DEVELOPMENT OF TEACHING MATERIALS AND THE DATA ANALYSIS COMPETITION FOR SECONDARY EDUCATION

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It is hard to say that statistical education in Japan is sufficiently widespread. Various researchers and scientific society are conducting dissemination activities of statistical education against this problem. For this problem, we are developing educational content and conducting competition. In the development of educational contents, we focus on flip teaching, presenting texts and related contents so that students can learn by themselves, and develop content that does not limit location and time. In this content, students have also released online tests to confirm the proficiency level. In the competition, we lend actual professional sports data to team consisted of student in secondary education, the team express the analysis results on a poster, and we evaluate these posters. Each team creates research questions, gathers required data from given data and open data, makes analysis data, analyzes it, and summarizes it in a poster. This activity considers the PPDAC cycle. This presentation will introduce these details.

INTRODUCTION

Since 2010, business journals, media and others have begun to focus to statistics and data science. Not only in business society but also in school education, there is similar movement in elementary school, junior high school, senior high school for the courses of study presented in February 2017 and 2018.

But it is hard to say that statistical education in Japan is sufficiently widespread. Various researchers and scientific society are conducting dissemination activities of statistical education against this problem. Fujii et al. (2014) introduce a set of examinations that carries out the Japan Statistical Society (JSS), called the JSS Certificate (JSSC), for students and professional statisticians or interviewers working in various fields related to statistics. Takeuchi & Suenaga (2016) investigated the work related to the utilization of data of employed workers in Japan and reported the results. Takeuchi (2017) aimed to construct an index for measuring the effectiveness of collaborative learning, analyzed the language data measured by collaborative learning class as its preliminary research, and verified the trend.

In this paper, we are developing educational content and conducting competition for secondary education.

LEARNING ENVIRONMENTS USING ELECTRONIC TEXTBOOKS AND LEARNING MANAGEMENT SYSTEM (LMS)

Electronic textbook changed learning. By using electronic textbook, students can learn anywhere and anytime. But in classes using e-books, teachers can not know student's learning record. Therefore, we have constructed a lesson environment using electronic textbooks and learning management system (LMS), and are creating student's subjective learning environments. We digitized commercially available textbooks. The electronic textbooks used in this study were electronized Ishibashi & Watanabe (2018) and were produced by the authors.

In this electronic textbook, not only text but also keyword search in the text and memo writing with the pen can be done, enlargement / reduction of the screen is also possible. Students can also download related class slides and Excel data files and can also be used for subjective learning. Many of these contents can be used not only on PCs but also on mobile phones and tablets. In addition, exercises and their scoring systems are included to confirm proficiency (Figure 1-Figure 4).

In M. A. Sorto, A. White, & L. Guyot (Eds.), *Looking back, looking forward. Proceedings of the Tenth International Conference on Teaching Statistics (ICOTS10, July, 2018), Kyoto, Japan.* Voorburg, The Netherlands: International Statistical Institute. iase-web.org

