# A Senior High School Chemistry Laboratory Class Observed by University Students

Sachiyo Kamitani[*,**], Yuka Arai[*,**], Yuki Konishi[*,**], Shinsuke Nakanishi[*,**], Takuya Oshima[*,**], Junko Yamaguchi[*,**], Arisa Ishii[*,**], Keiji Minagawa[*], Mikito Yasuzawa[*,**,†]
Department of Chemical Science and Technology, The University of Tokushima[*]
The Center for Innovation and Creativity Development, The University of Tokushima[**]

## Abstract

Upon request from the Tokushima Prefectural Senior High School of Science and Technology, two faculty staff members and eight students of The University of Tokushima visited the high school and set up a chemistry laboratory class for 59 students. Since the participating senior high school students were freshmen, four simple, safe and visual experiments were selected: 1) Water purification, 2) Surface modification, 3) Briggs-Rauscher reaction, and 4) Polymer synthesis and characterization. All experiments received a favorable reception as a follow-up questionnaire verified. Since the high school students enjoyed the experiments it is hoped that the results will strengthen the students' interest in chemistry. It was good opportunity for the observers; they recognized the difficulty of teaching students.

**Keywords:** Chemistry laboratory class, Teaching assistance, Senior high school chemistry education, Teaching experience

## Ⅰ. Introduction

Tokushima Prefectural Senior High School of Science and Technology (TPSHSST) requested to The University of Tokushima (UT) to perform chemical experiments in order to develop the students' interest for chemistry. The Center for Innovation and Creativity Development of UT decided to do that with the help of university students studying at the innovation center as teaching assistants (TAs). (Yasuzawa, 2010)

Four experiments were selected by taking into account the safety for all who participate in the lab class; 1) Water purification, 2) Surface modification, 3) Briggs-Rauscher reaction, and 4) Synthesis and characterization of polymers. The high school students were divided into three groups. There were four themes, and eight TAs participated; two TAs were arranged in each experiment. The high school students were rotated in order to give opportunity to perform all experiments.

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† Corresponding author: Mikito Yasuzawa, mik@chem.tokushima-u.ac.jp

The water purification experiment demonstrated the filthy water turning into clean because a magnet attracted the impurities in the water. In the surface modification experiment, water drops fall down from the surface of an appliance, just by coating a chemical reagent on the surface. Briggs-Rauscher reaction demonstrates repeated seemingly magical color changes. Polymer synthesis enables one to take out a solid "rope" from a liquid. Polymer characteristics can be observed by simply putting a test piece of the polymer into water or into fire. These types of experiments are useful for high school students to get an idea of chemical reactions.

## Ⅱ. Experimental

Aforementioned, two TAs took charge of twenty students in an experiment. Each experiment was performed as follows.

### 1. Water purification

Biodegradable "γ-polyglutamic acid" containing flocculants, linear polyglutamic acid (l-PGA), cross-linked polyglutamic acid (x-PGA) and cross-linked

polyglutamic acid combined with magnetite (PGM), were employed for the purification of turbid water. Firstly, l-PGA and x-PGA were dissolved in water and the difference in viscosity of the obtained solutions was compared. Higher viscosity in the solution with x-PGA was confirmed. Secondly, turbid water prepared by adding powdered tea in water was purified using three flocculants. Flocculants were added in stirring turbid water and was stirred continuously for a certain time. After stirring was stopped, the production of flocs and the turbidity of the treated water were checked. In the case of purification using PGM, the obtained flocs were removed using strong magnetic bar. The use of PGM and magnet give a strong impact to the student, since the treated water will get immediately clear as soon as the magnet bar was inserted to the solution.

### 2. Surface modification

Both super-hydrophobic surface and super-hydrophilic surface were prepared on polystyrene laboratory dish by painting particular solutions on it. The difference in water contact angle of the substrate before and after the treatments was observed.

"Siv CLEAR KK116" (CARMATE MFG. CO., LTD) was used for the experiment of the water-repellency and "KLINVIEW" (Taiho Kohzai Co., Ltd. Overseas Department) for the hydrophilic experiment.

### 3. Briggs-Rauscher reaction

All students must ware safety glass to perform the experiment. Three solutions*1, Solution A, B and C, for the reaction were prepared beforehand by TAs. The students go to the hood and get certain amount of each solution using measuring pipettes. Firstly, Solution A was stirred using a magnetic stir bar, and Solution B was carefully poured in. Secondary, Solution C was added into the mixture and reaction started. Change of color of the solution and any other observation obtained were requested to be carefully checked and described.

*1; Solution A: 4.3 g of potassium iodate was added to 80 mL distilled water. 0.4 mL of sulfuric acid was added and the solution was stirred until the potassium iodate was completely dissolved. Distilled water was added to make the solution to be 100 mL.

Solution B: 1.6 g of malonic acid and 0.34 g of manganese sulfate monohydrate was dissolved in 50 mL distilled water. Separately, 0.3 g of vitex starch was dissolved in 50ml distilled water and 5ml of starch solution was mixed with the aqueous solution of malonic acid and manganese sulfate monohydrate. Distilled water was added to make the solution to be 100 mL.

