

Co-research into Development of Sustainable Development Teaching Materials

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1. Development of sustainable development teaching materials

(1) Teaching materials focusing on risk assessment

For the past thirty years, we have pursued research and development of environment-related teaching materials together with joint researchers. This research has dealt with the concept of acceptable levels, including the duality of risk and benefit and quantitative judgments (Watanabe et al., 1980). The need to consider the duality of risk and benefit involved in activities relating to science and technology is even mentioned in the Course of Study for science in upper secondary school in 1979. In the 1980s, teaching materials were developed one after another, including Science in Society, SIS, (The Association for Science Education, 1982) and Science and Technology in Society, SATIS, (The Association for Science Education, 1986) in UK and Chemistry in Community, Chem Com, (American Chemical

Society, 1988) in US and so on. Using as subject matter mainly topics such as nuclear power, radioactivity and element cycling process, we developed teaching materials for lower and upper secondary school students that included risk assessments for these topics.

After these teaching materials had been put into practice, their effectiveness was recognized that the students took into account the duality of risk and benefit when they made scientific judgments or conducted decision-making (Matsubara S., 1990). However, in cases where lots of people believed some technology was harmful, when students learned about safety levels and even when the risk factor was extremely low, sometimes the students' decision on the technology was unchanged from their decision prior to study. This was thought to indicate an unwillingness to sustain even a minute amount of harm, and it was determined to be evidence of a disconnection between the level of "safety" and the level of "peace of mind." This calls

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into question whether or not they are able to accept the concept of risk assessment that is a pillar of education – that the question is not one of whether something is “absolutely safe” but whether there is “probabilistic safety.” It was revealed that students had difficulty accepting this concept.

(2) Green and sustainable chemistry and teaching material unit on air pollution

In the 1990s, Green and Sustainable Chemistry, GSC, emerged. Instead of treating wastes after they had been released, this approach was to not produce them in the first place. The GSC approach is now the mainstream in chemistry, and it was thought possible that incorporating this approach into teaching materials could compensate for students hard to accept the concept of risk assessment. Moreover, it was thought that informing students of this approach and creating the opportunity for them to think about the role of science and technology would be important from the standpoint of understanding the significance of learning about chemistry.

We developed teaching materials on air pollution which dealt with the ongoing transition of chemical industries to GSC-compliant processes. The curriculum included opportunities for the students themselves to make judgments and engage in decision-making in an effort to foster these abilities. The content relating to the GSC approach included a depiction of risk in equation form:

$$\text{Risk} = \text{Hazard} \times \text{Exposure}$$

The introduction of GSC represents a shift in approach. Of the two variables that determine risk in the equation above, the emphasis is on reducing risk by reducing the hazard that is the source of the risk, rather than reducing risk by reducing the chance

of being exposed to hazard (exposure level). The teaching materials explained that this approach had been initiated by scientists and engineers. Judging from the impressions, etc. of the students when these teaching materials were put into practice, they achieved the desired results. Obtaining information not only on the merits but on the demerits makes it possible to construct own approach. Moreover, the learning that demerits have been improved leads to a consideration of the future development of science and technology and fosters a positive attitude toward science and technology and so on. It was also found that some students who did not know that pollution and other environmental issues are being improved, and also a few who thought that pollution and other environmental issues were resolved simply by imposing legal regulations (Matsubara S., 2005). The GSC approach gave students confidence in science and technology.

(3) Sustainable development and development of teaching materials

GSC is considered to be a specific example of sustainable development, SD. We wanted to develop teaching materials that deal more broadly with SD. Their objective would be “learning to improve the quality of life for ourselves and our descendants that incorporates society, economy, environment and the culture,” as one point of view from a scientific standpoint to explore ways to improve quality of life centering on the relationship between science & technology and the environment. Within this frame of reference, the following three objectives were established (Matsubara S., 2007).

- To know the duality of benefits and risks, and understand how to make comprehensive judgments

- To know about the efforts of scientists and engineers, and possess a forward-looking awareness of science and technology
- To make individual decisions about social phenomena related to science and technology, and show a willingness to act as citizen

We added this framework to the GSC approach, of taking preventive action before a problem occurs, and worked to develop teaching materials on electricity. These teaching materials were provided with many cartoons and figures in order to make them accessible for even lower secondary school students. The teaching materials also taught that different methods of generating power were combined in order to achieve efficient power generation, and that this was called the “best mix;” this approach was made the cornerstone of the teaching materials on electricity. The teaching materials noted that changes throughout the day and changes over time were involved, and endeavored to give students a glimpse of the efforts of scientists and engineers throughout the changes in power generation methods. The students’ recollections and impressions noted on study history sheets of one page portfolio assessment, OPFA, confirmed that the content corresponded to each of the objectives and that the instruction had been in keeping with the framework (Takano, 2008).

