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REPORTS

Informatics and Programming Education at Primary and Secondary Schools in Japan

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Abstract. In this paper, we introduce the present situation of informatics and programming education at primary and secondary schools in Japan. Furthermore, we also explain post-2020 new informatics education. Previously, the importance of informatics education has not been recognized in Japan. However, with this educational reform, it is expected to start to change the attitude toward informatics education. In the New Course of Study, all elementary school students will experience programming and all high school students will learn informatics.

Keywords: informatics education, programming education, information study.

1. Introduction

In recent years, there is increasing interest in informatics and programming education at the elementary and secondary level around the world. In Japan, the Prime Minister Shinzo Abe declared at Industrial Competitiveness Council in April 2016 that Japan will make programming education compulsory from primary and middle school (Prime Minister of Japan and His Cabinet, 2016). This declaration had a great impact on the whole society in Japan including industries and local governments as well as

parents, teachers and schools. In Japan, school curriculum guidelines are revised every ten years.

MEXT (Ministry of Education, Culture, Sports, Science and Technology) prepares to reflect this policy in the new Courses of Study which will be published from 2017 to 2018 and implemented beyond 2020.

In this paper, we introduce the present situation of informatics and programming education at primary and secondary schools in Japan. Furthermore, we also explain post-2020 new informatics education.

2. Current Japanese Education System

The education system in Japan consists of 6 grades of primary education, 3 grades of lower secondary education, 3 grades of upper secondary education and higher education. The academic year starts from April and ends in March. Fig. 1 shows the education system in Japan. Compulsory education is nine years: six years in primary school and three years in junior high school. After compulsory education, about 98% of students enter high school and about 50% of students enter university. In Japan, in

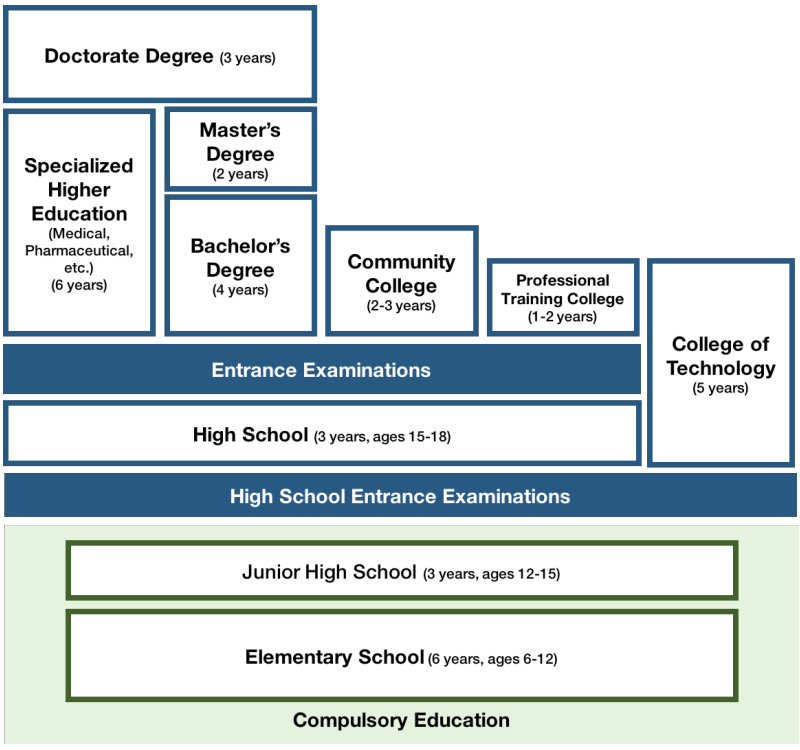

Fig. 1. Education System in Japan.

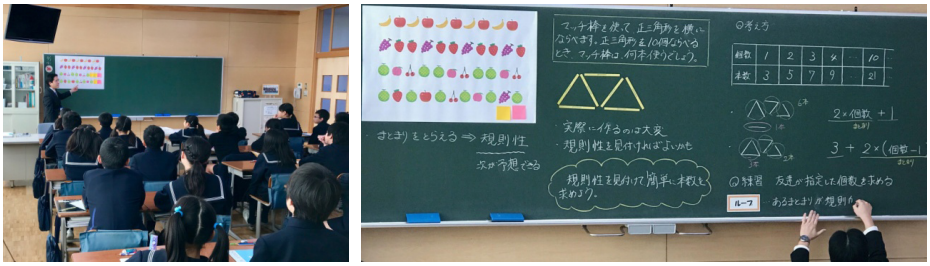

Fig. 2. Classroom in a primary school.

