Development of ICT-based learning materials for ICT literacy

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Abstract. ICT literacy can be divided into technical and ethical content; this study deals with technical content. In particular, in this study, teaching materials were developed to teach sorting algorithms. Students can learn about computer movements and algorithms through a game in which they sort 10 characters of animals in ascending order.

1. Introduction

With the development of ICT, people benefit from convenient and comfortable information technology. When it comes to Society 5.0, with advanced technologies such as artificial intelligence (AI), big data, IoT and robotics becoming more sophisticated and incorporated into all industries and social life, creating a situation where the very nature of society itself is undergoing dramatic change. People are expected to have the qualities and abilities to use such digital information and technology effectively.

In particular, in the field of research, ICT has made it possible to collect and analyze a great deal of information from all over the world and to disseminate the results to the rest of the world. In addition, e-learning and learning management systems (LMS), one of which is e-learning, are increasingly used in education, and the effective use of multimedia, including audio and video, is expected to enhance the continuity of learners' learning compared to existing paper-based materials [1]-[3]. ICT-based learning materials are therefore the best means of learning ICT literacy.

In this study, teaching materials for learning ICT literacy will be developed, and these materials will be further improved by having secondary school students at the secondary school stage experience the teaching materials.

2. "Information" as a Subject Area in the Curriculum Guideline

Learning in schools is undergoing major changes. Primary schools switched to the new Curriculum Guideline from 2020, junior high schools from 2021 and senior high schools from 2022. The new Curriculum Guideline revised in 2017 and 2018 aim to develop the following three skills in a balanced manner[4].

- ・ Ability to learn, humanity, etc.: to apply what they have learned to life and society.
- ・ Intelligence and skills: to live and work in real society and life.
- ・ Ability to think, judge and express: which enables them to cope with unknown situations.

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These suggest that students need the ability to make their own decisions and survive in unpredictable and unknown situations. The emphasis on independent, interactive and deep learning (active learning) and the establishment of curriculum management have been proposed as ways to help students acquire this ability.

The new Curriculum Guideline became a hot topic about "programming education" becoming a compulsory subject in primary schools. The MEXT document describes "programming education" as "experiencing and learning how computers are driven by programs and used in society."

The subject of "Information" has also been restructured in high schools, with the establishment of "Information Study I" and "Information Study II". Under the old Curriculum Guideline, students were required to take one subject of either "Information Study for Participating Community" or "Information Study by Scientific Approach". Under the new Curriculum Guideline, all students are required to take "Information Study I". This meant that all students learn basic knowledge of information technology, including programming, networks and databases.

3. Definition of ICT Literacy and the Topics Covered in This Study

ICT literacy can be divided into ICT technology itself, i.e. mathematical engineering content, and ethical content, such as judging the authenticity of information obtained using ICT. This study focuses on the former, mathematical engineering content. In particular, we developed teaching materials on sorting in order to learn "algorithms", one of the essential concepts for understanding ICT technologies.

The latter ethical content is known as "media literacy" and "internet literacy", and a lot of educational content is provided not only for child students but also for the elderly. The textbook [5] of my University's course "ICT Literacy" defines media literacy as "selective use ability to be able to use various media for different purposes", "critical receptive skills to be able to critically accept information through the media", "expressive transmission competence to be able to express oneself through the media", "communication skills to be able to practice relations with others". The textbook [6] for the high school subject "Information Study I" defines it as "the ability to analyze and evaluate information reported in the mass media from various perspectives, to judge the truth or falsehood of information correctly and to express it in effective forms by using various media such as text and images".

Based on the above, one definition of ICT literacy would be "qualities and competencies related to the use of digital information and technology" [7].

4. Developed Teaching Materials for Learning about "Sorting"

The teaching materials we have developed is described in this chapter. As the subject area "Information" has become a compulsory, there is a shortage of teachers who can teach "Information" in the field. In view of this situation, we developed the teaching materials on the assumption that non-specialist teachers will be teaching "Information" classes.

The material is developed in jQuery and JavaScript and can run in common web browsers. It also works on tablets and smartphones. At the same time, a teaching plan for the use of this teaching material and a printout for students were prepared and published together with the teaching material. It includes an introduction to the class, peripheral knowledge, how to use the teaching materials, and points to bear in mind when teaching, so that classes can be conducted even without a special computer environment or previous knowledge.

Figure 1 shows the teaching material and an example of how it works. Students sort the randomly presented animals in order from left to smallest. They complete the rearrangement as few times as

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possible, with the only restriction being that "clicking on two animals swaps their places". Through this game, students learn computer behavior, algorithms and concepts of computing cost.

