The alternate synthesis of vanillin falls more in line with the principles of Green Chemistry. The amount of necessary solvents has been reduced, concentrated acid can be replaced with a heterogenic catalyst, and less byproducts and waste are produced. Based on the context of vanillin synthesis learners can also be introduced to discussions about the complexity of production of everyday products and the impacts that these processes have on the economy and the environment.

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A trial and evaluation of experimental kit of handy body-warmer through a model lesson on the rusting of iron

Un ensayo y evaluación de kit experimental a través de oxidación de hierro

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Abstract

Development and practice of a lesson model on the rusting of iron using an experimental kit of handy body-warmer through the principle of SEIC ("Special Emphasis on Imagination leading to Creation") and an evaluation of the use of the experimental kit were conducted. The lesson was carried out for undergraduate chemistry classes of junior (third year) level student in Tokyo Gakugei University (TGU). Students did an individual experiment actively and smoothly using the experimental kit with quite simple description of B6 size leaflet. Answers from students to questionnaire revealed that the individual experiment by use of the experimental kit was effective for realizing images of the phenomenon of rusting of iron and understanding the chemical reaction.

Key words: *experimental kit, individual experiment, imagination, SEIC, chemical education, lesson model*

Resumen

Se describe el desarrollo de la clase modelo de oxidación de hierro mediante el uso de un kit experimental a través del principio de la SEIC ("la imaginación que lleva a la creación") . Las clases se llevaron a cabo en el curso de química de pregrado (tercer año) en Tokio Gakugei University (TGU). Los estudiantes hicieron los ensayos individuales utilizando el kit experimental usando la simple descripción en un folleto especial. Las respuestas de los estudiantes en el *cuestionario revelaron que los experimentos individuales mediante el uso del kit experimental fueron exitosos para entender el fenómeno de oxidación de hierro y la comprensión de la reacción química.*

Palabras clave: *kit experimental, experimentos individuales, imaginación, educación química.*

INTRODUCTION

It is important for students to be thinking and behaving imaginatively, and finally to have an outcome which is of value to the original objective Wardle, 2009, Finke Ward, Smith, 1992). Promoting creativity in science has been also reported and discussed in papers (Child, 2009, Osborne at al, 2003, Jarvis, 2009, Höhn, Harsh, 2009, Longshaw, 2009, Ohshima, 1920). Actually, school education in this early part of the 21st century faces many challenges especially in Japan, such as bullying, truancy, and disordered classes apparently, in which students are kindled with placing too much emphasis on knowledge and competition in a class. These bring about i) students receding from intellectual activity (learning science) in the cramming system of education in Japan, ii) lack of teaching on highly motivated creativity, and iii) also lack of teaching on morality (ethics). Learning on the basis of students' enthusiastic activities using imaginative thinking and appropriate behaviour would be of great importance in understanding science and chemistry.

We have reported a survey of current textbooks for "Chemistry I" and "Chemistry II" (Keirin-kan, 2003, Tokyo-shoseki, 2003, Dainihon-tosho. 2003, 2004) in senior-high school, sometimes used in junior-high school and compiled based on the Japanese course of study (MEXT, 1999). Text as a representative of knowledge (Ogawa, Okada, Takehara, Ikuo, 2006), skills for experimental study (Ogawa, at all, 2009), and schemes as a representative of image (Ogawa, at all, 2008) were analyzed and ordered. Large numbers of text items, schemes, and skills were cited in the present textbooks in Japan in order to understand scientific concepts, phenomena, and methodology. Then we proposed a fundamental feature of school lesson in science and chemistry in which a **S**pecial **E**mphasis on **I**magination leads to **C**reation (**SEIC**) (Ogawa, Fujii, Sumida, 2009). Having imagination is emphasized with the hope of acquiring sufficient knowledge and skills toward promoting creativity in this SEIC program. Development of the lesson models of rusting of iron through the principle of SEIC has been reported and the model found to be effective for students to understand the chemical reaction of rusting of iron accompanied by an acquisition of sufficient knowledge (Ogawa, Fujii, 2010). Presenting the lesson through drawings was one of the influential methodologies for enhancing images of the chemical reaction. Students felt this helped their imagination through experiment, observation and application of schemes, and was an important contribution to their learning.. In this paper, further improvement of the lesson model with experimental kit and practice are reported.