2015, there were about 20,601 primary schools, 10,484 junior high schools and 4,939 high schools (MEXT, 2017). There are several types of high schools including general course, specialized course (commercial studies course, technical studies course, and others) and integrated courses. Here, we report the informatics education in general high schools.

In elementary school, students learn mainly Japanese language, arithmetic, science, social studies, music, arts and handicrafts, homemaking, and physical education. The existing course of study does not include informatics education. Therefore, most teachers do not have training in teaching informatics. Each class is assigned a homeroom teacher. He or she teaches almost all subjects. In recent years, electronic blackboards were introduced to almost schools. Furthermore, some schools began to use tablets in the classroom. Fig. 2 shows a classroom in a primary school. In this class, the teacher lessons mathematics using informatics such as iteration.

In junior high school, students learn mainly Japanese language, mathematics, science, social studies and English language. Junior high schools have specialize teachers who teach their subjects. Students have different teachers for different subjects. All students also learn computer literacy and basic robot programming in "Technology", which is a branch of the subject "Technology and Home Economics". To study "measurement and control" section in "Technology" that covers basic robot programming, students purchase learning materials such as robots dedicated to line tracing. Fig. 3 shows some robots and sample program using in junior high schools. There are several kinds of robots. For example, Robot cars for line tracing such as the left picture in Fig. 3 have two

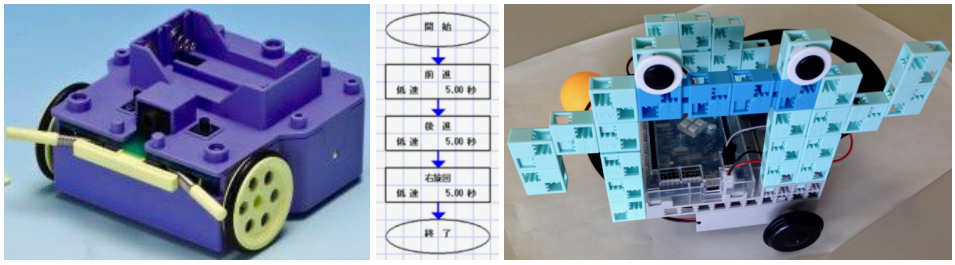

Fig. 3. Some robots and sample program using junior high school.

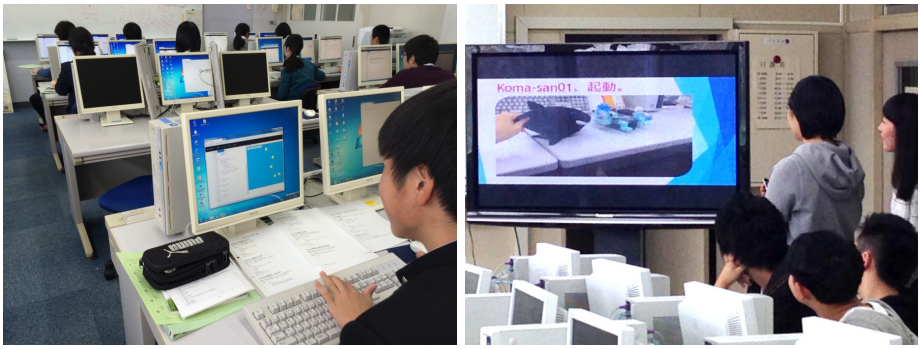

Fig. 4. Classroom in a high school.

motors, an infrared sensor and touch sensors. Robots such as the right picture in Fig. 3 are constructed by some blocks and CPU board (Arduino compatible). Students write programs using flowcharts, visual programming languages such as Scratch, and text-based programming languages such as Dolittle (Kanemune, 2005).

In high school, all students learn the subject "Information" from 2003. "Information" consists of two optional subjects named "Information Study for Participating Community (Society and Information)" and "Information Study by Scientific Approach (Information Science)". Students learn about programming in "Information Science". Schools are able to select either of the subjects to teach. About 80% of high schools teach "Society and Information" and about 20% of high schools teach "Information Science" (Kano, 2016). In other words, only 20% of students have an opportunity to get the education about "Information Science" and programming in high school. Fig. 4 shows a classroom in a high school.

3. Informatics Eeducation in New Curriculum

3.1. *Elementary School*

The New Course of Study is to be fully implemented at elementary schools from 2020. The course of study includes compulsory programming education. Students will learn logical thinking through programming experiences. However, there is no subject to teach informatics. Therefore, students will learn programming in the subject such as arithmetic and science or the Period for Integrated Studies, which is a period that has been allocated for cross-curricula study.