Solution C: 41 mL of 30% hydrogen peroxide was diluted with distilled water to make the solution to be 100 mL.

### 4. Polymer synthesis and characterization

The 20 students in this group were further divided into two groups. One half performed A) Polymer synthesis first and shifted to B) Polymer characterization after thirty minutes. The second half did two experiments in opposite order.

A) Poly (hexamethylene adipamide) (Nylon 6-6) was prepared using interfacial polymerization technique. The student took the solutions with pipettes, and poured carefully over the other solution in order to have a flat interface between the two solutions. Polymer film was produced at the interface of two solutions and was pulled out with tweezers. The pull out thread of Nylon 6-6 was put around a stick.

B) Characterization of various plastics was performed using simple experiments, such as dipping the material in water (specific gravity), mechanical strength, melting or burning behaviors, and flame-color observation.

## Ⅲ. Results

### 1. Water purification experiment

The high school students enjoyed handling the laboratory equipments during the experiment and were impressed watching the significant difference of clearness of water before and after treatment with flocculants, especially with PGM. Although most groups could successfully purified the turbid water, the turbidity of the treated water was not low enough for some group. The reason for unsuccessful treatment was that they added too much amount of flocculant. Since cross-linked polyglutamic acid flocculant have high water holding property, excess amount of flocculant produced a highly swelled floc, which

could not be easily removed from the container with magnetic bar. They notice that the addition of higher amount of flocculant is not always good for water purification and there is an optimum amount to be added for successful treatment.

### 2. Surface modification experiment

Although the coated films on the surface of the material were too thin to be observed, students could recognize the formation of the film by dropping a water drop on the surface. Super-hydrophobic surface provided sphere shape water drop, while water drop spread on super-hydrophilic surface and created a flat puddle with a contact angle of water close to zero degree. Super-hydrophobic surface production was more exciting for most students, since they could play rolling the water ball all over the treated laboratory dish surface.

### 3. Briggs-Rauscher reaction experiment

The time to finish the experiment was longer than we expected, since the use of measuring pipettes and safety pipetter was troublesome for many students. Some student could not satisfactory control the strength to pump up the solution using safety pipetter and put the solution inside the safety pipetter. Plenty of time was wasted for cleaning it. Although brief explanation of the use of equipments was presented on the beginning of the experiment, precise advise to the individuals by TAs was essential to allow correct handling of equipments. Moreover, the activity wearing safety glass and gloves, which was quite unusual for most students, made their movement uneasy. Nevertheless, all students were able to see magical oscillating color change and recognized that certain chemical reactions were occurring inside the glassware. Many students could not take their eyes off it until the reactions are completed and the color changes stopped. Some students recognized the production of gas in the reacting solution, while the chemistry of the reaction was difficult for them to understand.

### 4. Polymer synthesis and characterization experiment

**a. Polymer synthesis**

The students were surprised at a mysterious phenomenon that a thread was made continuously from the liquids. All groups succeeded to synthesize the polymer. Some students enjoyed taking pictures of the produced nylon. After they finished pulling out the nylon thread, students were comparing the length of the obtained thread with each another.

**b. Polymer characterization**

Although the experiment was quite simple, students enjoyed and learned the difference of plastics, which look similar. A particular color of flame was observed when plastics containing chlorine atom was burned. However, some groups could not obtain the color change of the flame. The experiment must be carefully performed not only to get good results but also not to get burned with the flame and heated copper wire.

## IV. Discussion

As felt troublesome when they taught how to do the experiment because they could not make some students to understand their explanation. They were impressed that it is important to be prepared to explain more clearly to each student. As a request for some experiments, it would be better to increase the number of TAs, since both full explanation to all and precise individual explanation seems to be effective for good experiment performance. In addition, it will be better to reconsider the schedule of the experiment, since some experiment finished early and some experiment extended. Preparation of some short experiment or omission of some step or experiment will be the consideration. Nevertheless, inexperience and shortage of an entirely satisfactory teaching preparation lead to unnecessary time consumption. After our first experience on chemistry lab class in high school, we can have a clear simulation of revised lab class, since we now know more about the students and also our ability.

The results of the short survey are shown in the graph. To the question, “Do you want to participate in a laboratory class in future?”, half of the students thought that they wanted to participate the lab class again.

To the question, “What kind of lab class do you want to participate in the future?, some students answered that they want to participate to a lab class

provided in the university. For most of the students, they did not indicate particular experiments that they want to do. This may be due to low information and knowledge on what the kind of experiments they can try to do. Nevertheless, considering that half of the students will advance to "Environmental science course" and another half will advance to "Information science coarse" next year, the result, "More than three fourth of the students got interested in chemistry after the lab class" indicate that the chemistry lab ended successfully.

By the precise investigation of short survey results including the attitude of the students, opinions and advice from the high school teachers and all participates, we hope we will be able to develop not only more interesting, exciting but also safe chemistry lab class. In addition, we would like to be prepared and perform clear and easy to understand explanation to the students.

