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EXAMINATION OF VISITING CLASS ON ENERGY AND ENVIRONMENT EDUCATION BY COLLABORATION BETWEEN JUNIOR HIGH SCHOOL AND UNIVERSITY

[a]Tokunori SATO & [b]Yoshio HIGASHIYAMA

[a]Graduate Student, Yamagata University, twt53118@st.yamagata-u.ac.jp
[b]Professor, Yamagata University, higashi@yz.yamagata-u.ac.jp

Abstract

To overcome environmental change and to build sustainable society, science literacy for the following generation has been developed through Education for Sustainable Development. Science literacy is based on a fundamental education such as science and mathematics. However, Japanese society has faced to the decrease in motivations for school students. We have carried out the learning programme on the theme of renewable energy in collaboration with the 6th Junior High School and Yamagata University since 2008. The programme aimed at development of students' interest in science and technology. The classroom for the 3rd grade students was divided eight groups consisting of three or four students. Each group designed their windmill and fabricated with given materials. Several teaching assistants helped them to make holes or to do some difficult works. The fabricated windmills were connected to a given small electric generator. The generated power of the windmills placed at a wind tunnel was measured. While the rate of science-liking students before class was 36% of the class, it increases to 75% after class. Especially, change in science-liking attitude of female students was prominent. Since the visiting class consisted of the several active factors of design, discussion, fabrication, cooperative work and presentation, students enjoyed these activities. Group work involving with fabrication might be effective to increase student's interest and to inspire environmental issue.

Keywords: education for sustainable development (ESD), disinterest in science, questionnaire survey, liking for science, science experiment, visiting class

INTRODUCTION

To establish sustainable society, education for the next generation is absolutely essential. One of the required educational contents is energy and environment through Education for Sustainable Development (Japan Council on the UN Decade of Education for Sustainable Development [ESD-J], 2005). In Japan, energy and environment education is treated in the subjects of Social study or Science in compulsory education at an elementary and junior high school. However, education aimed at the passing examinations is emphasis, and there are often not the cases as conducting the oriented learning concerning about energy and environment described at the New Courses of Study. As a result, both quality and quantity of learning energy and environment depend on a

will or passion of a school teacher. On the other hand, Japanese society has faced to decrease in motivations of school students such as disinterest in science since late 1980's. Therefore, to increase the motivation of the students is a crucial challenge. PISA and TIMSS survey drove the MEXT to increases the school hour and learning contents of science and mathematics, while the MEXT encourages a public school to make active utilization of external organization such as university (MEXT, 2008).

The visiting class on energy and environment for the third-grade student in a junior high school for three years was carried out by Yamagata University. The questionnaire surveys about students liking for science and their awareness or attitude to science learning were conducted before and after the visiting class. This paper developed the advantage and challenge of energy and environment education under collaboration between junior high school and a university.

METHOD

In Japan, there are three grades in a junior high school corresponding to age of 13, 14 and 15 years old. The visiting class for the number of around 50 of the third grade students in Yonezawa Sixth Junior High School, Yamagata Prefecture, Japan was carried out for the three years in from 2008 to 2010. Table 1 shows the contents of the visiting class. The visiting class aims to increase awareness of liking, interesting and valuing toward science in collaboration with our university and the sixth Junior High School in Yonezawa. Since the junior high school locates at the windy area, the contents related to wind energy for the visiting class was selected. School students could learn the relationship between energy and environment through the fabrication of a small windmill. The visiting class consists of four series of 50 minutes. There are two classes in the third grade and each class has about 25 students.

