Sixth NICE Conference

Network for Inter-Asian Chemistry Educators

NICE2015

ABSTRACT

29-31 July 2015
Tokyo, Japan

Welcome to Sixth NICE Symposium (NICE2015)

First of all, I would like to express my sincere welcome to all participants from abroad and from many areas in Japan.

The purpose of NICE symposium is promoting the communication between inter-Asian chemistry educators, exchanging the chemistry teaching strategies and materials in different countries, as well as sharing the fruitful results. To accomplish this purpose, NICE2015 will provide an ideal opportunity for all participants to share and exchange experiences and information related to important topics in chemistry education such as;

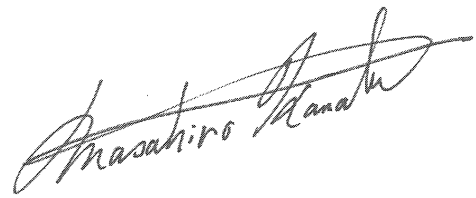
- Students' conceptions and conceptual change
- Instructional strategies
- Chemistry in daily life, Attitude toward chemistry
- Lab activities , Sharing / Exhibiting products of science fairs
- Representation of curriculums / textbooks

Since the participants are not only university researchers but also many in-service teachers, graduate/under-graduate students unlike most international conferences, more practical discussions and/or information exchange can be expected. Especially activities by senior high school students from three countries are expected to enhance our discussions and information exchange.

This unique NICE symposium was originally established based on the idea of Prof. Choon H. Do (Korea), Prof. Mei-Hung Chiu (Taiwan) and Prof. Masato M. Ito (Japan). As Chairperson of Sixth NICE Symposium, I would like to express my deep gratitude to them as well as Rimse that has sponsored and organized this symposium. In addition, I would like to show our special thanks also to NaRiKa Corporation, Suken Shuppan, Wako Pure Chemical Industries, Ltd., Wavefunction, Inc., GASTEC Corporation and TOKYO SHOSEKI CO., LTD. for their financial supports.

I really hope that all participants will have a wonderful time and unforgettable experience in NICE2015 in Japan.

July, 2015



Masahiro Kamata
Chairman of NICE 2015

1st day **Wednesday, July 29th.**

Name of Rm.	HAL	CR1	CR2	CR3
8:40-9:10	Registration			
9:10-9:30	Openinng			
9:30-10:15	Plenary Lecture 1		CLOSED	
10:15-10:30	Tea Break			
10:30-11:30	Oral Presentations by HS students			
11:30-12:00	Plenary Lecture 2			
12:00-13:00		Lunch		
13:00-14:00	CLOSED		Oral Session 1	
14:00-15:00		Poster Demo & WS 1	Oral Session 2	Exhibi. & Poster 1
15:00-15:15		Tea Break		
15:15-16:15		Poster Demo & WS 2		Exhibi. & Poster 2
18:00-20:00		Banquet		

Oral:15 min incl.Q&A

2nd day **Thursday, July 30th.**

Name of Rm.	CR1	CR2	CR3
9:00-10:00	Poster Demo & WS 3	Oral Session 3	Exhibi. & Poster 3
10:00-10:15		Tea Break	
10:15-11:00	Poster Demo & WS 4	Oral Session 4	Exhibi. & Poster 4
11:00-12:00		Oral Session 5	
12:00-13:00		Lunch	
13:00-14:00		Plenary Lecture 3 & 4	
14:00-16:00	CLOSED	Museum Tour	CLOSED
16:00-16:15		Closing	

Oral:15 min incl.Q&A

3rd day **Friday, July 31st. (at High School)**

9:30-16:00	School Visit

1st day: Wednesday, July 29th.

8:40- 9:10	**Registration**		
9:10- 9:30	**Opening Ceremony**		**Miraikan Hall**
9:30-10:15	**Plenary Lecture 1**		
	"Towards the Enhancement of "Scientific Literacy" and the Role of Chemistry Education – Wishes and Necessities, Challenges and Opportunities" Claus Bolte, Freie Universität Berlin, Germany	1	**Miraikan Hall**
10:15-10:30	Tea Break		
10:30-11:30	**Oral Presentations by High School Students**		**Miraikan Hall**
	Seoul National University High School, Korea; New Taipei Municipal Jinhe High School and National Tachia Senior High School, Taiwan; Mito Dai-ichi High School, Japan		
11:30-12:00	**Plenary Lecture 2**		**Miraikan Hall**
	Creating a Multicultural Opportunity for Learning Chemistry Li-Yu Fu, National Tsing Hua University, Taiwan	3	
12:00-13:00	Lunch		
13:00-14:00	**Oral Session 1**		**Conference Room 2**
	O-1 "Japanese High School Students' Self-Efficacy for Learning Electrolysis", Derek Cheung[1] and Hiroki Fujii[2] [1]Department of Curriculum and Instruction, The Chinese University of Hong Kong, Hong Kong, [2]Graduate School of Education, Okayama University, Japan	4	
	O-2 "Service-Learning as a Pedagogical Tool for Undergraduate Chemistry Courses", Henson Lee Yu, Department of Chemistry, Ateneo de Manila University, Philippines	5	
	O-3 "Effectiveness of Chem-Connect Project in Managing Large Classes in Chemistry", Ronaldo Reyes, Science Department, Tabaco National High School, Philippines	6	
	O-4 "Implementing Viva Voce (oral assessment) and setting of novel questions in pharmaceutical chemistry", Wee Chorng Shin, Loy Colin, Lim-Huang Shufen, Lim Junyang, Department of Science, Hwa Chong Institution (College), Singapore	7	
14:00-15:00	**Oral Session 2**		**Conference Room 2**
	O-5 "Students Engagement in Blended Model-Based Collaborative Learning in SPOCs Environments: The Impact of Concept and Spending Time in Learning", JONG, Jing-Ping, New Taipei Municipal Jinhe High School, Taiwan	8	
	O-6 "The use of augmented reality for promoting chemistry learning", Mei-Hung Chiu[1]* Chin-Cheng Chou[2] Yi-Hung Chen[3] Wan-Yueh Chan[4], [1]National Taiwan Normal University, [2]National Taipei University of Education, [3]Taipei Municipal Wanfeng High School, [4]University of Wisconsin, Madison, USA	9	
	O-7 "Development of Lesson Model on the Topic of Disposal Food Container in High School Chemistry: Focus on Students' Abilities to Make Appropriate Judgment", Hiroki Fujii[1], Atsushi Hiramatsu[2], and Kosei Kajiyama[2], [1]Department of Science Education, Graduate School of Education, Okayama University, Japan, [2]Hiroshima University High School, Japan	10	
	Poster with Demo & Workshop Session 1		**Conference Room 1**
	PD-1 "The Adsorption of Toxic Gas in Air by Homemade Pericarp Reprocessed Paper", Hsiao-Chien Liu, The Chemical Educational Resource Center (CERC) of Taiwan, National Changhua Senior High school	11	
	W-1 "Let's enjoy making sugar candy with friends without special equipment", Masahide Takanashi[1], Ayako Shirai[2], [1]Department of Science Education, Tokyo Gakugei University, Japan, [2]Department of Literature, Keio University, Japan	12	
	W-2 "Development of a science experiment on color for junior and senior high school students", Fumi Kouno[1], Izumi Imai[2], [1] Department of Environmental Science, Toho University, Japan, [2] Course of Teacher Education, Toho University, Japan	13	

1st day: Wednesday, July 29th.

