

Development of Computational Thinking Education System for Elementary School Class

Akiyuki Minamide¹, Kazuya Takemata¹ and Hirofumi Yamada²

¹ International College of Technology, Kanazawa, Kanazawa-shi, Ishikawa Japan

² Kanazawa Institute of Technology, Hakusan-shi, Ishikawa Japan

minamide@neptune.kanazawa-it.ac.jp

Abstract

This paper describes a new programming education method using stickers and a scanner that combine the features of unplugged programming and physical programming. The new materials developed in this study offer superior features compared to commercial materials, such as low cost, use in lower grades class in elementary school, and no need for teacher's ICT skills.

1. Introduction

In Japan, programming education will be compulsory at elementary schools starting in fiscal 2020. This programming education does not teach programming languages as higher education institutions do but teaches computational thinking [1]. However, there are some problems with 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

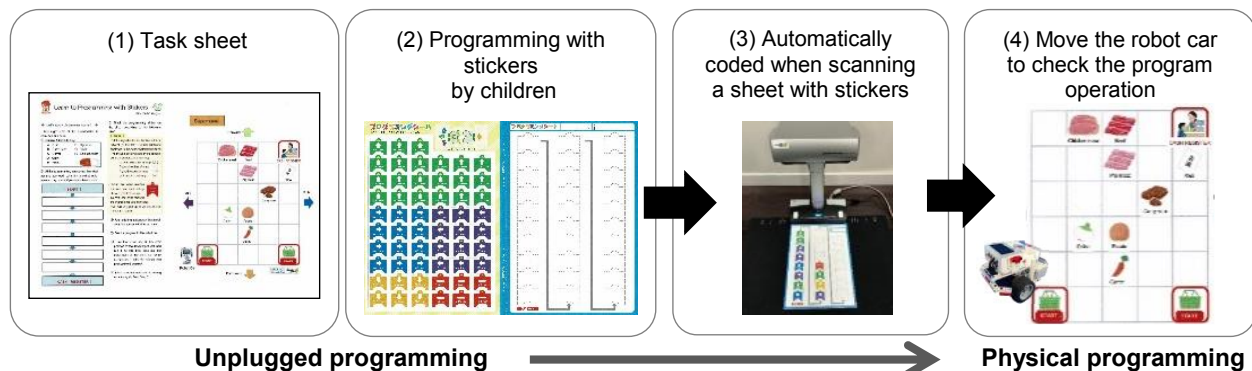
problems, it is necessary to consider programming education throughout the school and society, and new teaching materials that require less capital investment and have nothing to do with the programming skills of teachers are needed.

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

2. New Programming Education

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.

Children use the new materials in the following steps. (1) The children will be given the task written on the task sheet. For example, a task of controlling a robot car in a supermarket to buy rice and curry food. (2) Children choose the ingredients to buy and think of a route to buy them efficiently. 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. (3) The programming sheet with the PSs is read by an overhead scanner, automatically coded, and the control data is transferred to the robot car via a computer. (4) The children can check the operation of



school teachers to children. II Figure 1 Outline of Programming with Stickers.

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). Furthermore, unplugged programming [1] is performed in the program creation process, and the operation check of the created program is physical programming [2]. This has the advantage of reducing the number of devices required for the class, such as robots and computers.

3. Trial Experiment of New Education

Figure 2 shows the education system configuration. A non-contact scanner (Fujitsu ScanSnap SV600) was used to scan the image of the programming sheet with PSs. 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 (JSON data). The LEGO Mindstorms EV3 was used for the robot car. LeJOS firmware [3] was installed on EV3 to realize JAVA programming with LEGO. JSON 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. Only five types of stickers were used: Straight, Right turn, Left turn, Reverse and Stop.

Each child will stick PSs on the programming sheet according to the given task sheet. Such tasks can be freely arranged by teachers according to the grade of child and their programming skills.



Figure 2 Configuration of educational system.

Demonstration experiments in elementary school were conducted using new teaching methods. The target children were 66 third-grade students of Meiko Elementary School in Hakusan City, and divided into two classes. The task given to the children was to buy a food for rice and curry by controlling a robot in a supermarket. 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. Many children were able to freely attach the PS to the sheet without the help of the teacher, scan the sheet and transfer the data to the robot car. It takes only about 15 seconds to complete the data transfer from the scan, greatly reducing equipment occupancy time. Thus, eight robotic cars were enough to handle 33 children. Finally, children can check the operation on the running course.

A questionnaire survey was conducted to confirm that the proposed teaching materials could be used. The children were 35 boys and 31 girls, and 86% of them experienced programming classes for the first time. Figure 3 shows the results for the following questions. Q1: Was the content of this class difficult for you? Q2: Is the programming sticker easy to use? Q3: Is the scanner easy to use? Q4: Is the robot car easy to use? Q5: Did you enjoy this class? Q6: Were you interested in programming after this class? Q7: Do you want to take programming classes again? From the questionnaire results, 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 could be used for programming education for elementary school children.

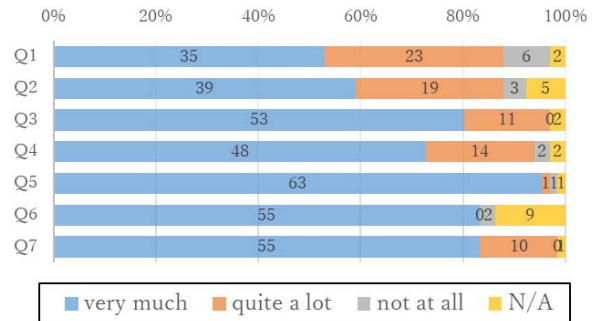


Figure 3 Results of questionnaire survey after class.

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

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