DEVELOPMENT OF A TYPICAL LESSON MODEL THROUGH SEIC

SEIC policy

SEIC has the feature of student-initiative-activities such as brain-storming and their own operation, if need be, teacher's support. The lesson puts a special emphasis on enhancing the imagination and creativity by handwork operations with mainly drawing, sometime forming clay in three-dimension (3-D) and doing experiments themselves. This approach of SEIC is expected that appropriate images can enhance and foster creativity through making good use of thought, ability for expression, and reason. Thereby the strength of will for imagination and creativity will be raised through SEIC together with the acquisition of sufficient knowledge and skills as a tool.

Lesson models

Fifteen themes were selected for the lessons in chemistry (for teaching profession in primary school) to an undergraduate university student. Fundamental contents on the topics were chosen on the basis of basic chemistry; *i.e.* the chemistry is roughly composed of three frames of structure, equilibrium, and change. Fifteen lessons in the model covered them moderately. Above all, three lessons from lesson 4 to lesson 6 include fundamental concepts in chemistry, *i.e.* stoichiometry, free energy, and entropy from the standpoint of rusting of iron. The lessons proceed toward the theme of topics, *i.e.*, the lesson 4, 5, and 6 proceed toward the themes of stoichiometry, activating complex and entropy change of the chemical reaction of rusting of iron, respectively.

Timetable

The lesson is typically divided in five activities. For example, even in a lecture in about 45 minutes frequent discussions are performed with no students' memorization, and then students' own recollection of their thoughts in 10 minutes are explored. Students' drawings presenting images of chemical concepts, phenomena and self-explanation should be performed in 15 and 10 minutes, respectively.

Drawing rule

Drawings should be attractive for everybody to see once again. Drawing is regulated, *e.g.*, description of text, mark, line, arrow, and illustration with simile are not allowed in a drawing area. Explanations in text could be used outside the drawing area on the sheet using chemical terms and separated by solid parting-line.

Practice with experimental kit

Fig. 1 Kit of handy body-warmer

Fig. 2 Leaflet

The students' experiment was carried out in the classes in chemistry (for teaching profession in primary school) of 33 undergraduate students of junior (third year) level in Tokyo Gakugei University (TGU). This experiment was an additional program in 30 minutes over three lessons on rusting of iron described in the former section of 2.2 of "lesson models". The experiment proceeded by the use of an experimental kit (Fig. 1) composed by reagents, apparatus and leaflet (Fig. 2) with B6 size; *i.e.* reagents: iron powder, charcoal powder and sodium chloride were all regent grade commercially available. Apparatus: tall beaker, stirring bar, pin for hole punching, tissue paper, polyethylene wrap, Japanese paper for ornamentation, and plastic bag (about 15 cm x 15 cm) for the outside cover.

Students started the experiment individually by only using the experimental kit with the leaflet. There was no explanation or lecture about the experiment in advance. Students did an individual experiment actively and smoothly with the help of the experimental kit and the simple description in the leaflet. Students' were enthusiastic about the activities and imaginative thinking and scientific behaviour were seen everywhere through the experiment (Fig. 3). They showed not only of the heat generation but also the prevention of an exothermal reaction by separating the body-warmer chemicals with plastic bags.

Fig. 3 Lesson scenes

RESULTS

An appraisal of the lesson with the experimental kit was conducted through a questionnaire (Appendix 1) to students. The questions were set up to students from Q1 to Q4 of "Were you touched by heat generation from your own body-warmer?", "Did you have clear images about the substances accompanied by heat generation?", "Did you have clear images of overall reaction of rusting of iron by the experimental kit?", and "Was your knowledge more strongly coupled with facts of heat generation through making body-warmer?", respectively. Numbers of "yes" equivalent including "strongly" and "fairly" in a whole were quite large with the slight tendency on Q2 of "Did you have clear images about the substance accompanied by heat generation?" (Fig. 4). The questionnaire implied that students had i) the feeling of being emotional, ii) images about the substance accompanied by heat generation, iii) clear images of overall reaction, and iv) integration of knowledge and facts through their own experiment with the kit. A way of the lessons attached experimental kit could be one of the influential methodologies for enhancing images and understanding of the chemical reaction.