Teacher education is a major challenge for elementary school programming education. Elementary school teachers in Japan teach all subjects. In other words, all teachers have the possibility for teaching programming classes. Conducting programming education to 400,000 teachers until 2020 is difficult.

Consequently, it is crucial that schools, communities, local governments and other organizations such as academic societies and educational institutions join together in resolving these challenges. It is also important that textbook publishers develop useful textbooks for teaching programming and the governments publish case studies books. Additionally, local governments need to conduct the training for teaching programming and send ICT support staffs to schools for helping teachers.

3.2. *Junior High School*

The New Course of Study is to be fully implemented at junior high schools from 2021. In the subject "Technology", students will learn two types of programming, "measurement and control" and "network communication".

The challenge of junior high school is class hours to study informatics. In 1976, the lesson of the subject "Technology" was specified that 315 class hours in 3 years should be spent on the subject including "drawing", "woodworking", "metalworking","machinery", "electricity", "cultivation" and "total practice". However, "Technology" in the present Course of Study has been specified that 88 class hours should be spent on the subject including "craft", "energy", "cultivation" and "information". Table 1 shows the proposed content of "Technology". It is not enough for learning informatics deeply.

Table 1

Proposed contents of the subject "Technology" in the new course

Technology
(1) Materials and Processing Technology • Materials and Processing Technology as a Foundation for Society • Problem-Solving using Materials and Processing Technology • Social Development and Materials and Processing Technology
(2) Cultivation Technology • Cultivation Technology as a Foundation for Society • Problem-Solving using Cultivation Technology • Social Development and Cultivation Technology
(3) Energy conversion Technology • Energy conversion Technology as a Foundation for Society • Problem-Solving using Energy conversion Technology • Social Development and Energy conversion Technology
(4) Information Technology • Information Technology as a Foundation for Society • Problem-Solving using Computer Network • Problem-Solving using Equipment Automation Technology • Social Development and Information Technology

3.3. *High School*

The new high school curriculum starts from 2022; however, the relevant year will apply only to the first grade. After that, it will be followed by yearly progress. Two selective courses of subject "Informatics" will be integrated into compulsory subject "Information I". A new advanced subject "Information II" will be prepared. Each subject has been specified that 70 class hours.

Table 2 shows the proposed content of "Information I" and "Information II". Both subjects have similar structures as follows: (1) is an introduction, and students learn about utilization of information technology in society. (2) Students learn to use information in their lives and work. (3) and (4) Students learn information science and technology including programming such as data processing, statistical processing and network programming, which are fundamental technologies of AI and IoT. Students learn a basic knowledge in "Information I" and learn an advanced knowledge of each fields in "Information II".

4. Conclusion

In this paper, we introduced the situation of informatics education and future educational policy in Japan. Previously, the importance of informatics education has not been recognized in Japan. However, with this educational reform, it starts to change the attitude

Table 2
Proposed contents of the subject "Informatics" in the new course

Information I (compulsory subject)	Information II
(1) Problem-Solving in Information Society • Utilizing computers in society • Information security	(1) Development of Information Society and Information Technology • Influence of information technology on society • Use of information technology to solve problems
(2) Communication and Information Design • Information and media • Information design	(2) Communication and Information content • Various communication using video, etc. • Appropriate use of information contents
(3) Computer and Programming • Data representation inside the computer • Basics of programming • Modeling and simulation	(3) Information and Data Science • Statistics basics • Processing according to characteristics of data
(4) Information Network and Data processing • How the network works • Server • Database	(4) Information System and Programming • Information system design • Communication of computers • Project management

toward informatics education. In the New Course of Study, all elementary school students will experience programming and all high school students will learn informatics. Adoption of 'informatics' at college entrance examination is also being considered. The Science Council of Japan's Committee on Informatics defined a reference standard in informatics (Hagiya, 2015).

The Japanese Committee for the IOI (JCIOI) conducts the Bebras challenge in Japan. It also develops computer science unplugged (CSU) activities and holds a CSU event for primary school students every year. We consider that these activities help primary and secondary school teachers to teach informatics. For example, some schools has been started to adopt the Bebras challenge. Bebras is a challenge-contest on Informatics and computational thinking (Dagienė *et. al.*, 2015). At a school, students make Bebras tasks to deepen understanding related to information science after the challenge-contest. Several tasks which are designed by students were suggested via JCIOI to Bebras task workshop. Furthermore, they are selected as good Bebras tasks and used in some countries. Actually, It was reported that a problem made by a student was one of the most interesting tasks among students in Lithuania (Dagienė *et. al.*, 2016). We would like to spread such practice nationwide and to keep preparing for new education from 2020.

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