論 文 の 内 容 の 要 旨

論文題目　Effects of Web GIS Technology and Curriculum Approaches on Education for Disaster Risk Reduction
（Web GIS の技術とカリキュラムの編成が防災教育に与える影響）

氏　　名　　宋　佳麗

With the increasing national and international policy agendas for DRR (disaster risk reduction) strategies, more web hazard maps have become available for education. Some teachers and researchers have applied these materials to disaster prevention education in schools. However, few studies have compared the effectiveness of web hazard maps with that of paper hazard maps in DRR education. Not much knowledge exists about whether students can improve their understanding of DRR through Web GIS technology and which factors affect students' learning of web hazard maps.

This study has provided materials and curricula for DRR education in Chinese and Japanese senior and junior high schools. The educational materials consist of web hazard maps and conventional web pages. The web hazard maps deal with several data layers that can be optimally combined during browsing. The web pages include two sections, “principles” and “examples.” The principles section explains the concepts, causes, and characteristics of disasters in relation to widely used geography textbooks. The examples section introduces some cases of past hazards using explanation text and illustrations. The curricula provide course plans to utilize the web hazard maps and web pages in which students identify areas vulnerable to hazards. The developed educational materials and curricula were used in classes and workshops in Chinese and Japanese high schools. The early version of materials and a curriculum (Version 1) was implemented eight times from 2018 to 2019. The total number of attended students was 237, with 153 belonging to junior high schools (7th to 9th grades) and 84 to senior high schools (10th and 11th grades). In terms of gender, 139 were male, 97 were female, and one student chose not to answer. The studied cases had two types: (a) a flood disaster example was taken from an area far from each school, and (b) an example was taken from a place close to each school. For the classes, both the constructed online materials and paper hazard maps were used for comparison. Students in a classroom were divided into several groups, each having several students working together. Students in a group share a device to use the online materials. The intended length of each class was 45–60 min.

The results of the implementations indicate that most students thought that DRR learning using Web GIS

technology needs to be introduced to school education. The web hazard maps are more helpful than paper hazard maps in terms of information abundance and accuracy. The web-based materials developed for this study can be used with various devices, including PCs, smartphones, and tablets, without installing additional applications. Although network speed may still affect the efficiency of online learning, the materials are relatively light and straightforward, and usable with a small number of operations. During the implementation at multiple Chinese and Japanese schools with different network conditions, technical problems related to the speed of the Internet did not occur, indicating the high usability of the materials. Many students preferred the web hazard maps, and almost all students could conduct the requested operations. Although the web maps seem to be a priority, using both web and paper hazard maps can provide the best DRR education. A somewhat unexpected result of this study is that a familiar case study area (Type B) made it harder for the students to understand the distribution of hazard risks, suggesting that more knowledge and information about a case study area made students view things from various perspectives, leading to complex thinking and difficulties with judgment. Everyone should understand the hazard risks around their place of residence. Accordingly, the education and popularization of local disasters, including historical cases, need to be advocated. Teachers and students in classrooms should work together to understand future disaster risks in local areas based on hazard maps and additional information.

To understand which factors influence students to learn web hazard maps, the second edition of the educational materials and curriculum (Version 2) was developed. More explanatory web pages with multi-media contents were added to provide a more fundamental knowledge of maps, GIS, and the natural environment. Also, hazard maps for different types of hazards were included. The Version 2 online materials utilize a local Internet server provided by the Center for Spatial Information Science at The University of Tokyo, Japan, and the domain name paid services of Alibaba Cloud, China. The Version 2 materials and curriculum were used in classes and workshops in Chinese and Japanese high schools eight times from 2020 to 2022. These classes had three forms of implementation due to the COVID-19 pandemic: online, onsite, and online-onsite mixed. The online and onsite forms were implemented multiple times in Chinese secondary schools. In the online-onsite mixed form, students were in classrooms, but the lecturers taught online through conference software. It was implemented in four classes in a Japanese high school. The number of attended students was 526, with 226 in the online form, 238 in the onsite form, and 62 in the online-onsite mixed form. In terms of gender, 238 were male, and 288 were female. Each student used his or her device during the Version 2 implementations. The students firstly answered a pretest. Then they learned about DRR using the explanatory web pages and the web hazard maps with answering quizzes shown on the pages. After that, they answered a posttest and a questionnaire. The intended length of each

class was 90–110 min. However, the onsite implementation in China took two class hours, whereas each implementation in Japan was shortened to 50 minutes due to the epidemic.

We investigate the previous DRR-related experiences of students. Among disaster types, earthquakes are often taught, and the three principal sources for students to acquire disaster knowledge are computers, smartphones, TVs, radios, and schools. This suggests that modern communication is the primary vehicle for disseminating DRR knowledge. As a supplier of fundamental and systematic knowledge, schools should combine advanced equipment and technology to achieve optimal DRR education results. In addition, many students are concerned about disaster prevention and mitigation-related content, even during ordinary times. Most students expect to introduce the digital DRR learning materials used in this study to general school curricula. Due to the network speed and the server for teaching materials, many web maps, videos, etc., were not loaded smoothly during the implementation processes, as reflected in the results of questionnaires to students. Therefore, schools should provide high-speed Internet access.

Students in Chinese high schools show significantly improved results after using the digital DRR materials. It is particularly obvious for the onsite implementations. The pretest scores for the implementations using local disaster cases are low, but the subsequent improvement is significant. Gender hardly affects the learning of students. The ability of students to utilize electronic devices affects the learning of GIS-related content but not other aspects. Furthermore, past experience in using online hazard maps influences the understanding of DRR-related content. The frequency of daily usage of online maps and that of the daily attention to disaster prevention and mitigation affect the learning of the entire materials. Increasing the use of online maps is a key to realizing social DRR.

We also compared the learning effects between the two versions of DRR learning materials and curricula, and those between the two countries. For both versions, the understanding and satisfaction of students are high, and Version 2 shows higher performances than Version 1. This suggests that the improvement made in Version 2 is effective for DRR education. However, students' understanding of the causes of disasters for Version 2 is not as good as that of Version 1. The oral explanation was more detailed during the Version 1 implementations because the explanatory web pages were less developed, which compensated for the limited content on the web. Finally, students gave more comments on the loading speed of the online materials for Version 2 than for Version 1. This may be because several students shared one device during the Version 1 implementations, which significantly reduced the number of visits to the DRR learning materials. If the number of equipment or the network environment is limited, device sharing provides better online learning. Other than tsunamis, the percentage of disasters of concern for Chinese students is much higher than that for Japanese students, especially forest fire disasters. Tsunami disasters are more worried

in Japan because it is a maritime nation. The surrounding seas provide abundant air moisture in Japan to reduce forest fire. There is no significant difference between Chinese and Japanese students in the utilization of web hazard maps to learn DRR.

In previous research on educational materials and curriculum development, educational effectiveness was usually examined in one country using a single set of materials and a curriculum, and implementations typically involved only dozens of students in one or a few schools. This study investigated the educational effectiveness of newly developed materials and curricula through the implementations to 526 students in more than ten schools in two countries, using two versions of materials and curricula. Therefore, this study is considered more extensive in scale and more comprehensive than previous studies, and hence provided various insights into the effectiveness of DRR education on a statistical basis.