Figure 1. Cover of electronic textbook

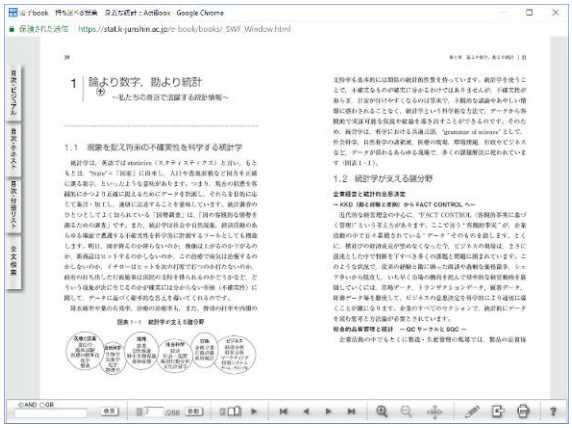

Figure 2. Contents of electronic textbook

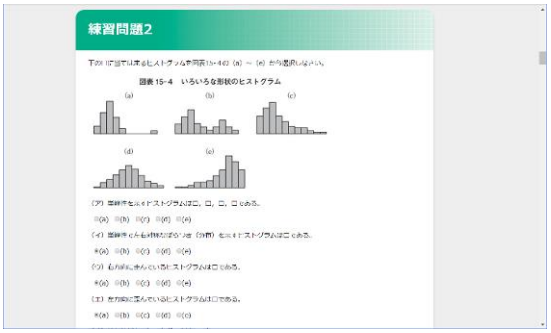

Figure 3. Sample of exercise

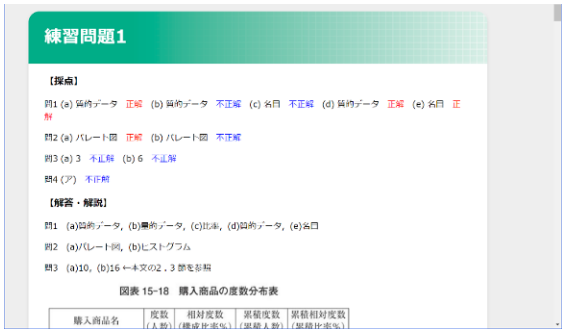

Figure 4. Examples of answers to exercises

By incorporating these contents into the LMS as teaching material contents, we plan to operate the browsing history and bulletin board among users. By using LMS, we can see the contents of the browsing history of students. Also, we can expect information sharing among participants by bulletin board. Of course, you can also submit the assignment, you can also test using computer. On the other hand, participants can also confirm their own learning records and look back on their own learning anytime, anywhere. By using the test function of LMS, automatic scoring is also done, and learners can know their score as soon as the test is over.

SCIENCE TOOL BOX FOR UTILIZING MATERIALS AND ANALYZING DATA IN MATHEMATICS

In modern society, it is required to develop statistical thinking ability to statistically grasp problems around us, analyze and evaluate them scientifically, and derive trends and results. In order to develop statistical thinking skills, it is important not only to learn how to organize data, but also to conduct processes such as collecting data, organizing / analyzing data, judging results, discovering knowledge by connecting with students' mathematical activities such as repeated it is necessary. In Europe and the United States and other foreign countries, the teacher repeatedly learns the way of thinking and utilization of data analysis according to the developmental stage from the early stage of school education for each student every year (Fujii, 2007; Fukazawa, 2007). Because of this situation, we need teaching materials for data utilization and data analysis, aiming to nurture statistical thinking ability.

Based on these facts, we are also developing “science tool box” (http://rika-net.com/contents/cp0530/start.html). “Science tool box” is a digital teaching material developed under the support of Japan Science and Technology Agency (JST). Figure 5 is top page of “Science tool box”.

Figure 5. Top page of “Science tool box”

In teaching material development, we emphasize the following two points. The first is the introduction of data analysis cases in advanced science and technology and various events in everyday life. By knowing how data is used and how it is utilized in advanced science and technology and everyday familiar events, it is possible to develop the ability to capture various events statistically. The second is to develop an environment that can analyze relatively large scale data of reality. Mathematical activities for students to repeatedly analyze and interpret the actual data themselves are important. To do so, realistic data corresponding to the developmental stage of the students and software to actually analyze the data are indispensable, so to include the data library and analysis software from the educational point of view as contents.

Based on these facts, "Science tool box" was developed for use in science and mathematics education at elementary school, junior high school, high school, and includes the following contents.

Interviews with experts

It is a mini lecture of various scientists and practitioners, such as research company, marketing, weather and so on (Figure 6, Figure 7). In this interview, we asked experts to explain the importance of data analysis, and introduced some of the advanced technologies and practical data utilization. In this regard, we recognized the usefulness of learning statistics for the future and aimed students to motivate learning.

