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Development of a lesson model in chemistry through "Special Emphasis on Imagination leading to Creation" (SEIC)

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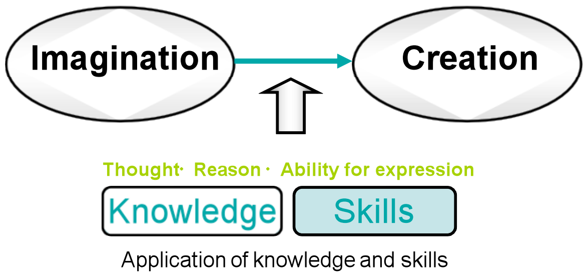
Abstract

Development of a lesson model in chemistry through "**S**pecial **E**mphasis on **I**magination leading to **C**reation" (**SEIC**) and its practice were carried out. **SEIC** has a fundamental feature of student-initiative-activities such as brain-storming and their own operation. The lesson put a special emphasis on enhancing the imagination and creativity by handwork operations mainly with drawing. The lessons for students to make images of chemical aspects were conducted for undergraduate chemistry classes of junior (third year) level students in Tokyo Gakugei University (TGU) and Bunkyo University (BU). Students' images toward a certain chemical concept or phenomenon by drawings had a large variety in representation and vivid description.

1. Introduction

International evaluations of PISA (OECD) [1] and TIMSS [2] show that Japan places still high level in education concerning about the competence of student. However, they simultaneously demonstrate some weak points of i) poor logical thinking, ii) quite little number of student in excellence, and iii) meager creativity. Special interest of ours is devoted to this school education, especially in science and chemical education on experimental study, where the lessons are favored to proceed under the way of dialogue between students and teacher with sufficient time, and of activities of mainly student himself after the former dialogue. However, the lessons still in Japan, even in the world, tend to be usually carried on the way of wiggle behavior of student's listening, writing, and answering including testing through a teacher-centered class-lecture.

Previously, we have reported a survey of present textbooks of "Science" [3a] in primary school and junior-high school and "Chemistry I, II" [3b] in senior-high school compiled based on Japanese course of study (MEXT, 1999). Boldface as a representative of knowledge [4a], skills for experimental study [4b], and schemes as a representative of image [4c] could be ordered. Large numbers of boldface, schemes, and skills were cited in present textbooks in Japan in order to understand scientific concepts, topics, and methodology. We introduce a fundamental feature of school lesson in science and chemistry in which a **S**pecial **E**mphasis on **I**magination is regarded toward **C**reation (**SEIC**) (Scheme). Promoting creativity in science has been reported and discussed in papers [5]. It is important for student to have thinking and behaving imaginatively, and finally to have an outcome which is of value to the original objective [6]. In this SEIC program, having imagination is emphasized also with acquiring knowledge and skills toward promoting creativity. In this paper, development of a lesson model in chemistry through **SEIC** and its practice are reported.



Scheme. From imagination to creation

2. Development of the lesson model through SEIC

2.1. 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 mainly with drawing. This approach of **SEIC** is expected that affluent images can enhance to foster creation through making good use of thought, ability for expression, and reason, where the strength of will for imagination and creation will be raised through **SEIC** accompanying acquisition of sufficient knowledge and skills as a tool.

2.2. The lesson model

The lesson model was made for the lesson in chemistry (for teaching profession in primary school) to an undergraduate university student. Contents of the lesson are listed in Table 1. Fundamental contents on the topics were chosen on the basis of basic chemistry; *i.e.* chemistry is roughly composed of three frames of structure, equilibrium, and change. Fifteen lessons in the model covered them moderately. Students' activities toward making images of some chemical concepts and phenomena should be performed. The lesson is typically divided in five activities as shown in Fig. 1.

The 1st period of ten minutes of the lesson is the time of review by use of samples of the pictures drawn by students in the last lesson under lecturer's initiative.