Teaching materials on water were also developed and put into practice. This also contained cartoons and figures to make them visually appealing to the students, and the content was revised to make it consistent with the sustainable development teaching material framework. Although there was little change in the students’ decision-making with regard to conserving water and so on as compared to prior to revision, students wrote comments about technical development, and

it was thought that the teaching materials had enabled at least some of the students to gain a better understanding of the efforts of scientists and engineers (Takano, 2010).

Moreover, teaching materials on plastics, which had been added to the content of new Course of Study for lower secondary science, were also developed. The teaching materials, too, were designed to get students to think of the use of plastics from the standpoint of a sustainable society. For example, after teaching with the teaching materials, the students had learned about the usefulness and problems involved in the use of plastics and understood that various efforts were being conducted to resolve these problems. In addition, virtually all of the students wrote comments from the standpoint of “To know about the efforts of scientists and engineers, and possess a forward-looking awareness of science and technology,” one of the objectives of the sustainable development teaching materials in science (Miyachi, 2011).

2 International co-research and holding of international workshops

(1) The quest for international co-research

We decided to conduct a study to determine whether the teaching material units on air pollution and electricity that had been developed and put into practice in Japan as sustainable development teaching materials would be accepted in other countries in Asia, and whether the views and approaches in the teaching material units would be communicated. Beginning in 2006, English, Indonesian and Korean versions of the teaching material units on air pollution were prepared, and the opportunity to put them into practice in the Philippines, Malaysia, Indonesia and Korea was secured. The students in all

countries showed enthusiastic attitude for the teaching material units. However, the teaching material units included teaching methods such as inquiry-based learning that are not used in those countries. The normal mode of class instruction is different from that conducted in Japan, and we learned that, for overseas classes, detailed explanations and a sufficient number of meetings are needed as a guide for teachers (Miyuchi, 2007). Moreover, the reactions of the Malaysian students revealed that, unlike Japanese students, the harm caused by air pollution made a strong impression on them (Odaira, 2007). This is thought to be due to factors such as the high regard that people in developing countries have for science and technology, and the fact that environmental education is almost never conducted. On the other hand, when the local Indonesian teachers were asked to list items as a summary assessment, they were similar to the viewpoints of Japanese teachers (Goto, 2008).

We also had the opportunity to use teaching material units on electricity in the Philippines and Korea. The ratios of the types of power generation are different in these countries, and the teachers in each school incorporated data about that country in the teaching materials on electricity. The information comprised specific examples of the “best mix” for a consideration of the appropriate combination of power generation methods. A comparison of the “best mix” for various countries was thought to be one possible example of an Asian version of the teaching material units.

In 2009, a condensed version of the teaching material units on air pollution was prepared and used at upper secondary schools in Malaysia (Nouchi, 2010). In the Philippines, the references for the teaching material units on electricity were changed to feature examples

from the Philippines, and various means were devised to conduct the lessons. For example, depending on the specific school or the type of school, Japanese vellum (large paper) was used, or a PC with presentation software was used and so on. In the Philippines, the teaching material units on air pollution were also used in the Philippine Science High School, PSHS. The teacher in charge of the class, Ms. Andaya, said the students engaged in the class with interest and was deeply impressed. Here as well, the sustainable approach was grasped, though the references and so on were changed considerably to tailor them to the school. In Korea, too, the class was taught using presentation software, with references that had been tailored to the situation in Korea. We had presented teaching material units consisting of examples of practical use by the teacher in teaching situations in Japan together with the teaching materials and evaluation methods, but for teaching in other countries it was thought more effective to grasp the sustainable development approach and change the references and the like to tailor them to the situation in the individual country.

Furthermore, in the Philippines, the framework of the sustainable development teaching materials and the concept of *TEIKEIBUN* instruction, Writing Report Template, was explained to the teachers and students, and experimental activities were implemented using specific examples of the use of *TEIKEIBUN* (Goto, 2010). In the questionnaire after instruction, many respondents wrote that they felt the importance of the framework and *TEIKEIBUN*. It is thought that creating opportunities like this for study with science educators will make it possible to conduct co-research that would include the preparation of Asian

versions of the teaching materials. It must be noted that, in developing countries, acquiring new knowledge and understanding the content is the focus of study rather than the consciousness, attitudes, views and thinking of the students. How to bridge this difference is an issue that must be resolved in the future.

