Teaching ICT Skills to Children and the Empowerment of Female College Students in STEM in Japan

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Abstract. According to the Japanese government, “Society 5.0” is defined as “a future society that Japan should aspire to” and we will be able to solve our social problems with the use of Big Data, IoT, AI, and robots there. For this reason, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has focused its attention on teaching computing skills from early stages in formal education. It was decided to teach computing skills at elementary schools in 2020 and junior high schools in 2021. It will be particularly important to encourage female students to be involved in using computer skills in the future and this paper has its purpose to introduce a project of female students at a national institute of technology in Japan who teach programming a robot to younger generations. Their goal is to foster interest in STEM, particularly among female pupils and introduce them to role models through workshops because the number of female students is very low in this field in our country.

1. The Background

1.1. Society 5.0 and Teaching ICT Skills to Children in Japan

The Japanese government has started making efforts to build “Society 5.0” which was first proposed in “the 5th Science and Technology Basic Plan” in Japan. We will solve our social problems with the use of Big Data, IoT, AI, and robots in the future society as shown in figure 1[1]. For this reason, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has focused its attention on teaching computing skills from the earliest stages of compulsory education. It was decided to teach computing skills at elementary schools in 2020 and junior high schools in 2021. The curriculum at all elementary schools and junior high schools needs to be designed to suit the government guideline. It follows that it is compulsory to teach computing skills in their curriculum. It is worth noting that computing skills are regarded to be as important as language skills for children to acquire in the new guideline. The goals are to enable them to acquire basic skills in using the computer and make them aware of the ICT in their everyday life. They need to be able to think in a logical way through using the computer in the classroom [2].
1.2. Problems to Be Solved before the Launch of Teaching ICT at Elementary Schools

In reality, there are some problems to be solved before starting teaching computing skills formally at the earlier stage of school education. First, we lack professionals to teach computing skills to children. Teachers are not sufficiently skilled to programme the computer, and it is needless to say that they are too busy to start studying it. In addition, Kuno (2016) states that teaching programming is not systematic in formal education in Japan [3] and there is a lack of computers available in the classroom at present as Igarashi (2017) pointed out in “Software Japan 2017”, a conference held by Information Processing Society of Japan [4]. For example, one of the authors was told by an elementary school teacher in a local city that elementary school students had little opportunity to use the computer. In this way, we had a request from the local boards of education for our students to become mentors for children in the computer classroom at the weekend next year. In the next section, let us look at a group of female student volunteers at a national institute of technology who teach children programming a robot with the computer.

2. The Project

2.1. Gender Issues in STEM

Some female students at National Institute of Technology, Kagoshima College, launched a project to increase the number of female students in their institution. “Gender equality” is one of the Sustainable Development Goals of the United Nations to be achieved by 2030 [5]. According to the UNESCO Science Report, Japan has the least number of female researchers among OECD countries, which is only 15%. In addition, we have the second smallest number of female researchers in engineering and technology out of 75 countries, which is only 5.3% [6]. As for undergraduate students in Japan, female students are only 15% in engineering [7]. This means that there are few role models in this field for girls in younger generations to meet, which creates a vicious cycle whereby female students do not enter such courses as STEM, especially engineering.
National Institute of Technology, Kagoshima College has the least number of female students among 51 national colleges of technology in Japan, which is currently only 10%. A national college of technology is a five-year college, which is a combination of a high school and a junior college and a two-year advanced course follows it so that you can receive a bachelor’s degree. The group of the female students at NIT, Kagoshima College would like to impact girls in younger generations and their goal is to increase this number up to 20% in the near future.

2.2. Female Student Volunteers at a National College of Technology
This is how the female college students have been trying to change the situation at NIT, Kagoshima College. They set up a chapter of a student-run international volunteer organisation which was established by Australian university students in 2008 for the purpose of increasing the number of female students in the STEM fields. Currently, it has the headquarters in Australia and more than 30 chapters all over the world in places such as Europe, Africa, North America and Asia Pacific. There are three chapters in Japan: the first one in Tokyo, the second one in Hokkaido and the third one in Kagoshima.

In their workshop, they normally use a line-trace robot to teach programming a computer. First, they show children how a robot traces a black line on a white sheet of paper. And then, participants do it themselves. To enable their robot to move properly without falling or going off the line, they are asked to check on figures of a program on the computer in order to adjust the robot’s speed and turns. At the end of a two-hour workshop, their robot moves playing a melody they programmed. According to the size of a workshop, the number of volunteer students varies from 3 to 13 and participants are from less than 20 to 80.

They first had a workshop in March 2017. Since then, the female students have been regularly implementing computer programming workshops for younger students in local elementary schools and junior high schools even before 2020 when computer programming will be taught in formal education. Their purpose is to foster children’s interests in STEM through teaching programming robots and to introduce them to role models through workshops. They will continue this project until the number of female student’s increases up to 20% in their college.

2.3. The Result and Suggestions
This project can empower college students themselves as well as children. First, they can learn from the feedbacks of the participants. When they organise a workshop, they have meetings to tailor them to the age of the participants. They make a plan to adapt their workshop to be easy enough for children to understand, which also help them develop their ICT and communication skills. Afterwards, they try to improve their workshop based on the feedbacks. When they go to local elementary schools, they receive a warm welcome. Children look very excited during the workshop. Surprisingly, after a while, they also receive a bunch of thank-you compositions from the 80 ten-year-old elementary school students. To take some examples, their feedbacks are as follows: “How great you are to programme such a wonderful robot in a day!” “My dream is to be a cook, but I want to make a robot, too.” “I am surprised that 5 girls solve a problem when their robot does not move.” “How cool a robot is!” “It is a lot of fun to learn about robots. Please come to see us again.” According to their teacher, it is a great experience for them to see something programmed by the computer because they have almost no opportunity to ‘touch’ the computer. It should also be added that one of the female students at the elementary school visit NIT, Kagoshima College with her mother to attend a programming workshop again. It seems that the female students at NIT, Kagoshima College manage to give a positive impact on her.

Second, it is possible to provide opportunities to learn to be a global citizen through this project. Since they belong to a global organisation, international members communicate with each other. When launching a chapter, they contacted with Australian members. Since then, they have kept in touch. Moreover, some of the students attended an international conference in Australia to make a presentation on this project and meet Australian university student volunteers. They shared their
volunteering experiences, brushed up their teaching skills in ICT, and learned the leadership together. Others went to universities in the USA and the UK for a short term to learn communication skills and teaching ICT skills for this project.

Finally, their workshops have a good reputation in that children have fun learning IT skills in the workshops. They are asked to participate in a variety of local events in Kagoshima. It is very fortunate that they receive financial support from leaders in the industry who appreciate the importance of educating female students to be engineers. They are provided opportunities to visit their factories to have a look at the latest technologies which will surely be a part of “Society 5.0” mentioned in the previous section. Their support also enables them to go abroad such as Australia, the USA and the UK. In this way, working for the younger generations seems to lead to the female college students’ own empowerment.

3. Conclusion
We may be able to conclude that this approach is innovative in Japan in that female college students are involved in the project for teaching ICT skills to children. Their purpose is to foster children’s interests in STEM and show them role models in this field. We hope that they will be able to reach as many girls in younger generations as possible so that the number of female students in STEM will increase in the near future, although the number at present is much lower than that of other countries.

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