The 2nd of 45 minutes is the time of lecture putting a special emphasis on operations in a

Table 1. Contents of the lesson

1. Invisible but being
2. Three chemical bonds; ionic, covalent, metal (+ hydrogen, and van der Waals)
3. Malleable and conductivity of metal; temperature up causes conductivity of Iron down.
4. Chemical reaction; rust of iron: stoichiometry
5. Free energy; rust of iron: reaction coordinate, activating complex (compound at transition state)
6. Entropy; rust of iron: exothermic
7. Whereabouts of chemical reaction: equilibrium and kinetics
8. Fuel cell
9. Water characteristics and dissolution
10. Colloid; Tyndall phenomenon on micro-scale, scatter
11. Surface-active agent (Surfactant, detergent); shampoo and rinse *vs.* hair
12. Penetration and diffusion; ume (Japanese apricot) liqueur, membrane
13. Structural formula; images of fundamental molecule
14. High polymer; PET (polyethylene terephthalate), ethylene derivatives, analogs of polyethylene
15. High polymer; saccharide and cellulose

brain such as discussion, brain-storming, and recitation under teacher's initiative without competition in a class where students use only their own brains. These processes are able for students to have some images with essential knowledge and skills acquired, where students think themselves through comparing with different activities and opinions of others by their own intention. Students need necessarily to have some images accompanying organization in brains about the theme for a subject because of their concentration on their own thinking. This concentration is also promoted by their obligation on the later step on drawing.

The 3rd of 10 minutes is only a chance for students to memorize their acquisitions from the former activities and/or writing on the blackboard into students' own note.

Fig. 1. Typical time table of a class of the lesson

The 4th of 15 minutes is the time to draw a picture and/or sometime to form the clay by students' own images to the theme mentioned by lecturer. Student-initiative-operations proceed under, if need be, teacher's support, where the lesson puts a special emphasis on operations mainly with handwork. The operations are obligated and expected to help their concentration. These processes are able for students to have some images and sometimes creativity with essential knowledge and skills acquired. They concentrate their attention on the operation such as drawing, industrial arts, and any other representation. Of course, plenty of relevant experiences in their lives simultaneously enhance to assist students to have their own images and sometimes creativity.

The last of 10 minutes is the time to explain their pictures or other operations making the best use of their own knowledge of chemical terms.

3. Practice of the lesson model

The lessons were carried out in the classes in chemistry (for teaching profession in primary school) of 42 undergraduate students of junior (third year) level in Tokyo Gakugei University (TGU) and 175 analogs in Bunkyo University (BU) in the period of spring semester in 2009. The lessons proceeded somewhere around 90 minutes on time, where the lectures with frequent discussions without memorization were performed, and then operations of making images of chemical concepts and phenomena were advanced.

Students drew pictures and/or sometime formed the clay in three-dimension (3-D) with their own images in 15 minutes along the theme mentioned by lecturer. Drawing rule is shown in Table 2. Prohibition on drawing was regulated, for example, description of text, mark, line, arrow, and illustration with simile in a drawing area. Explanations by text style were also available outside the drawing area using chemical terms by solid-parting line. Examples are shown in Fig. 2-6, "Invisible but being", "Entropy", "Surface-active agent", "Penetration and diffusion", and "Surface-active agent" by clay, respectively. Students' images toward a certain chemical concept or phenomenon were expressed in drawings sometimes with their own explanations outside the drawing area by the text style with chemical terms. Drawings had a large variety in representation and vivid description besides good practices of forming the clay in 3-D. In addition, students used so many chemical terms, acquired in the lesson, on

Table 2. Drawing rule

Be drawing which everybody wants to see again

1. Many tones of colors or black-and-white
2. Prohibition of text, mark, line, arrow in a drawing area
3. Prohibition of simile
4. Drawing occupied a half space more in a sheet