Towards the Enhancement of "Scientific Literacy" and the Role of Chemistry Education – Wishes and Necessities, Challenges and Opportunities

Claus Bolte

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Enhancing Scientific Literacy is – in my opinion – the overarching aim of science education. But what do people consider as relevant if they discuss the concept or the term "Scientific Literacy" and the objectives of science education in general and of chemistry education in particular? And which picture can be painted if representatives of different stakeholder groups (e.g. students, teachers, science educators or scientists...) express their image of current science and chemistry education practice? – If I had to paint that picture, I would portray an abstract picture of Tokyo at night impressing wishes and desires, necessities and challenges, which represent the variety of opportunities how chemistry education could be improved making science and especially chemistry more attractive and popular for the community in general and young adults in particular.

In my presentation, I will first draw the attention to the diversity of aspects which represent the concepts and terms "Scientific Literacy" and "Chemistry Education" by means of aspects which are assessed by a sample of European stakeholders (N>2.700) as relevant and desirable in this field. Besides, I will discuss the issues realized to a higher or lower extent in science – especially in chemistry – education in the opinion of the European stakeholders involved in this study. What is more, the comparison of the importance and extent of practice attributed to each aspect allows the identification of areas requiring further improvement and more efforts in order to enhance Scientific Literacy in Europe – and maybe also in Asian countries.

Especially these areas identified build the starting point for the development of innovative sequences of science lessons (termed as "modules"), which should support the enhancement of scientific literacy. For the development of those modules science teachers are of great importance. This is one reason why I will introduce a model for "teachers' continuous professional development (CPD)" which is based on cooperation between science teachers and science educators. The CPD model in which teachers are acting as partners and in the role of "curriculum developers" has been successfully tried out in 21 different European countries within the framework of an international project funded by the European Commission named "PROFILES". Outcomes of this CPD programme are modules for more successful science teaching and learning as well as a higher level of teachers' professional attitudes, which partners of the PROFILES project term as "teacher's ownership".

At the end of my presentation I will introduce one of these modules focussing on the topic "Bioenergy" developed in cooperation with science teachers in Berlin, which the teachers implemented in their classes and evaluated regarding the question how their students become more (intrinsically) motivated to learn science when they are taught based on modules like this. Some years ago we had the opportunity to apply a module like this in the frame of a German-Japanese-Cooperation we named the "German-Japanese Chemistry Class of Its Own". I will use this project as an example to illustrate how to enhance "Scientific Literacy" and demonstrate – on empirically based evidence – the role contemporary Chemistry Education could play to achieve this aim of general science education [in German termed as "Naturwissenschaftliche Bildung"].

Creating a Multicultural Opportunity for Learning Chemistry in a Digital World

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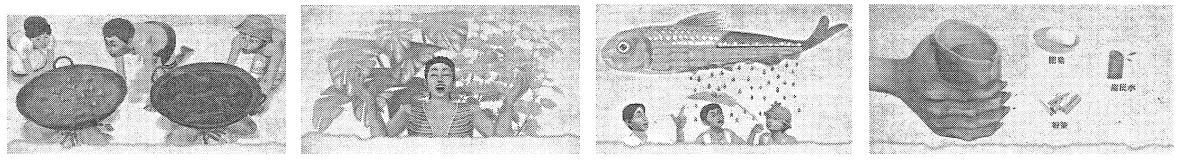
Digital technology permeates everyday life and supports many professions, including the teaching of chemistry, even though the teaching of chemistry also involves real-world hands-on activities. My speech will present some of my projects that are associated with creating a multicultural opportunity for youngsters in Taiwan to learn chemistry in a digital world. I began this work after my first field trip to an indigenous tribal village in 1997 to develop multicultural science learning activities and teaching modules. The YABIT Website, built in 2001, provides the basic platform for these projects. I will also provide five concrete examples of multicultural opportunities to learn chemistry that I created. These five examples concern Our Big River, the ASUS Indigenous Science Education Award (AISEA), YABIT 3D Animations for Indigenous Science Learning, YABIT Picture Game Books for Learning Science on the Cloud, and WOLF-TM (Teaching Module Generator) on the Cloud.

The Our Big River project involved students' monitoring the quality of water in the Front River using electronic apparatus, and uploading the data to the web-site YABIT (http://www.yabit.org.tw). Uploaded data included pH, temperature, and turbidity. Participants used computer software to produce charts, and shared and discussed their experimental results online. The AISEA competition required that all participants' project topics and research issues that were discussed at the fair were culturally responsive to their tribal life. All fair-related activities, including the interviews that all participants had to have with the judges, were carried out using cloud computing. The 13 episodes of YABIT 3D Animation for Indigenous Science Learning elucidate many chemistry-related concepts. Six volumes of YABIT Picture Game Books for Learning Science on the Cloud, based on the YABIT 3D Animations for Indigenous Science Learning, are now available for free download on Google Play. The main function of the WOLF-TM Generator is to help school teachers compose culturally responsive teaching modules.



Keywords: Digital learning, multicultural chemistry learning, On-line chemistry learning

Japanese High School Students' Self-Efficacy for Learning Electrolysis

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[2]Graduate School of Education, Okayama University, Japan
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Electrolysis is a difficult chemistry topic for most high school students. For example, students generally have great difficulty in writing ionic half equations for the redox reactions occurring at the two electrodes in an electrolytic cell. To learn electrolysis successfully, a strong sense of self-efficacy is needed. Students construct their self-efficacy beliefs from four sources of information: mastery experience, vicarious experience, verbal persuasion, and physiological states. Research has also indicated that the use of elaboration and metacognitive learning strategies by students can affect their self-efficacy. However, no published research has been conducted to determine the relative importance of the four sources of information and different types of learning strategy. In this study, questionnaire items were constructed to measure six predictors of students' self-efficacy for learning electrolysis. Data were collected from 781 Japanese grade-12 students. The students' level of self-efficacy for describing the chemical principles of electroplating was the lowest. Multiple regression analysis revealed that the most powerful predictor of students' self-efficacy was metacognitive strategy use (beta = .302), followed by mastery experience (beta = .284). Verbal persuasions and physiological states were not significant predictors of students' self-efficacy. The implications of these findings for chemistry teaching in school are discussed.

Keywords: high school chemistry, learning strategies, chemistry self-efficacy.

