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DESIGN OF EFFECTIVE CHEMISTRY LABORATORY CLASS BASED ON PARTNERSHIP AMONG HIGH SCHOOL, UNIVERSITY AND GRADUATE SCHOOL

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ABSTRACT

A chemistry laboratory class at a high school was designed on the basis of continuous cooperation of a high school and a university. The undergraduate and graduate students of the university acted as a teaching assistant (TA) at experiments performed in the high school class. The laboratory program contained experiments aiming at effective education not only for the high school students but also for the TAs themselves. A questionnaire survey for both the high school students and TAs was carried out after the class to evaluate the effectiveness of the class on their skills, knowledge and understanding of chemistry, and other influence. The answers of the high school students have shown that they were satisfied with the experience and interested in chemistry. The answers of TAs have also shown effects on their ability, thinking and/or behavior. They have felt that the teaching experience resulted in improvement of their scientific knowledge and understanding which are directly or indirectly related to their major. In addition, they have noticed the difficulty in explaining advanced scientific topics without using technical terms unfamiliar to high school students, and they have come to understand the importance of communication skills as well as the exact knowledge. From these results, the effectiveness of the cooperation class on the education for both high school and university students has been confirmed.

KEYWORDS: High-School/University Partnership, Chemistry Laboratory Class, Science/Engineering Education, Teaching Assistant

INTRODUCTION

The graduate students majoring chemistry usually work at their laboratory under the guidance of professors and staffs. They frequently teach undergraduates both at the laboratory and at experimental and exercise classes as a teaching assistant (TA). In addition, they sometimes have opportunities to teach younger people outside the university, e.g., visiting lectures at high school and science events for children, etc. We have continuously performed a chemistry laboratory class at a high school designed on the basis of cooperation of a high school and a university (Yasuzawa, 2010). The undergraduate and graduate students of the university acted as a TA at the experiments performed in the high-school class (Kamitani, 2010). Here we report practice in developing graduate/undergraduate students' abilities through their teaching experience.

VISITING LECTURE AT HIGH SCHOOL

Aims

Chemistry laboratory class was planned based on a request from Tokushima Prefectural Senior High School of

Science and Technology at the occasion of founding new courses of the high school. Faculty staffs and students were invited to teach chemical experiments attracting high school freshmen. These high school students were required to choose either environmental science or information science courses at the end of the first grade. Experiencing chemical experiments was expected to promote motivation to study and also to be useful for the decision of the course selection.

Procedures

The experiments were exhibited in the laboratories of the high school. Some 'attractive' materials (Minagawa, 2014) were chosen and the experiments were designed considering the understanding level of high school freshmen, i.e., i) Water purification using magnetic flocculant, ii) Super-hydrophilic or super-hydrophobic surfaces, iii) Oscillatory chemical reaction, iv) Synthesis and properties of plastics. Two or more TAs supervised each experiment. The faculty staffs gave the direction to the high school students at the start of the class and the TAs supervised the lab work of the high school students. The TAs were required to have a proper understanding of the materials and methods prior to the visiting class. The high school students were divided into small groups so that all of them can participate in all steps of the experiments. After finishing the class, the high school students had time to discuss with TAs (and university professors). The discussion included not only scientific questions or topics but also many things such as the study and life in the university. The impression and/or opinions of the attendees, including high school students, teachers and also TAs, have been collected from a questionnaire survey. This visiting class has been continued for 6 years. The same experiments were performed every year but detailed procedure was modified while taking into account the results of questionnaire surveys.

Results

The experiments performed in the continuous visiting classes have already described in previous reports (Yasuzawa, 2010; Minagawa, 2014). In the water purification experiments, for example, tap water containing green tea powder instantaneously changed to transparent by removing impurity with a magnetic flocculant as shown in Figure 1. The obvious change in the appearance of water from turbid to clear states attracted much attention of high school students. As another example, in the experiments of super-hydrophilic/hydrophobic surfaces (Figure 2), the opposite properties of modified surfaces were easily observed by eyes (Figure 3) and also evaluated by measuring the contact angle (Figure 4). TAs explained principles of observed phenomena and evaluation techniques on the basis of their knowledge and experience of research activities in the university.