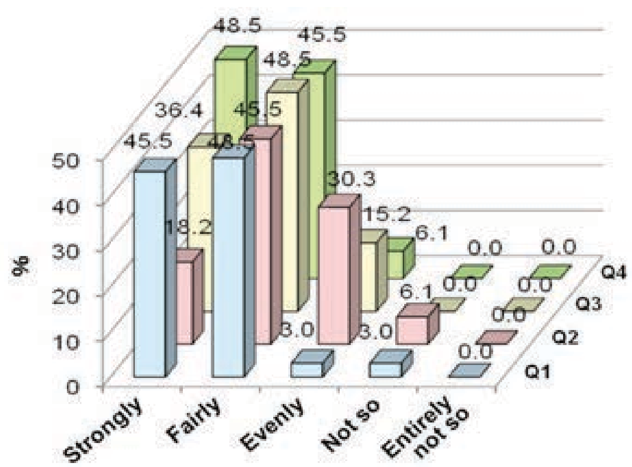

Fig. 4. Questionnaire (33 students). Q1: "Were you touched by heat generation from your own body-wormer?"; Q2: "Did you have clear images about the substance accompanied by heat generation?"; Q3: "Did you have clear images of overall reaction of rust of iron by the experimental kit?"; Q4: "Was your knowledge is strongly coupled with facts of heat generation through making body-wormer?"

The following questions in the questionnaire were conducted; Q5 of "Select two items from those described below which maintain contents uplifting your feelings through the experiment!" and Q6 of "Learning while making the experiment is important!" From the question of Q5 interest was signalled through the experiment for uplifting students' feelings (Fig. 5) while most of students thought the making was important for introducing in lesson from the answer of question of Q6 (Fig. 6). Feelings were uplifted through the making of body-warmer. Experimenting by the use of the experimental kit would be one methodology for motivating students' interest in the desired theme.

The questions in the questionnaire were conducted; Q7 of "Select two items among those described below which maintain an importance for understanding chemical concept and/or phenomenon" in Fig. 7 and Q8 of "Select three items among learning methodologies described below which enhance your images!" in Fig. 8. For comparison purposes data of the class without this experimental program was put in the back. Students had preference comparatively to the items of "Imaging," "Experiment & Observation", and "Knowledge" as an important item for understanding chemical concept and/or phenomenon (Fig. 7). Knowledge was slightly decreased, and then imaging and making were increased through the experiment. Drastic change of thought was appeared from the question of Q8.

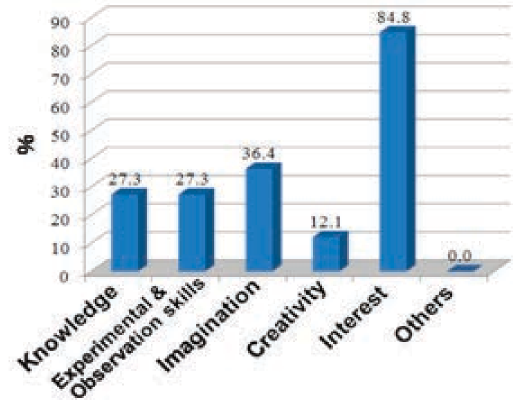

Fig. 5 Questionnaire (33 students). Q5: "Select two items from those described below which maintain contents uplifting your feelings through the experiment!" [Knowledge, Experimental & Observation skills, Imagination, Creativity, Interest, Others]

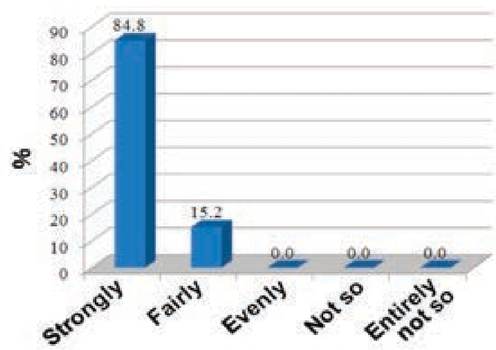

Fig. 6 Questionnaire (33 students, duplicate answer recognized). Q6: "Learning while making the experiment is important!"