* Students create theory.
* help kids with orphan disease.
* journal log to record the dialogue between community & students

Service-Learning as a Pedagogical Tool for Undergraduate Chemistry Courses

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Traditional lecture-type discussion has been challenged in favor of more active learning to increase student performance in science, technology, engineering and mathematics (STEM) undergraduate courses[1]. A form of active learning is service-learning where service to a community is coupled to academic requirements. While service-learning is known to be more feasible for more 'applied' and softer disciplines[2], we used the Ateneo de Manila Chemistry Department service learning programs as a case study to outline projects that integrate chemistry to these softer disciplines to create an interdisciplinary approach to learn chemistry. This also gave students the opportunity to appreciate the other fields normally not studied by undergraduate chemistry (and other STEM) students. We conducted a survey to examine the elements that contribute to the learning of the students. Our findings show that students of service-learning viewed the academic load more positively; and their critical reflection on the experience and their community immersion have led to more civic consciousness and awareness of their social responsibility.

[1] S. Freeman, S.L. Eddy, M. McDonough, M. K. Smith, N. Okorafor, H. Jordt, M. P. Wenderoth, *Proceedings of the National Academy of Science,* 111 (23), 8410-8415 (2014).
[2] D. W. Butin, *The Review of Higher Education,* 29 (4), 473-498 (2006).

Keywords: service-learning, chemistry pedagogy

Effectiveness of Chem-Connect Project in Managing Large Classes in Chemistry

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With the low performance of the students in Chemistry due to large class size, there's a pressing need to implement interventions that will address the abovementioned problem; and one of these interventions is the Chem- Connect Project, which is a combination of innovative instructional strategies: Practical Work Approach, ICT applications, Chemistry promotion in the school and community.

This study was conducted to determine the effectiveness of Chem- Connect project in managing large classes in Chemistry. It investigated students' Chemistry performance and determined the correlation between performance and attitude towards Chemistry. Quasi experimental and correlational methods were employed in the study.

Implementation of the project showed promising results since it significantly improved students' Chemistry performance and enhanced students' attitude. There was a significant relationship between Chemistry attitude and students' performance in Chemistry.

Chem- Connect Project was effective in managing large classes in Chemistry since it significantly improved Chemistry performance of the students in the experimental group. The attitude of students towards Chemistry has a great effect on their performance. Positive attitude towards Chemistry leads to a better performance.

The implications of the results can serve as baseline in employing Chem- Connect Project in handling large classes to promote effective Chemistry learning.

Keywords: Large Classes, Practical Work Approach, Chemistry Promotion in the School and Community, ICT, Attitude towards Chemistry

hand-on. mind-on. heart-on

50.-70 students/classroom — large class

lead to misconception

ICT applications.

11 chemistry teachers

descriptive method
Correlational method.

Chemistry achievement test
chemistry attitudes test.

formating question.

use environment to talk about chemistry.

Blogging — Journal

barangays

resources.

what's the video clips you used? for your program how many minutes

community support money

Implementing Viva Voce (oral assessment) and setting of novel questions in pharmaceutical chemistry

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In the final year of junior college education (equivalent to the final year of senior high school) in Singapore, students who are passionate in chemistry will get to opt for an extra module titled pharmaceutical chemistry[1]. The level of difficulty is usually pitched at the equivalent of freshmen and sophomore level.

Over the past 8 years, Hwa Chong Institution (College) ran one of the most successful pharmaceutical chemistry program amongst all the school in Singapore and this is reflected by over 90 percent of students getting distinction and merit for the GCE 'A' level exam yearly. In fact, for the 2014 'A' level results which was released in early March 2015, 78% of our students obtained distinction, way above the national average of 46%.

We have shared some of our best teaching practices in several platforms and they are as follow:

- 31 May 2013: Sharing with over 40 educators from the other Junior Colleges in HCI (College) campus itself.
- 20 Aug 2013: Invited lecture at the 15th Asian Chemical Congress in the technical session "Chemistry Education in Emerging Asian Economies".
- 21 Jan 2015: Sharing with over 30 educators from the others Junior Colleges in Singapore at IPSG (a chemical education sharing forum in Singapore).

Two of the key successes in our curriculum is the implementation of oral assessment towards the end of the second term (end of May) and the novel questions which we set in our assessment which expose the students to the breadth of pharmaceutical chemistry. This presentation attempts to share some of the strategies which we used in Hwa Chong Institution (College) in the implementation of oral assessment and in the setting of novel questions.

This workshop is relevant for those who teaches related courses in senior high schools or universities, especially so if one who likes to adopt a different mode of assessments and would like to know more about the setting of novel questions.

5 TBO.

[1] https://www.seab.gov.sg/content/syllabus/alevel/.../9812_2014.pdf

Keywords: Novel Questions, Viva, Assessment

self-discovery

Student's eye contact with teacher's expression might influence students performance

{ reaction mechanism
Structural elucidation
Integration of knowledge

* Unclear/ambiguous question and to be clarified.

* Authenticity.

Students Engagement in Blended Model-Based Collaborative Learning in SPOCs Environments: The Impact of Concept and Spending Time in Learning

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Abstract

This study investigated the effects of a blended teaching strategy in term of model-based collaborative learning in SPOCs environments (as shown in Figure 1) on tenth graders' engagements and achievements in stoichiometry via quasi-experimental designs. The participants included 140 tenth graders assigned to two groups: (a) the experimental group who learned in a blended environment ($N = 69$) and (b) the control group who learned in traditional a lecture environment ($N = 71$). The results revealed that (a) the experimental group not only performed significantly better than the control group for the certain main concepts after the intervention but they spent much more time in learning self-reflectively and (b) the correlation between the students' performance on the conceptual assessment and their spending time in learning revealed significant differences. These findings implicated that the blended model-based collaborative learning in SPOCs environments, with proper design, facilitation and face-to-face interaction group, provided students opportunities to engage themselves in learning to improve their achievements.

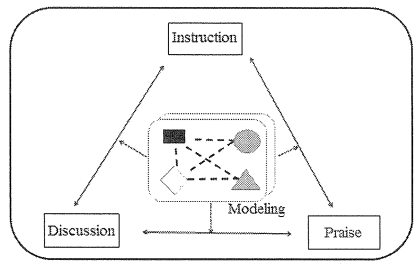

Figure 1: The framework of this study

Keywords: Stoichiometry, model-based collaborative learning, Small Private Online Courses (SPOCs)

Selected references:

[1]. Johnson, R. T., & Johnson, D. W. (1994). An overview of cooperative learning, In J., Thousand, A., Villa, & A., Nevin (Eds.), *Creativity and Collaborative Learning*. Baltimore, Maryland, USA: Brookes Publishing.

[2]. Chen, Y. H., & Chen, P. J. (2015). MOOC study group: Facilitation strategies, influential factors, and student perceived gains. *Computers & Education*, 86, 55-70.

experimental group watch video at school.
15' – 20' video watching at home.