Figure 1 shows an example showing the whole series of 4-hours group work. In the first class, the students observed wind energy transformed into electric energy. Then classroom was divided into eight groups consisting of 4 or 5 students. Each group chose their favorite windmill and designed it to be fabricated by themselves. In the second and third classes, the students made the windmill. The constraints for fabrication are as follows: The materials to be used are out of bamboo stick, plastic plate, piano wire, cloth, paper etc, provided the size of the windmill never exceeds 300 x

Table 1. Learning contents of the visiting class studying "Generation and Usage of Wind Energy"

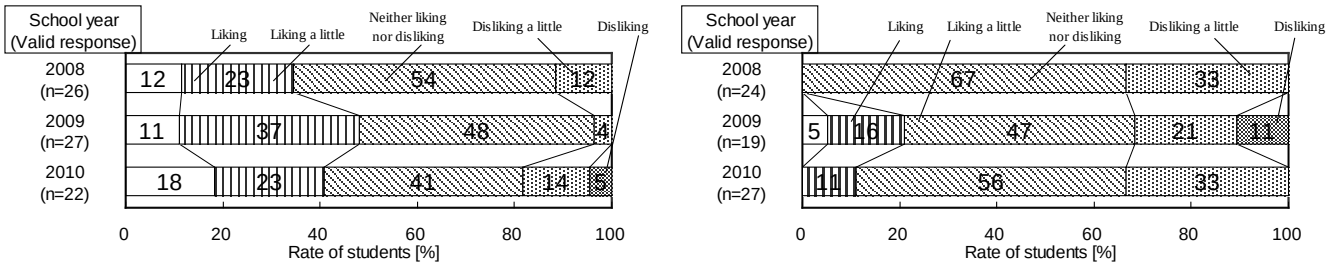
Period	Themes	Contents
1	Energy and design of windmill	Energy conversion between wind and electricity, LED lighting with wind generator, Windmill design drawn by each group of students
2	Fabrication of windmill (1)	Design and fabrication of windmill by each group
3	Fabrication of windmill (2)	Fabrication of windmill by each group, Test of windmill by each group
4	Performance of windmill	Competition of generated power of windmill fabricated by each group

300 mm. They can ask a teaching assistant for help to relatively dangerous work as shown in Figure 1(a). In the fourth class, every group gave a presentation about an idea for fabrication in the front of the class room as shown in Figure 1(b) and the performance of completed windmill was evaluated by placing it at the out let of a wind tunnel with an outlet size of 300 mm x 300 mm and the maximum wind velocity of 12 m/s. The fabricated windmill was located at the proper position of the outlet. The voltage and current flowing through a load resister were measured with a data logger and the generated power processed with a PC was displayed on a screen. All of the students in the classroom could see the time variation of the generated power. Each group competed in the maximum outlet power for 15 seconds during adjusting the angle or location of the windmill.

The effect of the visiting class was evaluated by questionnaire before and after the visiting class. The points of view are liking for learning science, interesting and importance of science and technology. To confirm the change in awareness for science by the visiting class, the liking for science was investigated at the first and last visiting classes.

(a) Fabrication of windmill (b) Presentation (c) Various windmills

Figure 1. Group working in the visiting class



(a) Male students (b) Female students

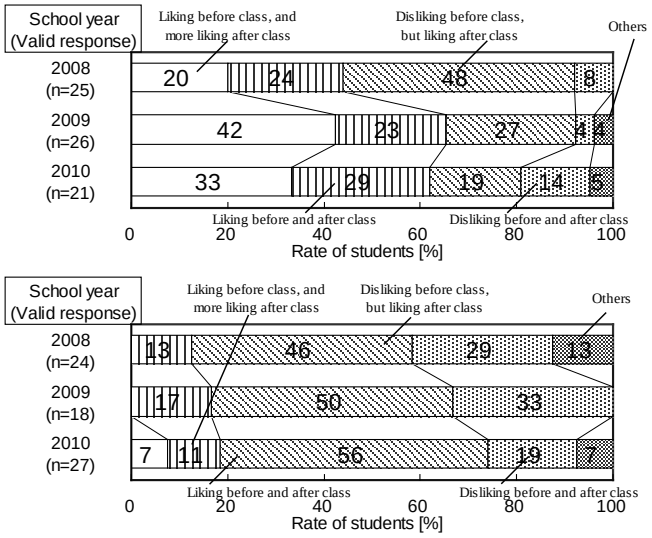
Figure 2. Male and female students' liking for learning science before the visiting class

FINDINGS

Figure 2 shows gender difference of the liking for science. The rate of male students for the liking science or liking a little is 35 to 48 % and that of female students was below 0 to 7 %. The rate of students disliking science or disliking a little was 4 % and 33 % for the male and female students, respectively. It is obvious that the female students dislike science more than the male students. This tendency is consistent with the survey of National Institute for Educational Policy Research of Japan (2003).