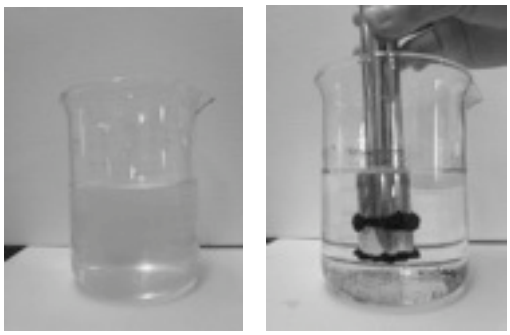

Figure 1: Water Purification by Magnetic Flocculant

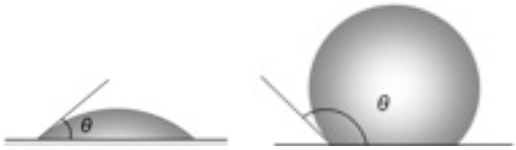

Figure 2: Super-Hydrophilic (Left) and Super-Hydrophobic (Right) Surfaces

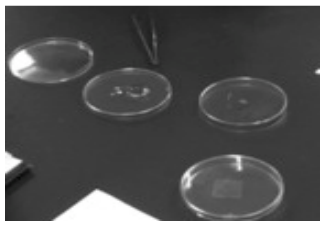

Figure 3: Water droplets on different surfaces

Figure 4: Contact Angle measurement

The class has sufficiently provided the opportunity to experience chemical experiments and stimulate the intellectual curiosity in science, especially in chemistry. Here we focus on the influence of the teaching experience on TAs. A qestionnaire survey for TAs was performed after the class. For a question about the effectiveness of the teaching experience on their own knowledge, understanding and/or experimental techniques directly related to their major, most of the TAs answered “a little” or “no” improvement. Some TAs showed that the experience improved their knowledge and understanding ‘indirectly’ related to their major. On the other hand, for another question about the influence of the experience on their presentation and communication abilities, many TAs answered ‘useful’ for improvement. The comments described by some TAs showed positive influence on the improvement of their ability, especially communication and presentation skills. Examples of the comments are as follows: “I feel that teaching high school students has enhanced my scientific knowledge and also improved my presentation and communication abilities.” “This work was a good experience for me to think how to make the explanation clearly understandable.” “I have learned the importance of sufficient preparation prior to the class so that the students can easily understand my explanation.”

Application for Science Events and Other Teaching Opportunities

There have been increasing demand for science events in local community especially for children, aiming at promotion of science for young people. Universities, institutes and scientific societies often organize or support such events. Among them, demonstration of chemical experiments may attract attention of children. Since the organizers should take special care for treating chemicals, the instructors of the event have to guide and perform the experiments safely. In the science events, the role of TA is important. It is thus necessary to improve the ability of TAs to perform the event successfully. This is another opportunity for TAs to improve their abilities through teaching younger people outside the university. In this case, the high school students also experienced ‘learning by teaching’. Figure 5 shows the demonstration

of ‘liquid traffic signals’, where the solution color changes like a traffic signal, performed by the high school students at a event for children, after they attended to the above mentioned chemistry laboratory class.

Figure 5: Presentation by High School Students Demonstrating the Color Change of Solutions

DISCUSSIONS

In each experimental theme, graduate/undergraduate students participated as a TA. The efforts for better understanding of the high-school students would be effective for improving the knowledge and teaching ability of the TAs. From the answers to the questionnaire after the class, it has been found that the teaching experience in the class affected their ability, thinking and/or behavior. They have felt that the teaching experience resulted in improvement of their scientific knowledge and understanding which are directly or indirectly related to their major, although some of them felt no significant effect. On the other hand, all of them have noticed the difficulty in explaining advanced scientific topics without using technical terms unfamiliar to high school students, and they have come to understand the importance of communication skills as well as the exact knowledge. It has been shown that the experience of teaching assistant significantly improves the ability and increases the motivation for study of university students. The feedback from high school students through discussion was also found to be useful. From these results, the effectiveness of the cooperation class on the education for both high school and university students has been confirmed. Effective education can be designed under appropriate cooperation between universities and high schools, considering the balance of education effects and load of TAs. In addition, active participation of not only university but also high school students as a TA in science events for children would give similar positive influence for the students.

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