The use of augmented reality for promoting chemistry learning

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The purpose of this presentation is to introduce the use of augmented reality (AR) in science textbooks and science classrooms for promoting chemistry learning. Research in the area of AR has shown that the physical component of AR experiences benefits student learning, especially in the areas of natural interaction and embodied representations (Bujak et al., 2013). This presentation is based on a study that took place at a municipal senior high school located in Taipei, Taiwan. There were two criteria for selecting the appropriate concepts for the development of AR learning tools. The first criterion was that the abstract and complex concept had to have a high difficulty level associated with conceptualizing it in the microscopic world. The second criterion was that the concept had to involve the interplay of multiple chemistry representations. In this study, we developed three sets of AR materials for chemistry concepts, namely organic compounds, polarity of compounds, and DNA for chemistry and biology. We found that the students were more highly motivated to learn chemistry when they utilized poker cards that had AR targets of different types of chemical compounds (such as methane, alkene, and alkyne) in conjunction with their smartphones. In addition, the students developed better understanding of the concepts of intermolecular forces among molecules and the polarity of a molecule. Finally, students performed significantly better on the posttest compared to the pretest on DNA structure when they used tablets or smartphones to visualize the complex structure of DNA. The results suggest the emerging need to design AR targets for teaching abstract and complex scientific concepts that have been documented to be obstacles for students learning chemistry. AR targets have the potential to scaffold students' construction of chemistry concepts and motivate them to learn chemistry. Instructional implications will be discussed.

Acknowledgement

This study was supported by the Ministry of Science and Technology (MOST) in Taiwan (Grant # 101-2514-S-003-007, 103-2514-S-003 -003). The authors express their appreciation for the support from MOST and teachers and students at Wanfeng High School in Taipei that made this study possible.

Reference

Bujak, K. R., Radu, I., Catrambone, R., MacIntyre, B., Zheng, R., & Golubski, G. (2013). A psychological perspective on augmented reality in the mathematics classroom. *Computers & Education*, *68*, 536–544.

*augmented reality
abstract and complex

Development of Lesson Model on the Topic of Disposal Food Container in High School Chemistry: Focus on Students' Abilities to Make Appropriate Judgment

Hiroki Fujii[1], Atsushi Hiramatsu[2], and Kosei Kajiyama[2]

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A lesson model proposed in this study aims to help high school students to understand disposal food container as plastics based on scientific knowledge and to make an appropriate judgment regarding its utilization for broadening sustainable society. The lesson content is as follows: 1) lectures about the spread and controversial points of plastics; 2) experiments on the strength, thermal conductivity, and synthesis/decomposition of disposal food container; and 3) group discussions about its desirable utilizations in modern society.

The series of the lessons was carried out for 39 Japanese students and 38 Korean students of the 11th grade in January 2014. Some findings that emerged from the analysis of a questionnaire were as follows. (1) Regarding the merits of disposal food container, the students understood its physical and chemical properties, e.g. the resistance to thermal conductivity and recycling nature. (2) Regarding its demerits, the students understood the difficulty in treating and the use of fossil fuels as raw materials. (3) Regarding its desirable utilization, the students expressed the ideas accompanied with appropriate reasons, e.g. avoiding wasteful usage and recycling. It was suggested that the development of such ideas were promoted by the understanding of disposal food container based on scientific knowledge.

[1] K. Kortland, Decision-making on science-related social issues: The case of garbage in physical science – A problem-posing approach, In G. Welford et al. (Ed.). *Research in Science Education in Europe: Current Issues and Themes*, The Falmer Press, 115-125 (1996).

[2] J. Lewis and J. Leach, Discussion of socio-scientific issues: The role of science knowledge. *International Journal of Science Education*, 28(1), 1267-1287 (2006).

Keywords: Decision Making, Ability to Make Appropriate Judgment, High School Chemistry, Disposal Food Container

厨餘桶 disposal food container
company join

* STS. context.
awareness
language skill.

The Adsorption of Toxic Gas in Air by Homemade Pericarp Reprocessed Paper

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Abstract

One summer field trip, I took my students to visit Kwong Hing Paper Workshop in Puli Nantou, learning how to manufacture handmade paper. The students feel very interesting about the papermaking process. So we try to find the appropriate equipment and materials in the laboratory and make handmade paper.

Taiwan is known as a cornucopia of fruit and the consumption of fruit produces a lot of peel waste every year. Actually, those peel wastes are very good materials for handmade paper.

We learned "Chemistry and Environmental Ecology" which discussed about the influence of chemistry on air pollution in class. So we have a new idea to test the adsorption of toxic gases in air by homemade pericarp reprocessed paper.

I designed a two-class in one week program to make the students understanding the air pollution further and learning how to control the experimental condition and measure the result. This program should be a good training for students when they do the further scientific research.

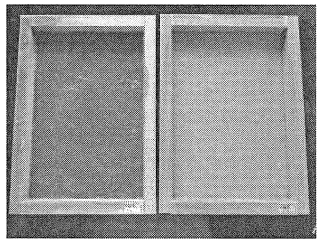

Fig. 1 Handmade paper made by serigraphy net

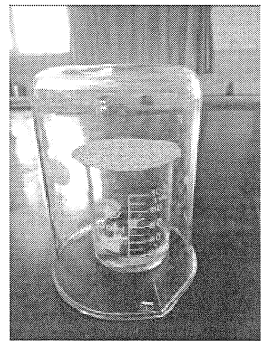

Fig. 2 The adsorption of organic gases methanol (CH_3OH) and formaldehyde (CH_2O)

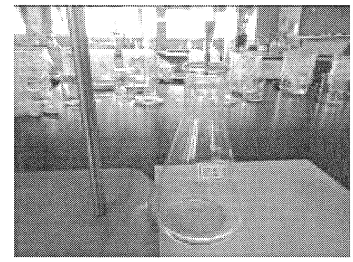

Fig. 3 Measurement of methanol content by titration of potassium permanganate($KMnO_4$)

Keywords : recycle, adsorption of organic gases, redox.

Let's enjoy making sugar candy with friends without special equipment

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Sugared water solution heated to 130C from 125C has a property to turn into a solid cooling.
Sodium bicarbonate was decomposed to water vapour, carbon dioxide and sodium carbonate.
The experiment of making sugar candy shows combination of the nature of sugar and sodium bicarbonate

[1] M. Takanashi, *Chemistry and Education Japan*, 44**(1),** 42-43 (1996).

Keywords: Sodium bicarbonate, decomposition, white sugar, temperature 125-130C, egg white

Development of a science experiment on color for junior and senior high school students

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Both children and adult students are known to show a keen interest in color changes that occur during science experiments. However, primary and secondary education provides few opportunities to systematically learn about color. To address this issue, we have developed a pre-service and in-service training program for teachers that systematically teaches them about color[1)]. The approach in this study was to develop a program for teachers to understand the concept of color based on physics, chemistry, and biology. The program included many experiments because both children and adult students are always interested in seeing science in action. We have thus introduced an experiment through which the junior and senior high school students can enjoy colors (Fig.1, 2).