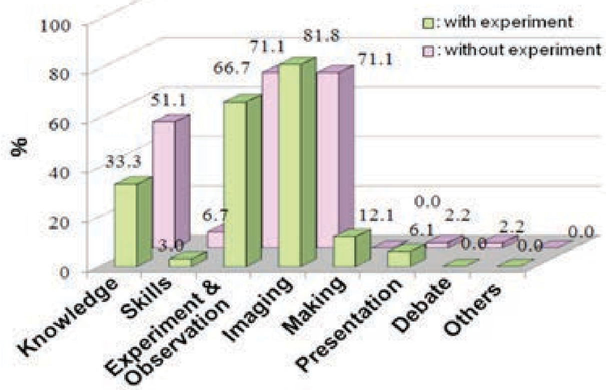

Fig. 7 Questionnaire (33 students with the experiment, 45 students without the experiment). Q7: "Select two items among those described below which maintain an importance for understanding chemical concept and/ or phenomenon!" [Knowledge, Skills, Experiment & Observation, Imaging, Making, Presentation, Debate, Others]

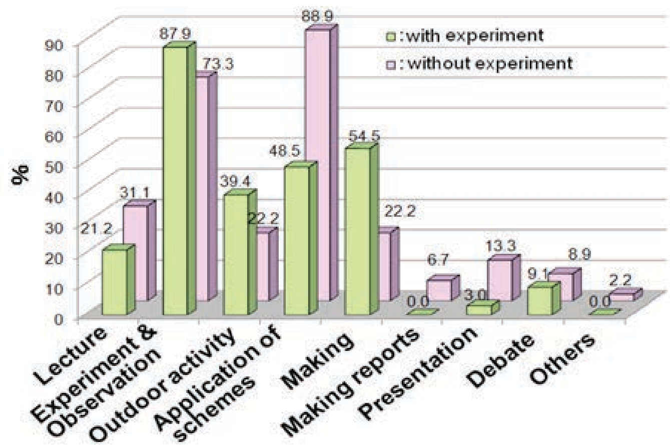

Fig. 8 Questionnaire (33 students with the experiment, 45 students without the experiment). Q8: "Select three items among learning methodologies described below which enhance your images!" [Lecture, Experiment & Observation, Outdoor activity, Application of schemes, Making, Making reports, Presentation, Debate, Others]

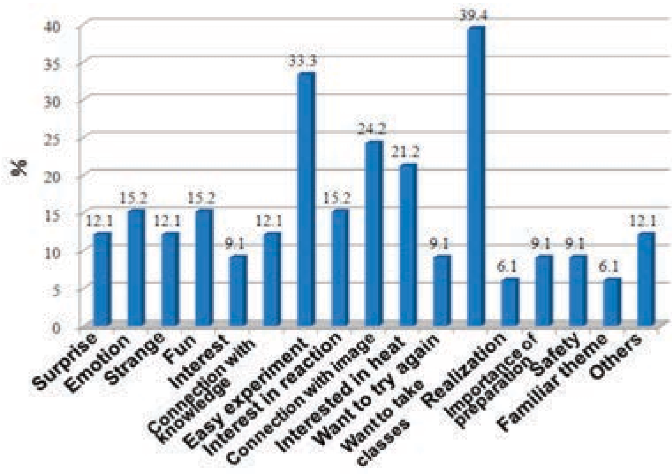

Fig. 10 Questionnaire of free description (33 students, duplicate answer recognized) Question of "Do you have any opinions through the experiment?"

While students without the experiment had the preference to "Application of schemes" and "Experiment & observation" as an important item for learning methodologies which enhances images, students through the experiment had the preference to "Experiment & Observation" and evenly to "Making", "Application of schemes", and "Outdoor activity" (Fig. 8). Especially, application of schemes halved and the making doubled in value. This indicates that learning methodologies accompanied by actual behaving such as the making and outdoor activity would be expected to enhance more of the images of objectives besides experiment & observation and application of schemes.

In addition, free description in a questionnaire was ordered from the stand point of mentioned items in Fig. 9 and Fig.10 based on questions of "What ideas come to mind when you try to make body-warmer once again?" and "Do you have any opinions through the experiment?" Students picked up items concerning "Quantity of materials" and "Temperature change" for a second challenge to make body-warmer which was expected to be as a candidate for students own teaching class with the feeling of easy experiment.