## V. Conclusion

Teaching experience of high school chemistry lab helped to develop the skill of the experiments and also the teaching ability. However, only eight university students had the chance to participate in the teaching lab class. Therefore, we want many students to get this valuable opportunity. In order to make this possible, we need to make advertisement of lab class to other high school and produce more teaching lab classes. Moreover, it will be better to manage the whole lab class by the students as a project, since students have more time for the action than professors and opportunities will be expanded. Authors hope that they will be able to perform chemistry lab classes on various schools in the future.

## Acknowledgements

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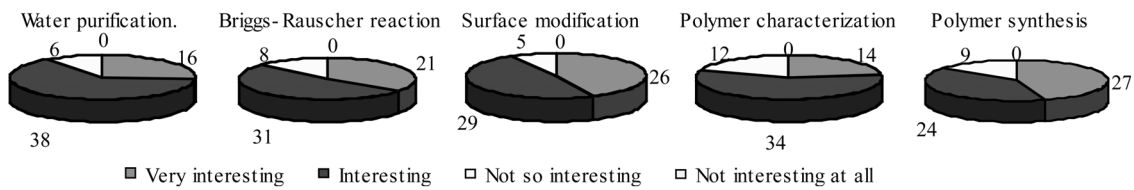
## References

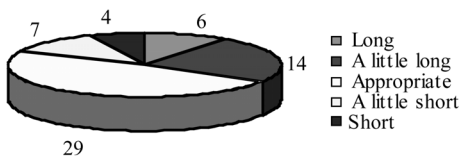
Yasuzawai M., et al. (2010), Production of Chemistry Laboratory Class for Senior High School Freshmen, *Journal of Engineering Education Research* Vol. 13, No. 5, Special Edition 2010.11.

**Q. What was your impression of the experiments?**



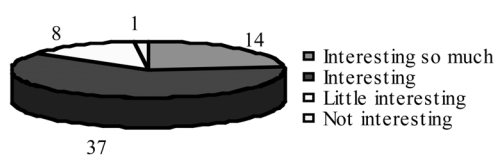

Many experiments interested the students. No one answered that the experiments were not interesting at all.

**Q. How was the length of the lab class?**




Half of the students answered that the length of the lab was appropriate.

**Q. Did the lab class interested you in chemistry?**

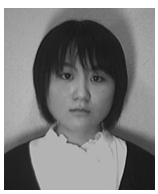



More than three fourth of the students got interested in chemistry after the lab class.

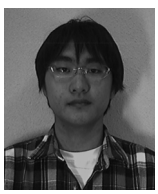
## The Author


**Sachiyo Kamitani**
entered the University of Tokushima in 2008. She is a senior student of Department of Chemical Science and Technology, Faculty of Engineering. She belongs to Center for Innovation and Creativity Development She is a member of LED design project.

**Yuka Arai**
entered the University of Tokushima in 2008. She is a senior student of Department of Chemical Science and Technology, Faculty of Engineering. She also belongs to Center for Innovation and Creativity Development. She is a member of LED design project.



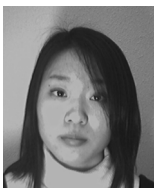
**Yuki Konishi**
entered the University of Tokushima in 2008. She is a senior student of Department of Chemical Science and Technology, Faculty of Engineering. She also belongs to Center for Innovation and Creativity Development. She is a member of LED design project



**Shinsuke Nakanishi**
entered the University of Tokushima in 2008. He is a senior student of Department of Chemical Science and Technology, Faculty of Engineering. He also belongs to Center for Innovation and Creativity Development. He is a member of Tatara project

**Takuya Oshima**
entered the University of Tokushima in 2008. He is a senior student of Department of Chemical Science and Technology, Faculty of Engineering. He also belongs to Center for Innovation and Creativity Development

**Junko Yamaguchi**
entered the University of Tokushima in 2008. She is a senior student of Department of Chemical Science and Technology, Faculty of Engineering. She also belongs to Center for Innovation and Creativity Development. She is a member of LED design project



**Arisa Ishii**
entered the University of Tokushima in 2008. She is a senior student of Department of Chemical Science and Technology, Faculty of Engineering. She also belongs to Center for Innovation and Creativity Development. She is a member of LED design project

**Keiji Minagawa**
received the Bachelor of Engineering degree from the University of Tokushima in 1987, received the Master of Engineering degree from the University of Tokushima in 1990, and the Ph.D degree from Nagoya University in 1993.
He had worked for Yamagata University during 1993 to 1995, and for the University of Tokushima from 1995 to present. His current research focuses on stimuli-responsive polymer materials, electrorheological fluids, and inorganic layered materials.
Phone : +81 88 656 9153
Fax : +81 88 655 7025
E-mail : minagawa@chem.tokushima-u.ac.jp

**Mikito Yasuzawa**
received the Bachelor degree of Engineering from Osaka City University in 1983, received the Master degree in 1985, and the Ph.D degree in 1999.
He had worked for University of Tokushima since 1987.
His current research focuses on the development of biosensor for in vivo real-time monitoring, eco-friendly flocculant for water purification, biocompatible surface and materials.
Phone : +81 88 656 7410
Fax : +81 88 655 7025
E-mail : mik@chem.tokushima-u.ac.jp