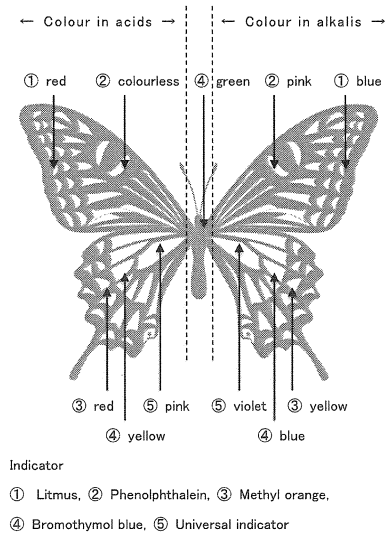

Fig. 1 Some indicators and their colors

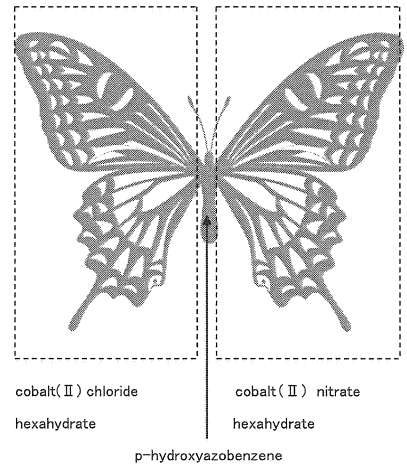

Fig. 2 Dyes and chemical equilibrium

[1] I. Imai, M.Takahashi, K. Tominaga, K. Makide, Development of a Pre-Service and In-Service "Color Science" Training Program for Teachers, in Cooperation with Toho University, JACI, and DIC Co., Ltd., *Pacifichem 2015*.

Keywords: Color science, Indicators, Dye, chemical equilibrium, Experiment

Students' Understanding of Amorphous State of Materials Using Energy Diagram

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Changes in the energy state of materials that occurs accompanied by the phase transitions and chemical reactions and depending on temperature are the fundamental learning subject in chemistry courses in higher secondary schools, in which energy diagram plays an important role for facilitating students' understanding.[1,2] It is expected that the understandings of the energy state of materials and energy diagram can be practically utilized for describing energy changes of materials accompanied by further advanced processes.

In this study, students' ability of describing the energy changes during the vitrification and devitrification processes of materials using energy diagram was investigated through a series of written assessments by administrating for introductory chemistry course students at our university. Besides a fairly good understanding of the energy change of a material during solid–liquid phase transition, students have large difficulty to expect the energy state of glass materials on the energy diagram (Figure). Through analyzing the students' answers for a series of assessment questions, possible causes of the difficulties and misconceptions were identified. On the basis of the present results, an effective way to integrate students' understanding of the energy state of materials and energy diagram is discussed.

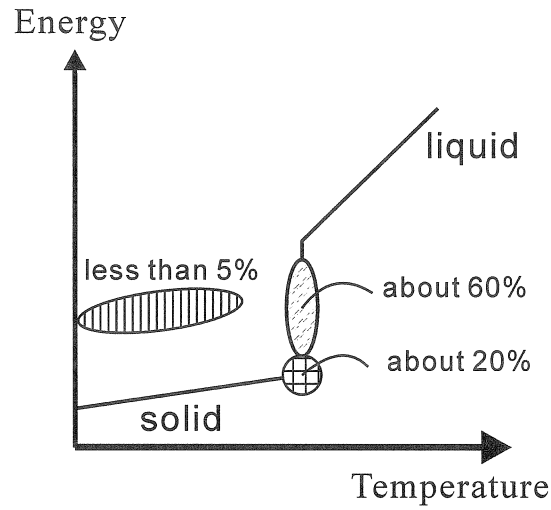

Fig. Studnets' answers for the energy state of a glass.

[1] T. Tatsuoka, N. Koga, *J. Chem. Educ.*, **90(5)**, 633-636(2013).

[2] N. Koga, K. Sigedomi, T. Kimura, T. Tatsuoka, S. Mishima, *J. Chem. Educ.*, **90(5)**, 637-641(2013).

Keywords: Energy of materials, Energy diagram, Amorphous state, Polyethylene terephthalate

Bio-energy applied in a Junior High School science and technology curriculum- The case of Kaisyuan Junior High School

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Abstract

Nowadays, closing the relationship between energy, environment and ecological distribution, environmental energy education related to bio-energy seems to be an important topic. However, it is rarely noted in the current nature and living-science field curriculum of junior high schools. In this study a technique of pre-experimental design is utilized with a method of inquisition that would be applied to find the feasibility of bio-energy being merged into the current nature and living-science field and energy course and the subsequent learning performance of students. Results based on a series of statistical analyses show that a bio-energy course merged into the current course is workable. The bio-energy course applied will give a positive impact on energy recognition and on the behavioral attitude of students. These findings will be suitable in the future for a smaller type of school with a total class number of less than eighteen, or a mixed type of school with students coming from both the city and the country.

Keywords: bio-energy、energy course、energy recognition

Applications of Three-Tier Diagnostic Assessment in Content Analysis for Chemical Molecular Particulate Properties

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Abstract

This study aims at employing the method of content analysis to analyze and approach students' conceptual responses for particulate properties of molecular levels. It elucidates the matter states, temperature, pressure and volume by three-tier diagnostic strategies in students' chemistry learning. This study presents results based on participants' responses after they were formally instructed on the topic. As an innovative research, this study accounts for four required statistical results with a high quality three-tier tests, to examine low achievement students' explanation for molecular particulate with misconceptions, to select scientific conceptual answers in spite of their lack of molecular particulate behavior, and to propose students' incorrect reasons for incorrect responses of molecular particulate behavior. To sum up, applications of three-tier tests in content analysis for chemical molecular particulate properties could detect students' lagging problem-solving of conceptual learning.

Keywords: content analysis, misconception, molecular particulate, three-tier tests

Using TIMSS Items to Examine Students' Science Modeling Ability: A Cross-Countries Comparison in the Topic of Classification of Matter

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Abstract

Given the scarcity of modeling ability assessments, this study made use of the TIMSS 2011 items to introduce the design of modeling assessment. Referencing the Modeling Process by Halloun (1996), and the Modeling Ability by Biggs and Collis (1982), and Hempel (1958), this study established a framework for modeling test items. A content analysis on 93 items for the 8th graders and 77 items for the 4th graders was conducted. And then, the Classification of Matter in Chemistry was selected as the research theme. Finally, the modeling performances among students from Taiwan, Japan, Korea and Singapore were compared. The findings show: TIMSS items didn't measure all stages of the modeling process, and primarily emphasized on Levels 1 and 3. Comparing cross-countries performances in the topic of the Classification of Matter, in the stage of Model Selection, the Singaporean 8th graders performed best (Level 3); whereas the Taiwanese and Korean 8th graders performed worst (Level 1). In the stage of Model Analysis and Application, except for Korea, other three countries could reach Level 1. When the 4th graders were concerned, students of all four countries were able to handle simple relationship tasks related to Model Selection, and Model Analysis and Application.

Keywords: Classification of matter, Cross-countries comparison, Modeling ability, Modeling process, TIMSS

Reference

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Biggs, J. B. & Collis, K. F. (1982). *Evaluating the quality of learning: The SOLO taxonomy.* New York: Academic Press.

