An Initial Survey of Japanese Elementary School Students' Reactions to Robots and Tablets in the Classroom

An Initial Survey of Japanese Elementary School Students' Reactions to Robots and Tablets in the Classroom
教室でのロボットやタブレットに対する日本の小学校生の反応についての最初の調査

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Abstract

From 2020, elementary schools in Japan will be required to teach programming to their students. It is clear that Japanese publishers have already done their homework and published numerous materials to help elementary school teachers to fulfil Japanese government's requirements. Nevertheless, it is still unclear how teachers can successfully teach programing concepts without proper training and materials, and also how receptive to new methods and tools elementary school students will be. This paper focuses on the later, on an initial attempt to teach programming concepts to elementary school students and evaluate their level of engagement while using tablet computers and robots. By conducting a small experiment, it is shown that students naturally engage with the content, but special care must be taken to keep students focused on the lesson objectives.

Introduction

In 2017, the Japanese Ministry of Education (MEXT) released its General Course of Study Guidelines [1]. The guidelines are usually reviewed every ten years and this time it is said to include directives for programming education in elementary school. As most computer scientists know, teaching programming requires the understanding of algorithms, and a good deal of procedural thinking. Also, considering these guidelines apply to Japan, it is easier to foresee problems related to language of instruction and school infrastructure. Regarding the language of instruction, most programing applications make use of English words. Taking Apple's Swift [2] as an example, although the interface language can be changed to Japanese, the commands are still written in English. At the moment, English is not taught in the first years of elementary school in Japan and even after the 2017 guidelines are enacted, English instruction will only become mandatory for fifth and sixth graders [3]. Thus, in actual classroom instruction teachers will have the additional burden of explaining the language used to write down programs and algorithms.

One way to circumvent this problem is for the teacher to choose applications that use the students' native language in their command syntax. Although the selection is quite limited at the present time, it can be done and it has been proven successful by Korean and Japanese researchers

[4][5]. Another solution, is for the teacher to actually teach the language necessary before hand, but this assumes that the teacher knows the words to be used and is prepared to use them.

Another issue that many schools in Japan face, is the lack of available equipment and infrastructure. It seems unrealistic that all schools will be able to offer computers to each student in the classroom. One alternative way to address such problems is to use methods that are connected to programming, but can actually be exercised without a computer. One example is the CS Unplugged initiative [6], which is sponsored by the tech giant Google and comes with a book in Japanese [7].

The use of books in this regard is an area in which Japanese elementary school teachers can be sure to find some support. A quick search of an online bookstore will reveal more than a hundred results for "puroguramingu kyouiku", as it reads in Japanese. Many of these books are already focusing on elementary school students. Because of this, teachers can find many examples and activities to integrate into their own classes [8][9].

Unfortunately, the conversation takes a tangent at this point. MEXT guidelines do not specify programming as a new subject, but as something to be taught in conjunction with other subjects. The document refers to "programmatic thinking," something that students should learn in order to be able to understand and solve problems.

Although teacher training and work overload [10] do come to mind when reading the guidelines, the purpose of this paper is not to discuss if the MEXT guidelines can be fully implemented but to actually survey on how receptive elementary school students are to programming as a subject. Next, we will try to understand how programming education fits into 2017 MEXT guidelines and later, report on the results of a small experiment conducted with Japanese elementary school students.

Understanding MEXT Guidelines for Programming in Public Education

Reading the 2017 MEXT General Course of Study Guidelines [1], we find programing education discussed, but the guidelines regarding the methods or tools to be used are not clear. One thing clear in the text is that, instead of creating a new subject, programing concepts should be taught using different subjects already in the curriculum. The document even goes further as to provide examples of how to achieve this end.

The whole idea of introducing programming education to Japanese elementary schools is based on asking teachers, who did not learn programming or algorithms, to actually introduce its concepts while teaching a plethora of other things to students. This situation is very similar to asking teachers to teach English, even though most elementary school teachers in Japan did not receive English language training and many cannot even speak it [11].

Although the idea does not seem very good at first, teaching programming together, or inside, other subjects actually opens up many possibilities to elementary school teachers. For the tech savvy, companies like Sphero [12], have already a lot of content that can be used for Mathematics, Science, Social Studies and Art [12], and many other free websites like Hour of Code [13] offer a great variety of activities that can be used by teachers.

As mentioned before, not all schools may have the resources to actually use or purchase equipment. In such cases, the use of unplugged activities [6] can be very helpful. Researchers have analysed a set of Japanese textbooks related to programming education, and discovered that, more than 50% of textbooks contained at least 12 unplugged activities [14]. This research finding suggests that it is possible for Japanese elementary school teachers to teach those twelve themes in the classroom by using such books.

As mentioned before, the purpose here is to find out how receptive Japanese elementary school students might be to programming classes. To answer this question, a small experiment was conducted in order to survey the use of robots, iPads and algorithm instruction to students of different ages.

Materials and methods:

Participants

For this preliminary study 3 Japanese elementary school students were observed while learning a set of basic programming concepts in 5 sessions. Each session was planned as a 45 minute lesson, in which students were introduced to the concepts of the lesson, practiced it and finally reported to the instructor on their experience. Students were first, third and fourth graders, and were chosen by availability due to the tight schedule imposed by this project.

Instrument

For the duration of the five sections we made use of Sphero SPK+ robots, iPads, and different programming applications.