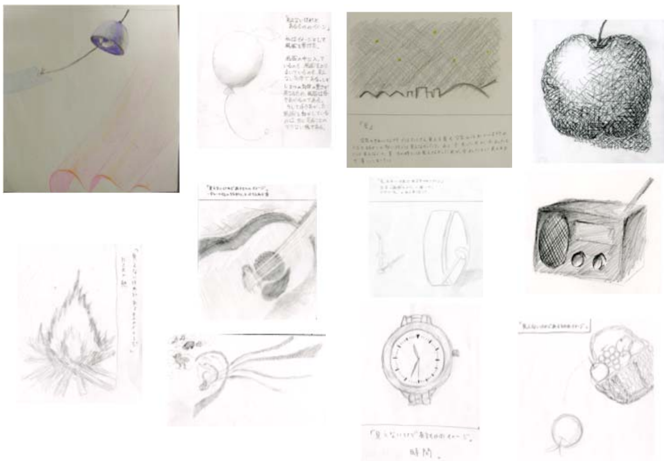


Fig. 2. (1) Invisible but being

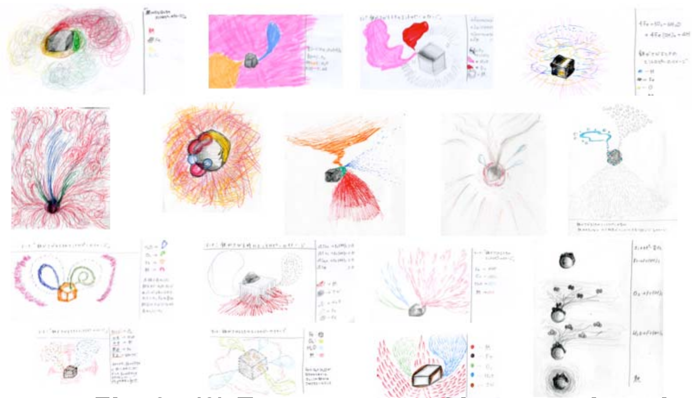


Fig. 3. (6) Entropy; rust of iron: exothermic

subsequent practices of their explanations that they could explain adequately their own images of drawings.

4. Closing

Development of the lesson model in chemistry through **SEIC** and its practice could be reported. The lesson model was comprised of 15 lessons with fundamental contents in chemistry. Students' images toward a certain chemical concept or phenomenon were expressed in drawings sometimes with their own explanations outside the drawing area by the text style with chemical terms. Drawings had a large variety in representation and vivid description besides good practices of forming the clay in 3-D. This approach of **SEIC** is expected that affluent images could enhance to foster creation, in which the strength of will for imagination and creation would be raised through **SEIC** accompanying acquisition of sufficient knowledge and skills as a tool. Further improvement in the adequateness for emphasis on imagination at the appropriate level in each grade would be a great help for student.

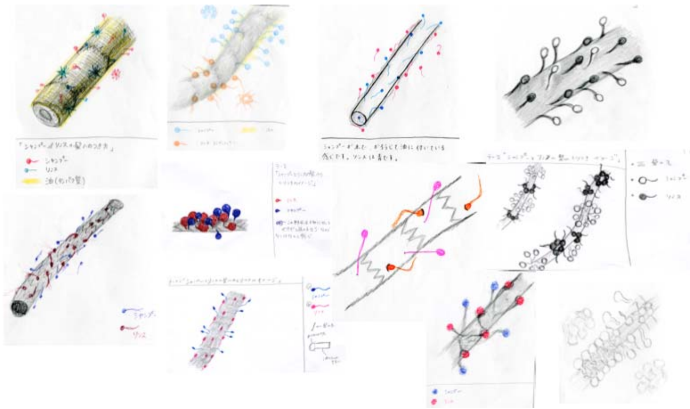


Fig. 4. (11) Surface-active agent (Surfactant, detergent); shampoo and rinse *vs.* hair

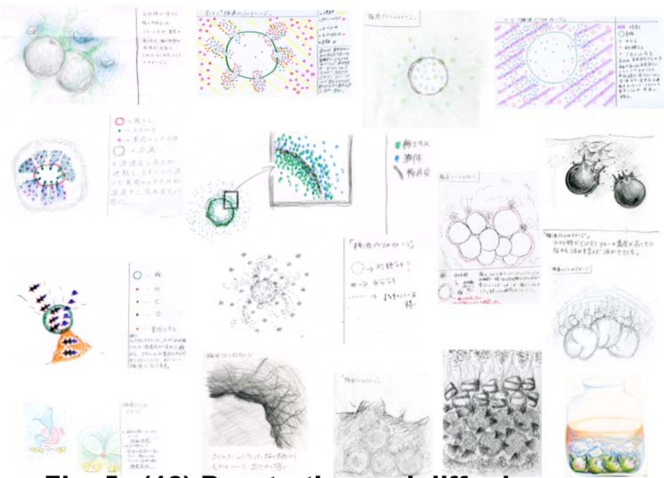


Fig. 5. (12) Penetration and diffusion; ume (Japanese apricot) liqueur, membrane

Fig. 6. (11) Surface-active agent (Surfactant, detergent); shampoo and rinse *vs.* hair

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