Hempel, C. G. (1958). Fundamentals of concept formation in empirical science. In C. G. Hempel (Ed.), *International encyclopedia of unified science: Foundations of the unity of science, volume 2* (pp. 88-93). Chicago: University of Chicago Press.

Changes of A Science Teacher's Knowledge and Instruction on Reading Science Text

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Abstract

The ability to read texts carefully, critically, and with an enquiring mind is a key indicator of scientific literacy. Yet over the last few decades, a survey of teachers' knowledge on teaching science, indicates that little is known about how a teacher teaching reading comprehension of science text. This study explored the professional change for a science teacher in the instruction of reading comprehension on science text. The participants included a science teacher and her fifth-grade and sixth-grade students of an elementary school in southern Taiwan. The science texts and reading lessons were embedded in the lessen unit *Watching Stars* designed by the case teacher. The data were collected through the ways of classroom observation, interviews with the case teacher and her students. The teacher's journals, teaching plans and mind maps about teaching science reading were also collected. The teacher's pedagogical content knowledge about reading science text was context-dependent and developed gradually. The teacher's knowledge about teaching science influenced her teaching practices through self-reflection and self-awareness in actions. The factors causing teacher's professional change included the students' assignments, debrief discussions among school teachers and university professor, and teacher's self-reflection and awareness.

Keywords: professional development, reading comprehension, science text

Teaching mirror image throgh integrating inquiry instruction with seamless assessment

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Abstract:

Assessment and instruction are logically linked. Assessment can help teachers determine what students learned. And, assessment can help students reflect on their own learning. Seamless assessment is aimed to accomplish these purposes across a unit of instruction. Whenever a mirror (whether a plane mirror or otherwise) creates an image that is virtual, it will be located behind the mirror where light does not really come from. The second characteristic has to do with the orientation of the image. The mirror image is a reflected duplication of an object that appears identical but reversed. But students do not perceive the mirror image is left-right reversal.

In order to help students understand the concept of mirror imagine, we applied seamless assessment techniques within inquiry instruction. There were three activities in this teaching unit. Participants of this study were second grade students from Southern Taiwan. The first activity was designed to assess students' existing ideas of mirror image. In the second activity, a maze game, students were requested to find the route through a maze, in which the pathways and the mirror walls are fixed. The third activity applied poker cards and POE strategy. First, students were requested to predict and drew the mirror image of a single symbol of each suit (numerical color and shape) according to the characteristics of mirror imagine. Then they observed a reflected image through a mirror and drew the correct mirror imagines. Finally, students generalized the patterns of findings and explained what they discovered. The development of special cognition was found to be positive associated to understanding the concept of mirror imagine. Recent perspectives on the role of special cognition and the language in science education and suggestions that support learning during instruction are briefly described.

Keywords: seamless assessment, mirror image, 5E model, P.O.E

Effect of Junior College Students' Operating Skills from Interactive Whiteboards Integrated into Cosmetology Instruction

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Abstract

The purpose of this study was to explore the effect of operating skills by integrated interactive whiteboards into cosmetology course. There were 90 fourth grade junior college students from two classes in north Taiwan attending this study. Static-group comparison was adopted. This study implemented during second to sixth weeks in the first semester of 2014 academic year. Self-developed operating skills test as assessment tools. Result reveals that no significant difference was found on operating skills between these two groups. Similarly, no significant differences were found on the variable factors on their economic and schools scores. Material contents might be overweight on knowledge, understand, and memory and other lower level cognitive domain. It implies that this study should increase high-level cognitive contents and further to analyze the effect for students' learning performance.

Keywords: cosmetology instruction, high level cognitive ability, interactive whiteboards (IWBs), operating skills

A Survey study on Knowledge and Attitude of Sustainable Development for Junior College Students

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Abstract

The purpose of this study was to survey junior college students' Sustainable Development knowledge and attitudes. There were 300 nursing freshmen from six classes in north Taiwan attending this study. This study implemented at the first week of the first semester in 2014 academic year. Tools contain environmental sustainability knowledge and environmental sustainability attitude questionnaires which developed by researcher. Questionnaire reliability is .854. Result shows that there are four items which the correct rate are lower than sixty percent, contain the key conceptions of sustainable development, the cause of global environmental change, globalization environmental problems and eutrophication definition in knowledge aspect. In terms of emotion, students generally agree with the attitude of willing to care about natural environment, improve environmental quality, meet the need of energy-saving measures, but for the " In keeping with the need for sightseeing, environmental regulations are willing to relax restrictions", their attitudes are showing a neutral position. In the action aspect, students are willing to take action to save environmental resources, buy energy-efficient products and report on the guilt of damage environment people to support sustainable environmental behaviors. However, "Purchase products which probably is harmful for wild animals and plants or habitats" is showing a neutral view. This study will contribute to teachers understand students' environmental sustainability entering behavior and further improve their environmental education.

Keywords: junior college students, knowledge and attitude, sustainable development

The Use of Toys to Illustrate the Exhaust Control Process of an Automotive Three-way Catalytic Converter

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A unique hands-on demonstration has been developed using interlocking plastic bricks and ping-pong balls to illustrate the exhaust control process of an automotive catalyst. This demonstration is intended to be used for middle and high school students at science festivals.

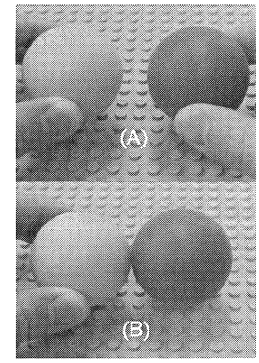

Fig. 1

Interlocking plastic bricks have already been used as teaching aids in chemical education, and we previously demonstrated that these bricks could be used to illustrate several catalytic processes.[1–4] Ping-pong balls can also be used to represent atoms and molecules. With this in mind, it was envisaged that ping-pong balls equipped with magnets could be used to illustrate the dissociation (Fig. 1(A)) and formation (Fig. 1(B)) of simple molecules.

Despite the importance of exhaust emission control technology, there have been no reports pertaining to the development of teaching aids dedicated to this topic. To address this issue, we have constructed a series of brick models illustrating the fundamental concepts of automotive catalysis (Figure 2).

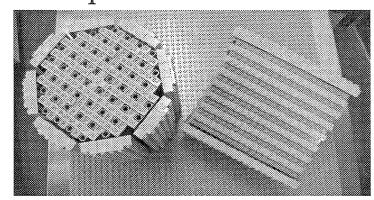
Fig. 2

Herein, we report the result of the hands-on demonstration of this teaching aid in science festivals. Using interlocking plastic bricks and ping-pong balls, the chemical reactions performed by an automotive catalyst became more straightforward and interesting.