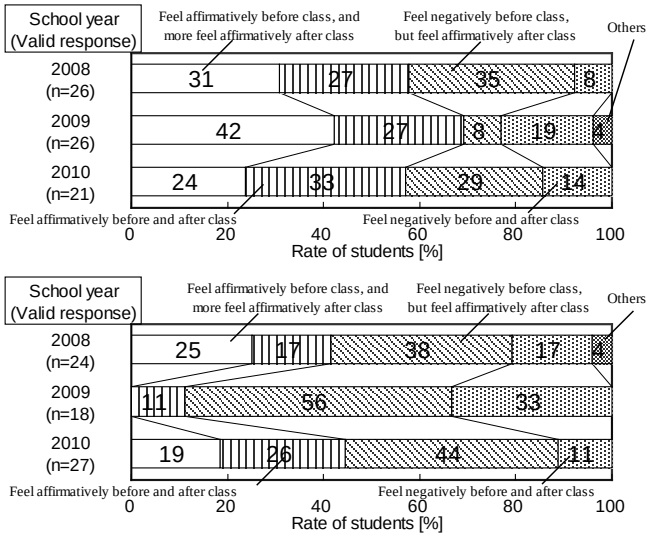
Figure 3 shows the change in favor for learning science before and after the visiting class. Before the class, only 13 to 18 % of female students like science, while more than 44 % of male students like science after the class 80 % of male and 60 % of female students become science liking. Although 75 to 83 % of female students disliked science before the visiting class, it made 61 to 74 % out of science disliking students change into science liking students.

Figure 4 shows the change in valuing of learning science before and after the class. The female students changed their mind for importance of science learning from negative feeling to positive feeling. While around 60 % of the male students had positive feeling before the class, relatively



(a) Male students (b) Female students

Figure 3. Change of male and female students' liking for learning science before and after the visiting class



(a) Male students (b) Female students

Figure 4. Change of male and female students' valuing of learning science before and after the visiting class

fewer female students did. Therefore, the change in valuing of science learning seems to be large in the female students.

DISCUSSION

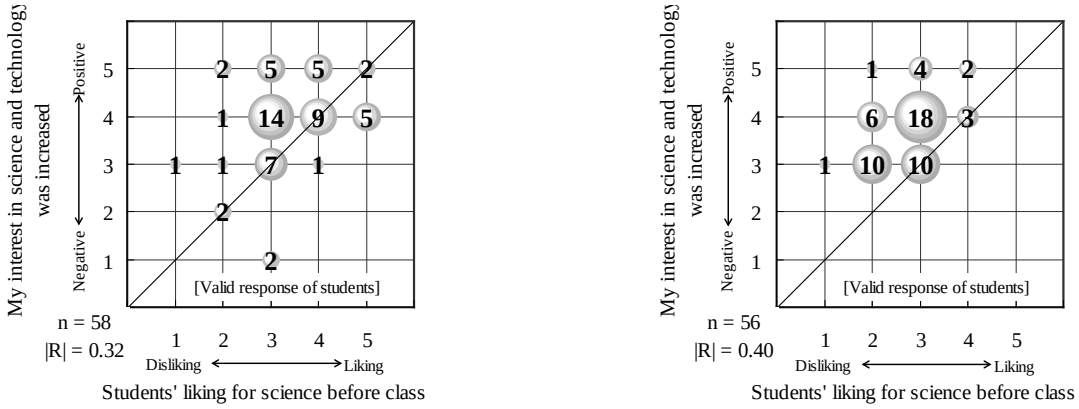
Influence of liking before the class on attitude toward learning science