Figure 6. List of interviews

Figure 7. Contents of interviews

A video based on a story

“Science tool boxes” contain videos to learn the analysis story based on mathematics and topics in science (Figure 8, Figure 9). The analysis story introduces a series of data analysis stories, such as the background of data collection and data collection and reading results, with video animation and Flash animation. It is possible to learn the use situation of statistical analysis in the real world which can not be learned in the lesson which is the main purpose of teaching the concepts of statistics and learn the necessity of statistically grasping various events.

Figure 8. List of videos based on a story

Figure 9. Sample of video

Animation to learn statistics by familiar characters

In the “Science tool boxes”, a story of statistics using familiar characters is also included (Figure 10, Figure 11). This animation is a Flash animation which explains statistical concepts, graph reading and how to make, and notes in a clear way. To make it easy for students to learn primary content, we used animation by characters. Voice narration also comes with more advanced content. These voice information can be viewed as character information.

Figure 10. List of animations

Figure 11 characters in animation

Data available for analysis

In order to experience the analysis of the data, the actual data is included in the “Science tool boxes” (Figure 12, Figure 13). The data library included compact size data sets and large data sets, considering various uses, such as using in exercises during lessons or developing learning such as self study. By doing this, the teacher aims to develop students' ability to voluntarily utilize the data, to develop knowledge discovery and problem solving skills.

Figure 12. List of data library

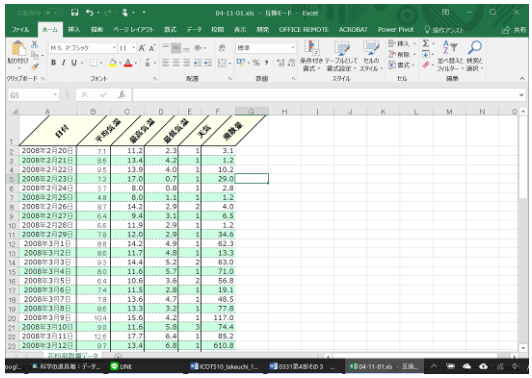

Figure 13. Data of data library

Statistical graph software capable of simple analysis

From the data collection, individual data can be downloaded with Microsoft Excel (Excel) format data. Also, since the simple statistic graph software is developed using Excel macros, it can be used if it is a PC on which Excel is installed (Figure 14-Figure 17). Statistical graph software is an intuitively easy-to-understand interface that focuses only on necessary functions, considering operability and terms that students can use easily, and can analyze without being influenced by personal computer operating skills.

Figure 14. Software for primary school students (1)

Figure 15. Software for primary school students (2)

Figure 16. Software for junior high school students and high school students (1)

Figure 17. Software for junior high school students and high school students (2)

We hope to contribute to the development of statistical thinking skills of students by using 'Science Tool Box' for class.

SPORT DATA ANALYSIS COMPETITION FOR SECONDARY EDUCATION

We are holding a sports data competition in secondary education from 2013 in collaboration with the Japan Statistical Society sports statistics subcommittee. In this competition, we will lend actual Japanese sports data to students and compete for analytical skills. Participants will summarize the analysis results in an electronic poster. Each team creates research questions, gathers required data from given data and open data, makes analysis data, analyzes it, and summarizes it in a poster. This activity considers the PPDAC cycle. Figures 18 and 19 are awards poster for 2017 created by students of Kanonji Daiichi High School.

Table 1 shows the number of participating teams of sport data analysis competition for secondary education. With this competition we will continue to support that students are interested in data analysis and motivation to learn data analysis. These reviews are conducted by members of Special Committee of Statistical Education of Japan Statistical Society.