[1] R. Horikoshi, *J. Chem. Educ.*, **92(2)**, 332-335 (2015).
[2] R. Horikoshi, *Chem. Educ. J. (CEJ)*, **17(1)**, 101 (2015).
[3] R. Horikoshi, Y. Kobayashi, H. Kageyama, *J. Chem. Educ.*, **91(2)**, 255-258 (2014).
[4] R. Horikoshi, Y. Kobayashi, H. Kageyama, *J. Chem. Educ.*, **90(5)**, 620-622 (2013).

Keywords: interlocking plastic bricks (construction toy), ping-pong ball, automotive catalyst

Development and Use of a Small-scale Experimental Kit for Observation of Recrystallization of Ammonium Chloride in Science Lessons and Workshops

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Ammonium chloride and its aqueous solution have been used for observations of recrystallization in science classes to learn physical properties of aqueous solutions. So far teachers have often demonstrated such recrystallization phenomena, while students have rarely carried out the experiments individually. We therefore developed a small-scale experimental kit for learners to practice easily and individually the experiment on recrystallization of NH_4Cl. We used this teaching material in a science class, a science workshop and a research activity [1]. Based on responses from learners and teachers in these learning activities, we evaluated its usability and educational effects on learners. We also discussed the usefulness of the experiment in terms of the variety and multiplicity of teaching materials in chemical education. This teaching material is easy and safe to operate, and it allows learners to clearly observe the recrystallization process and heat of reaction. Using this teaching material for the science workshop, the learners were interested in the recrystallization phenomena. Moreover, upper secondary school students enhanced their scientific thinking and expression through their research activity with the teaching material. This teaching material can be useful for various learning activities.

[1] Y. Terashima, *Journal of Research in Science Education*, **55(2)**, 209-218 (2014) (in Japanese).

Keywords: Ammonium Chloride (NH_4Cl), Recrystallization, Small-scale Experimental Kit

Chemical Magic Presentation by University Students of Science Teacher Training Programs as Chemical Education (in English)

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We have investigated and developed many chemical experimental methods, including chemical magic presentation, for practices of delivery lectures. Over 100 times of "Dema-e Kagaku Jikken", meaning delivery practices of chemical experiments, were performed as Service-Learning, which is an involuntary educational activity, officially planned, operated and evaluated by university supervisors, then strictly distinguished from a volunteer group activity. The procedures and presentation methods have been improved by the estimation of every practice. In 2012, a textbook[1)] of the experiments, which were mainly observed and partly joined by the audience, such as chemical magic presentation, was published in Japanese. We have been performed the practice with PowerPoint presentation in Japanese so far. However, English education is going to start at 3rd grade in Japan. Over two thirds of the students of Science Teacher Training Programs are going to be teachers of the primary school. They have a tendency not to use English well. So we challenge to show a chemical magic "Automatic Rainbow Color Change" in English to returnee students of affiliated Nagoya junior high school as training in chemistry and English. Translation of the textbook in English is also planned. Come to see our presentation, please. Don't miss it.

[1] Y. Toya et al., *"Chemical Experiments as Teaching Tools"*, Aichi University of Education, pp 1-123 (2012). ISBN 978-4-903389-59-2 Only described in Japanese.

Keywords: Delivery Lecture, Chemical Experiments, Chemical Magic, Chemical Education

The Impact of Interactive Whiteboards Integrate into Curriculum on Student Learning Performance: A Case Study of Cosmetology Teaching

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Abstract

The purpose of this study was to explore the impact of students learning achievement by integrated interactive whiteboards into cosmetology course. There were 90 fourth grade junior college students from two classes in north Taiwan attending this study. Nonequivalent pretest-posttest design was adopted as research methods. This study implemented during second to sixth weeks in the first semester of 2014 academic year. Tools contain knowledge test and learning attitude questionnaire. Result reveals that no significant difference was found on their learning achievement. In terms of affective domain, experimental group has positive attitude on material design, learning feelings, teaching activities, and learning outcomes by integrated interactive whiteboards into course. This study could assist teachers understanding the impact of IT technology into students' learning achievement and further to be a basis to improve teaching and learning.

Keywords: cosmetology teaching, interactive whiteboards (IWBs), learning achievement, learning attitude

Integrate coffee roasting and brewing methods into applied chemistry education

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Abstract

Coffee is a very popular drink in the world. From roasting green coffee beans to making a cup of good coffee, many chemistry reactions happen. Caramelization and the Maillard reaction are the major reasons turning green coffee beans into aromatic roasted beans in the coffee-roasting process. These chemical reactions cannot always be comprehensively understood by students when teachers teach in the class. To impress the students, we design some hand-on experiments to show how coffee products change when we use different experimental conditions, like reaction temperature and time, to roast coffee. Students can directly compare the results from different experimental conditions (over-temperature, optimum temperature and under-temperature with different time duration) and deeply know how these reactions change coffee beans. In addition, we also use different coffee brewing methods (boiling, steeping, filtration and pressure) to demonstrate the differences of extraction. Students can easily realize the concept that many factors can change the extraction result, by drinking a cup of coffee prepared by themselves. In the future, we will go further to analyze what elements make coffee so charming by integrating instrumental analysis into this teaching program.

Keywords: coffee, hand-on experiments

CSimulator: A Chemical Educational Support Tool for Smart Devices

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In recent years, high school and junior high school students have a problem, which is called "disinterest in science". One of the main reason for the problem is that they have less and less time for scientific experiments or practices in the curriculum. As a solution for this problem, the efficient use of ICT (Information and Communications Technologies) becomes popular. In particular, smart devices (e.g. iPhone) attract a great deal of attention as educational support tools. Smart devices have an advantage that they can make learning fun for everyone, anywhere, at any time. From this stand point, we have already reported the prototype implementations of iOS application that simulates the experimental procedure of the funnel extraction[1)] or that of qualitative inorganic analysis of metal cations[2)].

In this study, we further extend the application for simulating qualitative analysis of several metal cations (Fig.1). Specifically, we integrate the processes for Group I to III, to enable to make a blind quiz (unknown mixture). We will discuss the possibilities and limitations for this kind of application based on user feedback.

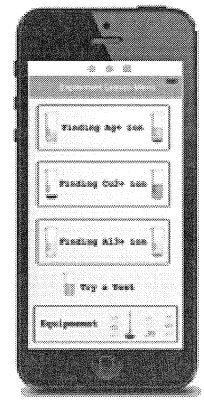

Fig.1 CSimulator

[1] S. Takane, et al., poster presented at *Pacifichem 2010*, Honolulu, Hawaii, USA (2010, December).
[2] A. Falmban, S. Takane, poster presented at *ICCE2014*, Toronto, Canada (2014, July).