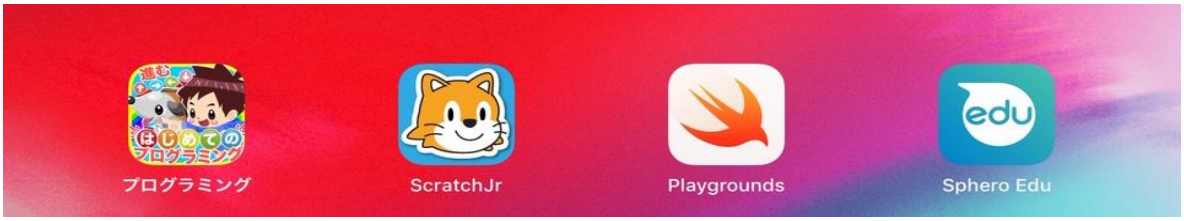

Figure 1 - All applications used in the experiment as shown in the iPad screens

Results

Lesson 1:

All three students were extremely excited to see the Sphero robots and also the tablet computers. The first thing that was necessary in order to keep the lesson going was to set Guided Access into the tablets. When students first received the tablets their first reactions were to check all the applications available in it and also to begin to play with the camera. Guided Access ensures that only one application will run at a time, and until it was set up in all iPads, the lesson was delayed.

This lesson actually ran for two hours, much longer than expected. The reason for this was that students wanted to try out different things with the Sphero robot and also experiment with the different applications installed in the iPads.

Instructor's observations: it looks very clear that students get excited with gadgets. Proper instruction is necessary before handing the hardware to students.

Lesson 2

In our second encounter, students were posed with the challenge of creating a track for the Sphero robot. It was amazing how the students were interacting among themselves by exchanging ideas and collaborating to create a race track for the Sphero robots. Physics concepts were clearly being applied when students try to create a cardboard bridge for the robots. Geometry concepts were also there when students were drawing circles on the cardboards and calculating were to cut them.

The lesson finished really quickly as students were enjoying the preparation more than the race itself. As a reward, students were allowed to race their Sphero robots for an additional 10 minutes.

Instructor's observations: Although not on purpose, this lesson showed how the robots can be used as a motivational tool or students to use concepts from other disciplines.

Lesson 3

For our third encounter we decided to focus on programming applications. Students went back to the programming applications introduced in the first lesson. All students were asked to start with the same application and after ten minutes, a new application was introduced. Once all three applications were shown, students were free to go back to the application that they liked the most. It is important to note that all available applications were carefully chosen so as to be applications that teach the same concepts, in this particular case, procedural thinking.

Instructor's observations: Students' progress within the applications was different. This seems to suggest that children of young school years might benefit from applications with simple interfaces that have bigger appeal to their age range.

Lesson 4

In this lesson, students were exposed to the concept of functions. The flow into this lesson was very easy as students remembered the tasks from the previous lesson. The concepts of functions and function calls were explained by the instructor and students were able to grasp it very easily.

Instructor's observations: Explaining functions required a little bit of role-playing. For example, to explain the function "turn right" as being the same as three calls of the function "turn left", students had to stand up and act as if they were the character inside the application.

Lesson 5

This lesson served as review of the previous lessons. The concepts of commands and functions were reviewed and the lesson ended with recreation time with the robots.

Instructor's observations: It became clear that students were waiting for the recreation time. Teachers can label an activity as recreation, but, in fact, such time can be used to teach programming concepts. The review was very successful: students remembered all the content of previous lessons.

Figure 1 - Students using the Swift Playground application

Figure 2 - Unplugged activity: Student follows commands from other students in order to reach the marked carpet tile

Discussion

After interacting with the students for five lessons it became clear that the content of the lessons needed to be tailored according to the student's age. Even though all three students had no previous programming experience, the difference in how fast the concepts were understood created huge gaps during the third lesson.

	Observations		
Student	**Crafting**	**Using commands**	**Using functions**
1st year	Very active during the craft activity while making the race track for the robots.	Using commands in English was not a challenge. Had some problem understanding the instructions in Japanese	Took some time to understand the concept of function calls. Writing down function names in English was problematic.
3rd year	Participated well and was very creative providing many suggestions.	Had no problems with directional commands.	Was able to create own functions. English naming was a problem (many functions had simple names like "aaa" or "bbb").
4th year			Was able to create own functions. Spent some time crafting the function names.

Student feedback was collected orally. Overall, all three students showed a lot of enthusiasm and reported that they wanted to continue learning. Surprisingly, the first-year student reported that the most enjoyable activity was the "writing in English to make the character move". This comment was related to the Swift Playground application and showed that the student perception was very different from the instructor's.

Final Considerations

Although a great number of videos have been developed for Sphero, and schools outside of Japan have successfully implemented it, special care needs to be taken regarding how children interact with the tablets and the robot. Children tend to play with it a lot and the focus of the lesson can be lost very quickly, requiring the instructor to be always attentive and checking if students are following the lesson.

Although the approach here has been quite different from MEXT guidelines, response from students has been so positive that it leads one to believe that both methodologies (i.e. teaching programming as a separate subject and teaching programing with other subjects), can be effective. From my personal experience, and looking at the current workload of Japanese elementary school teachers, I believe many elementary school teachers would rather "include" the programming-like way of thinking in their classes rather than learn a new set of tools themselves.

This raises an interesting question: Should instructors and professors, in our university, begin to teach programming to those students in our educational department who are aspiring to

become elementary school teachers in the future? And to what extent? Presently, our next step is to create seminars for such students and make sure that MEXT's recommendation can be achieved in the next couple of years.

At this point, it becomes clear that teachers themselves have to try out whatever activities they are planning to use in the classroom so that they might become comfortable with them. It is important to understand the different ways a class may go if the teacher is not properly trained and prepared. Without such training and experience, the teacher's learning objectives may not be achieved.

Due to time and volunteer constraints, this experiment is far from decisive, but served to give a good insight of future steps in our research.

Acknowledgements

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