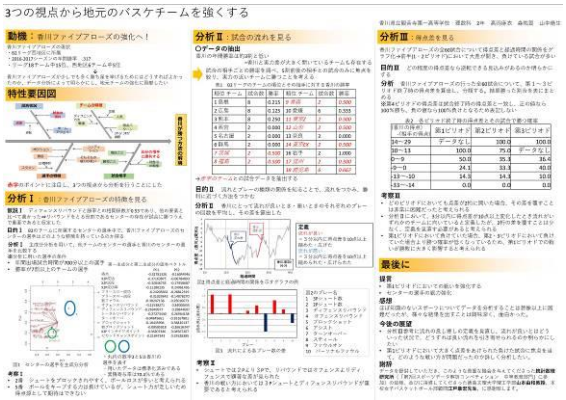

Figure 18. Poster that won the Best Award

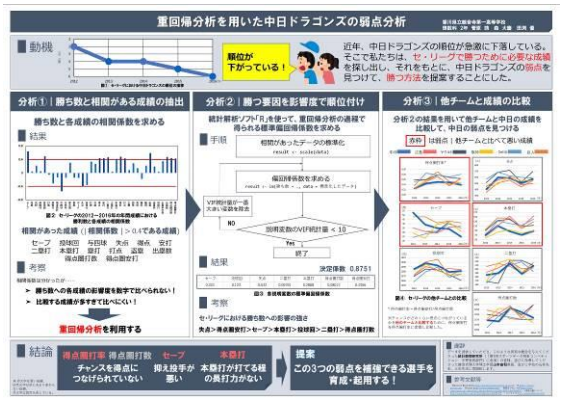

Figure 19. Poster that won the Excellence Award

Table 1. The number of participating teams

Year	2013	2014	2015	2016	2017
Team	10	15	10	5	65

FURTHER DEVELOPMENTS

In this paper we introduced two electronic contents we developed. By using this electronic content, learning statistics becomes more familiar, we believe that statistical learning which is not limited to place and time will be possible. In the future, we will collect learning record data using LMS and carry out awareness survey and make improvements based on the analysis result.

In addition, I introduced sport data analysis competition for secondary education. According to the students who participated in this competition, analysis of the data was difficult but it was fun and valuable experience was able to be made. Moreover, I heard that the participants also led to motivation to learn the analysis of the data.

It may be hard to say that these statistical education activities are sufficient in Japan now. As a factor, there are not many teachers who have learned statistics so far, and some teachers are concerned about their guidance. Based on the teaching materials and competitions introduced in this paper, we are considering support of teachers with these uneasiness. For that purpose, we are also considering sharing information with teachers, developing teaching materials based on needs, and studying the lesson method. Also, as a place for these presentations, we hold workshops every year. We would like to continue these activities in the future.

REFERENCES

Fujii, Y. (2007). Guideline in Statistics Education proposed by American Statistical Association. *Journal of Japan Society of Mathematical Education*, *89*(7), 49-54. (in Japanese)

Fujii, Y., Fukazawa, H., Takeuchi, A., & Watanabe, M. (2014). A certification system for statistics knowledge and skills by Japanese Statistical Society. In K. Makar, B. de Sousa, & R. Gould (Eds.), *Sustainability in statistics education. Proceedings of the Ninth International Conference on Teaching Statistics (ICOTS9, July, 2014), Flagstaff, AZ, USA*. Voorburg, The Netherlands: International Statistical Institute.

Fukazawa, H. (2007). Comparative Study of Statistics Education in School : Statistics Curriculum in New Zealand. *Journal of Japan Society of Mathematical Education*, *89*(7), 39-48. (in Japanese)

Ishizaki, K., & Watanabe, M. (2018). Familiar Statistics, The Open University of Japan. (in Japanese)

Takeuchi, A. (2017). The influence of student staff in collaborative learning lesson from language data of impressions, *In Proceedings of The 31st symposium of The Japanese Society of Computational Statistics (JSCS)* (pp. 179-180). (in Japanese)

Takeuchi, A. & Suenaga, K. (2016) Statistical basic education seen from survey results on data science education. In *Proceedings of The 30th symposium of The Japanese Society of Computational Statistics (JSCS)* (pp. 169-170). (in Japanese)