The students' attitude toward the science learning before the class would affect the contents of answer to questionnaire. The relationship between students' liking for science before the class and their interest in science and technology after the class was shown in Figure 5. The size of balloon is proportional to the number of students denoted in the balloon. The contents of 5-step evaluation as follows; 1. Not increase, 2. Relatively not increase, 3. Neither yes nor no, 4. Increase a little, 5. Much increased. 19 male and 22 female students who neither disliked nor liked science before class became to have feeling increase of interest in science and technology. Furthermore, even the 3 male and 7 female students who disliked science before class could have interest in science and technology.

Table 2 shows the answer of the open-ended question for impression of students who disliked a little before class, but became liked or liked a little after class.

Careful survey showed that the female students enjoyed a group work itself. This would results from the feeling during their experience. They pointed out they really enjoyed making something cooperatively, while male students enjoyed the content itself and they want to study more deeply on energy and environment. Since the question about the matter of energy and environment was not included in questionnaire, it is hard to quantify the effect of visiting class. Appropriate question on energy and environment should add in a future class.

The visiting class has a function to not only inspire a temporal interest but also have a little



(a) Male students (b) Female students

Figure 5. Change of Male and female students' value of learning science before and after the visiting class

Table 2. Answer of the open-ended question for impression on the visiting class

Gender	Impression of students who disliked science a little before class, but liked or liked a little after class (n = 10)
Male (n = 3)	・Since the visiting class was easy to understand, I want to participate it again. I really enjoyed it.(2008) ・I have had an image that science is difficult but the visiting class cleared the image. Science is difficult but I felt joyful in invention or endeavor of something new. Science is attractive. (2008) ・I enjoyed the visiting class, because we could attend what we never experienced in a usual class. (2008)
Female (n = 7)	・I enjoyed it! (2008) ・I enjoyed making sort of propeller. Since I understood various things, I felt well. (2008) ・I had a good experience. I want to do it again. (2008) ・Since we could make a windmill by ourselves, I had more interest in science than before. (2008) ・I enjoyed much. (2008) ・I had hated science but I enjoyed much more than expected and I had a new finding. It was good to do cooperative work and I want to do it again! (2010) ・It was an enjoyable and hard work to make a windmill cooperatively. I understood how electrical energy was generated. I would feel better if other methods of electrical generation were invented. (2010)

significant effect to increase the positive attitude toward learning science. The difference in gender for visiting class should be noted. To improve the influence of visiting class, it is essential to employ the interactional knowledge and understanding as well as a team work, especially for a female student.

Effect of collaboration between junior high school and university

A teacher in a junior high school in Japan often has many classes, for example 22 classes out of 29 classes for a week. Therefore he or she could hardly have a time to study deeply the contents or teaching materials. The school teachers have usually extra works, such as in charge of a coach to the student activity after school and supervisor the school event and etc. Therefore, the science experiments taken a lot of work and time for preparation are hardly carried out and in some cases never done. If the external institution such as a university or technical college could organize a visiting class, junior high school students would have an opportunity to have a class focusing on science experience almost without teacher's extra load. Furthermore, the visiting class could enhance the students' attitude toward science. To keep and expand the collaboration, it is need to establish the system of budget, time, person, close partnership etc.

5. CONCLUSION

The visiting class focusing on energy and environment learning through design and fabrication of a windmill by group work in collaboration with the junior high school close to the a university was carried out. It certainly affects students' attitude toward science learning, although the attitude depends on clearly gender. To develop the educational tool concerning energy and environment learning is a future challenge. The visiting classed in 2008 and 2009 were supported by Science Partnership Projects, Japan Science and Technology Agency (Ko-A-Dai 83004, AD093077).

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