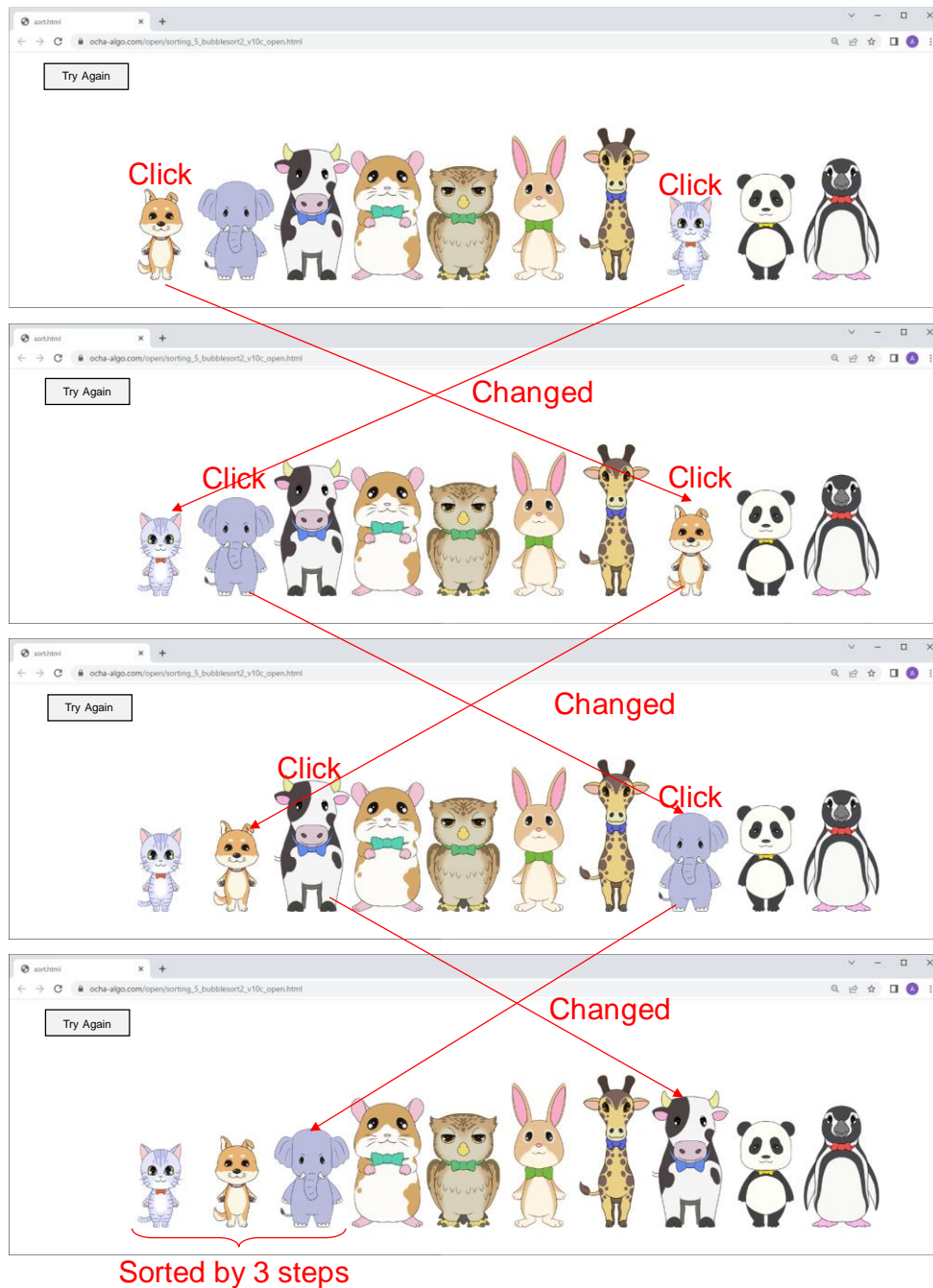All teaching materials and instructional plans were prepared in Japanese.

Fig. 1 Developed teaching material and an example of how it works.

5. Conclusion

A teaching materials developed for understanding sorting algorithms through a game in which animals are sorted in a small number of steps under the restriction that "the places of two animals are swapped" were presented. Teaching materials for learning different algorithms and a tool for teachers

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to analyze students' operation logs and use them for teaching are under development. Furthermore, the teaching material will actually be used in high school classes.

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