(2) Holding of international workshops

In September 2010, the first international workshop, IWS-1, was held in the Tokyo area. The purpose of the workshop was to provide an opportunity for researchers from various countries to observe practical efforts in Japan and feature reports on efforts that have been promoted in individual countries in order to deepen mutual understanding, as well as to introduce the development and revision of teaching material units being promoted in Japan and learning methods and so on to provide the opportunity for joint study. The participants observed several upper secondary school classes, and by talking with the teachers and students, they were able to deepen their understanding of the teaching of methods of expression using sustainable development teaching material units and toy blocks (Matsubara K., 2011).

In addition, researchers and teachers who are using sustainable development teaching materials in each of the participating countries of the Philippines, Korea and Malaysia gave presentations on the experience of applying these teaching materials in class instruction. The three presentations concerned instruction using air pollution teaching material worksheets. The content consisted of the teaching material units developed in Japan that had been revised to tailor them to the situation in the individual countries. There was a shared recognition that GSC is

needed for society and that children should be taught about GSC at all levels of education - elementary education, secondary education and higher education. GSC content is not included in tests, but the presenters stated that children recognized that the instruction regarding GSC was valuable. In the question and answer session, the importance of GSC was emphasized, and there was a discussion regarding how GSC should be used in actual teaching situations and what kinds of improvements were needed.

Moreover, a study was also conducted of the idea of using the framework of the aforementioned sustainable development teaching materials as a foundation for the development and revision of teaching materials, and of the proposal to add a new worksheet, WS4, to the teaching materials on air pollution as an Asian version of the materials. It was decided to adopt the framework and to work together to use Asians version in actual instruction and analyze the results.

(3) Continuation of international workshops

Several members who had participated in the first international workshop in 2010 showed a strong interest in holding a second workshop. Accordingly, in September, a second international workshop, IWS-2, was held in the Tokyo area with the aim of presenting reports on the results of the use in each country of the worksheet four, WS4, that had been added to the teaching materials on air pollution, and allowing participants to observe the use of the materials in Japan in order to achieve a deeper common understanding.

Participants from each country gave a presentation on the use of the sustainable development teaching materials and research on the results. Each presentation was followed

by a spirited question and answer session and exchange of views regarding matters such as the significance, usefulness and achievability of the sustainable development teaching materials within the educational situation and socioeconomic context of each country. Dr. Teratani had made an important proposal at the previous workshop, IWS-1, with regard to the development of Asian versions of the sustainable development teaching materials, and it was confirmed that there was a particular need for guidelines for development of sustainable development teaching materials, for reflection on the part of both researchers and students, and for the development of Asian versions of the sustainable development teaching materials that were equivalent to the GSC in the West. Moreover, as a response to the needs of participants in each country and questions from these participants, Dr. Teratani (2012) explained the principle of the study of sustainable development teaching materials and future expectations for these materials (Matsubara K., 2012).

On the following day, discussions began toward the preparation of Asian versions of the sustainable development teaching materials. First, Professor Matsubara gave a big-picture explanation of the development of sustainable development teaching materials. This was followed by presentations regarding the issues involved and the prospects for the preparation of Asian versions of the sustainable development teaching materials in each participating country. In the discussions following each presentation, further revisions were made to the additional worksheet WS4 that will employ the concepts of sustainable development and GSC in the Asian versions of the teaching materials on air pollution, and it was confirmed that co-research would be pursued, including practical application

of the teaching materials in each country. Moreover, the need for the accumulation of ongoing achievements in research and practical application for this topic was confirmed, and all participants agreed to hold a third international workshop, IWS-3, at the University of the Philippines. It was also decided that the name of the co-research project would be Educational Co-research for Sustainability, ECoS. In March, an exchange of views was held with Korea, which had been unable to participate in IWS-2, and Korea agreed to participate in the abovementioned activities.

In October, Professor Manzano and a group of undergraduate and graduate students, 17 persons in all, visited Japan from the University of the Philippines. The reason for the visit was that preparations had begun for a revision of the public education system in the Republic of the Philippines, and they wanted to learn from the experiences of Japan. In addition, as the third international workshop, IWS-3, will be held at the university, they wanted to learn about research into sustainable development teaching materials in Japan. As one facet of the co-research activities, the following research presentations relating to sustainable development were given at Tooin University of Yokohama by Professor Manzano and two graduate students, Ms. Romero and Ms. Marasigan (2012).

- 1) Study of mother tongue based multilingual education (MTBMLE): one study aimed at improving the basic education curriculum
- 2) Proposed curriculum guidelines for environmental education
- 3) Achieving sustainable development by learning about the law

In the future, based on coordination with each of the countries involved, sustainable

development teaching material units that are suitable for nurturing the scientific attitude needed to resolve problems relating to scientific phenomena in society will be developed and revised. In order to measure their effectiveness, the materials will be used in cooperating schools in each country, and student responses noted on study history sheets based on the one page portfolio assessment and mutual evaluation forms will be analyzed by means of student discussion.

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