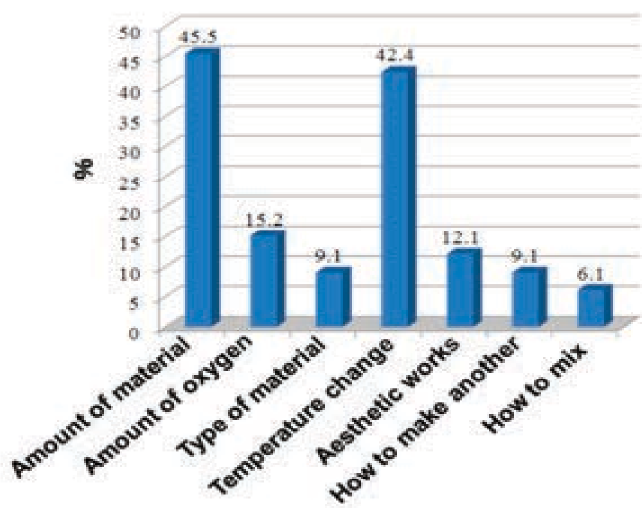

Fig. 9 Questionnaire of free description (33 students, duplicate answer recognized). Question of "What ideas come to mind when you try to make body-warmer once again?"

DISCUSSION AND CONCLUSIONS

Thinking and behaving imaginatively in science is important to promote creativity as an outcome with value to the original objective (Wardle, 2009, Finke, Ward, Smith, 1992, Ohshima, 1920). The answers to the questionnaire in this work showed that students felt the importance of actually doing the experiment and making observations for developing imagination, creativity and skills. These are important items for learning methodologies. Child and/or Osborne, *et al.* mentioned that students should appreciate that science is an activity that involves creativity and imagination as much as many other human activities and that some scientific ideas are enormous intellectual achievements Child, 2009, Osborne *et al*, 2003). Scientists, as much as any other profession, are passionate and involved humans whose work relies on inspiration and imagination. Domin has reported incorporation of the role of creativity plays in science into a problem-based laboratory activity of an undergraduate first-year chemistry curriculum (Domin, 2008). The learning on the basis of students' enthusiastic activities and imaginative thinking and behaving are of great importance to understanding science. Student's attitude being enthusiastic toward the possibilities of their own abilities with their own images would enhance the understanding of objectives.

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Appendix 1 Questionnaire

1: Strongly, 2: Fairty, 3: Evenly, 4: Not so, 5: Entirely not so

No.	Items	Scale
Q1.	Were you touched by heat generation from your own body-wormer?	**1-2-3-4-5**
Q2.	Did you have clear images about in and out of the substance accompanied by heat generation?	**1-2-3-4-5**
Q3.	Did you have clear images of overall reaction of rust of iron by the experimental kit?	**1-2-3-4-5**
Q4.	Was your knowledge is strongly coupled with facts of heat generation through making body-wormer?	**1-2-3-4-5**
Q5.	Select two items from those described below which maintain contents uplifting your feelings through the experiment! [Knowledge, Experimental & Observation Skills, Imagination, Creativity, Interest, Others]	
Q6.	Learning while bringing in making through is important !	**1-2-3-4-5**
Q7.	Select two items among those described below which maintain an importance for understanding chemical concept and/or phenomenon! [Knowledge, Skills, Experiment & Observation, Imaging, Making, Presentation, Debate, Others]	
Q8.	Select three items among learning methodologies described below which enhance your images! [Lecture, Experiment & Observation, Outdoor activity, Application of schemes, Making, Making reports, Presentation, Debate, Others]	
Free 1.	Free description; What ideas come to mind when you try to make body-wormer once again?	
Free 2.	Free description; Do you have any opinions through the experiment? [for example, want to take classes of yours, impressions actually made, relationship between knowledge and image and so on.]	

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The production of ecological paints as a contribution to the teaching of chemical concepts

La producción ecológica de pinturas como contribución a la enseñanza de los conceptos de química

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Abstract

This article aims to present the contributions of the subject’s utility for the teaching of chemical concepts. The title of the project was “the production of paints from “soils” in the region of Ponta Grossa, in the State of Paraná – Brazil”. The study was carried out with 16 students from the fourth-year of the Building Technician course at a state public school, in the discipline of Control and Environmental Protection. The methodological approach was qualitative with participant observation, whose techniques of data collection were images, testimonials, observation and notes of remembrance in field journal. The main results showed that there was a significant learning of chemical concepts worked in the production of paints from “soils”. The analysis and interpretation of the values of density, and viscosity of each specimen resulted in acceptable values of standard deviation for most specimen. They also provided reflections on environmental implications in relation to the materials that are typically used in civil construction.

Key words: chemistry teaching, projects, ecological paint, viscosity.