementary school does not learn programming languages such as higher education institutions but learns computational thinking. However, there are some problems in introducing programming education in elementary school.

Japanese elementary schools have 30 to 35 children per class, and one teacher must be in charge of one class. Although programming materials used by a small number of children are commercially available, there is no teaching material intended for large classes. In addition, elementary schools do not have sufficient budget for facilities such as ICT (Information and Communication Technology) devices and robots including personal computers, and there is no programming skill or knowledge to teach elementary school teachers to children. In order to solve these problems, it is necessary to consider programming education throughout the school and society, and new teaching materials that require less capital investment and have nothing to do with the programming skills of teachers are needed.

In this paper, we describe a new programming education method using stickers to solve these problems.

2 NEW PROGRAMMING EDUCATION

2.1 Comparison of programming education

Programming education is divided into unplugged programming [1], visual programming [2] and physical programming [3]. Table 1 summarizes the features of each programming education when teachers conduct classes at an elementary school.

It is easy to think that programming needs to be learned on a computer, but if you want students to gain a deeper understanding of the concept of the program instead of operating the program blindly, learning in the unplugged form is effective. Furthermore, the unplugged type has features such as low facility budget and easy to carry out classes in the classroom. Since programming classes are conducted in general classrooms, not in the laboratory, there is little space for equipment, so the unplugged type is suitable.

However, there is a problem that children get bored faster than physical programming methods that use robots. Robot control that children do in physical type is impressive and seems to be highly motivated. Therefore, in this study, we proposed a new educational method that makes use of the features of both unplugged type and physical type.
2.2 New programming education

Figure 1 is an outline of the new programming education. A new teaching method uses a sticker with robot car control instructions (PS: programming sticker), and each child thinks of a procedure for solving problems at his / her desk and applies a sticker to control the robot according to the procedure. The PS is a special sticker that can be stuck or peeled off any number of times, and can be programmed by the child in trial and error. Next, when the sheet with PS stuck is read by the image scanner, it is automatically coded and the control instruction is transferred to the robot car via the computer. The children can check the operation of the program by running the robot car containing the program created by themselves on the actual course. The operation is simple from scanning to moving the robot car, and it can be performed only by children without the help of teachers. Therefore, an elementary school teacher can give lessons in the form of 1 (teacher) vs. N (the number of children). In addition, there is the advantage that the number of equipment needed for classes can be reduced because children do not need computers, robots, etc. in the process of creating programs.

Table 1. Comparison of programming education.

<table>
<thead>
<tr>
<th></th>
<th>Used items</th>
<th>Introduction cost</th>
<th>Technical knowledge required by teachers</th>
<th>Children’s interest</th>
<th>Ease of class management</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Unplugged Programming</td>
<td>Cards, Papers</td>
<td>5 Low cost</td>
<td>5 Not required</td>
<td>2 Lose interest easily</td>
<td>5 Possible with one teacher Possible in any classroom</td>
</tr>
<tr>
<td>B Visual Programming</td>
<td>PCs, Tablets</td>
<td>3</td>
<td>3 A little required</td>
<td>4 Interested</td>
<td>3</td>
</tr>
<tr>
<td>C Physical Programming</td>
<td>PCs or Tablets, Sensors, Robots</td>
<td>2 High cost</td>
<td>2 Strongly required</td>
<td>5 Very interested</td>
<td>2 Difficult to prepare</td>
</tr>
</tbody>
</table>

5: Excellent, 4: Good, 3: Fair, 2: Poor, 1: NA

3 TRIAL EXPERIMENT OF NEW PROGRAMMING EDUCATION

In order to confirm that the developed teaching materials can be used in elementary schools, we used the teaching materials to actually carry out several classes in the second grade, third grade and fourth grade of elementary school in Ishikawa Prefecture, Japan.

3.1 Education system configuration

Figure 2 shows the education system configuration. A non-contact scanner (Fujitsu ScanSnap SV600) [4] was used to scan the image of the programming sticker. This scanner is suitable for scanning uneven sheets with programming stickers since it is contactless with stickers in overhead scans. The laptop computer captures the image from the scanner, identifies the sticker image, and converts it into robot control information. The LEGO Mindstorms EV3 was used for the robot car. LeJOS firmware [5] was installed on EV3 to realize JAVA programming with LEGO. Robot control data
was sent from the computer to EV3 via the USB cable. There is no need for expert knowledge at all, as all steps are just pressing a button.

Figure 3 shows programming stickers for lower grade children in elementary school. For beginners, only five types of stickers were used: straight, right turn, left turn, reverse and stop. Each child applies a sticker on the sheet on the right side of Fig. 3 according to the task as shown in Fig. 4. Such tasks can be freely arranged by teachers according to the children’s age and programming skills.
3.2 Demonstration experiment in elementary school

Demonstration experiments in elementary school were conducted using new teaching methods. The target children were 70 third graders of Hakusan City Meiko Elementary School, and divided into two classes. The task given to the children was to buy a food for rice and curry by controlling a robot. (Fig. 4) The task sheet and programming sticker were distributed to each one. Two sets of scanners and laptop computers, eight robots, and eight traveling courses of robots were prepared. Figure 5 shows a picture of a child programming with PS. Many children were able to stick PSs on the sheet freely without the assistance of teachers. Figure 6 shows a scan of the sheet and data transfer to the robot car. Since it takes only about 15 seconds to complete data transfer from scanning, equipment occupancy time can be reduced considerably. Therefore, eight robot cars were enough to deal with 35 children. Figure 7 shows the robot car moving on the traveling course. The movement check can be performed by the child comparing the movement of the robot car with the programming sticker.

Figure 4. Task example of programming with sticker.

Figure 5. Scene of programming by PS.
3.3 Questionnaire after class

From the questionnaire results after class, more than 90% answered that they enjoyed this class, and more than 85% answered that they were interested in programming. From the above results, it became clear that the new educational method we developed could be used for programming education for elementary school children.

4 CONCLUSIONS

A new programming education using stickers was mentioned. This method combines the features of unplugged programming and physical programming, and it was popular among children as a result of the questionnaire.

REFERENCES