Keywords: smart device, iOS, educational support tool

Simple Model to Provide Feeling of Bonding

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Understanding the vibrations of polyatomic molecules is important to understand infrared absorption spectra, which is basic technique for instrumental analysis. However, obtaining image of vibrational mode is not easy for beginners. Often, arrow with molecular structure is used in the textbook. Image of two-dimensional representation is limited. Teaching material of tangible model, which can show vibrational mode, may help beginners to grasp image of vibration of molecule. We developed a simple model made by plastic capsule and small Neodym magnet. Each magnet was placed inside of the small capsule in the bigger capsule so that magnet can move freely. Therefore, there is no need to care the polarity of the magnet when the bond is formed. This feature enables bonds to be formed or broken between two capsules. Since each capsule is connected by magnetic force, the model could easily show a bending mode. The model could also be used to explain ionic bond, for example, students could feel an attractive force between two atoms. The model was demonstrated at a class for non-science major and science major university students, and was evaluated through questionnaires. The results of the questionnaires indicated that the model effectively show shape of molecule and show some effect on vibrational mode compared with showing a figure of vibration.

Keywords: Model, Teaching material, Bending mode, Ionic bond

Development of Experimental Program for Acquisition of Mole Concept

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Mole concept is applicable fundamental concept in chemistry to clarify the changes of the phenomena. However, instruction by teacher and understanding of the concept requires so much effort. Therefore, many studies were carried out. Two aspects exist in the concept as a "number" and a "scale". Most reports focus on one aspect of those.

We developed an experimental program being integrated both aspects. A survey of present educational-research on “mole” was conducted, and related experiments were extracted and classified on the bases of the two aspects. Step with targets of attainments were set and corresponding contents of study were selected. Packing module type of experimental program was developed including, e.g. “Change of state in ethanol” of 4th grade (g4), “Determination of Avogadro constant, NA, with crystalline NaCl ” (g11), and “Calculation in real gas” (g13). The program was composed of the text for experiments, materials, background information, and explanatory power point file. The text was taken into consideration of insertion of numerous photographs in order for student himself to be able do each experiment smoothly.

Keywords: Experimental Program, Mole Concept, Number, Scale

Coloring of Titanium Plate as Teaching Material for Introduction of Electrochemistry

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It is our aim to produce a teaching material, in which students have good experiences of the joy of discovering the "how" and "why" of chemical reactions. The teaching materials by visualization used for tuition's introduction are also effective to suggest student's interest and aggressive thought. In this paper, the coloring of titanium plate on experimental scale was conducted by the method of electrochemical reaction. The plate was readily colored where variable change of color pattern could be observed and easily controlled through the electrochemical conditions such as applied voltage and electrified time. For example, the voltage of 30 V in 5 minutes led the plate to change vivid color of blue from apparently original color gray. The proposed teaching material might be used for the motivation to the lesson of electrochemical reaction causing student's interest and behavior to the next stage of the lesson effectively.

Keywords: Teaching material, coloring of titanium, electro-chemical reaction, experiment module

Trial and Evaluation of Experimental Kit of Handy Body-Warmer through the Lesson of Rust of Iron

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Development and practice of the lesson model of rust of iron by use of an experimental kit of handy body-warmer through the principle of **SEIC** ("**S**pecial **E**mphasis on **I**magination leading to **C**reation") and an evaluation of the use of the experimental kit were performed. The lesson was carried out for undergraduate chemistry classes of junior (third year) level student in Tokyo Gakugei University (TGU). Students could make an individual experiment actively and by use of the experimental kit smoothly with quite simple description of B6 size leaflet. Answers from students to questionnaire revealed that the experiment by use of the kit was effective for realizing images of phenomenon of rust of iron and understanding the chemical reaction.

Keywords: Experimental kit, handy body-warmer, rust of iron, lesson model, chemical education

Approach to Making Experimental Kit of Fuel Cell towards Teaching Material

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Hydrogen is a high-potential future energy source. In the near future, fuel cell will be a familiar source of energy for everyone. We reported a packing module type experimental program with a series of experiments of fuel cell, which leads people to understand the energy concept [1]. Recently, fuel cell vehicles from some automobile company have been released. It would be worthwhile developing an experimental kit, which is a model of practically used fuel cell. In the class, the electrolysis needs to be performed first to produce hydrogen and oxygen in the cell and then experiment of the fuel cell can be performed. It is easy way to teach the reaction of the fuel cell is the reverse reaction of hydrolysis. There is a report which stated that this type of experiment may create misunderstanding that the fuel cell is a secondly battery [2]. We have decided to make experimental kit with hydrogen gas feed. The kit could be used as a teaching material in addition to the experimental program previously developed. The program would help people to understand not only advanced technology but also the concept of fuel cell. In this paper, approach of making a kit using the proton exchange membrane will be presented.

[1] A. Ikuo, S. Okada, Y. Yoshinaga, H. Ogawa, *J. Sci. Educ. Jpn.*, **33(3),** 201-213 (2009), (in Japanese) .
[2] T. Kobayashi, *J. Energy Environ. Educ. Jpn,,* 6(1), 97-101(2011), (in Japanese).

Keywords: Fuel Cell, Experimental kit, Gas feed

Chemical Delivery Service of the fuel cell of effective teaching

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This lesson plan is designed to outline the contents of the high school class, with effective teaching strategies, in addition to establishing the proper knowledge of chemistry students, but also to enable students to enhance the scientific capacity of expression and communication, capable of caring environment that will enhance students' ability to learn the pyramid " panel discussions, implement exercises, to others or immediate application "level, and therefore have a different curriculum planning with the use of teaching strategies:

(1) The teacher describes the basic concepts and guide students to identify problems, causing students to scientific curiosity, thinking, concern energy issues.

(2) information into the teaching, students with group units cooperative learning, students to search the Internet information, the panel discussions, aggregated data, written into the report put together a report.

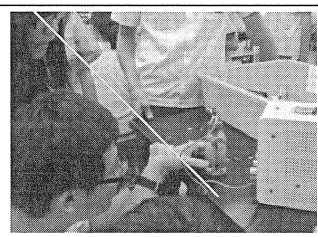
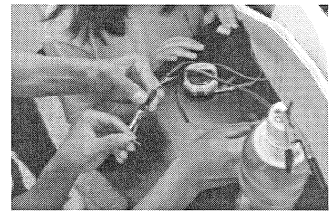
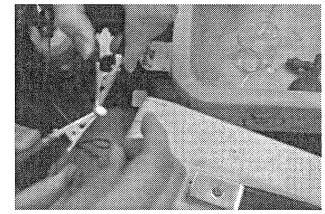
(3) by sharing thematic reports, students can observe each other to share and increase knowledge of their own shortcomings, practice clearly expressed the correct scientific concepts.

(4) students in experiential learning, challenges teachers to design levels, carry out inquiry teaching and solving problems.

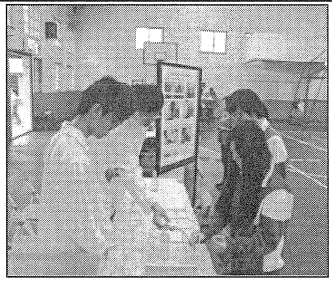
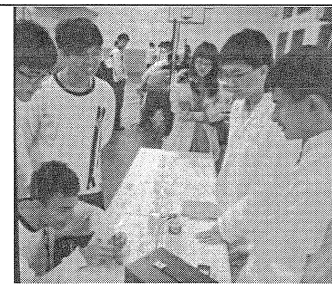
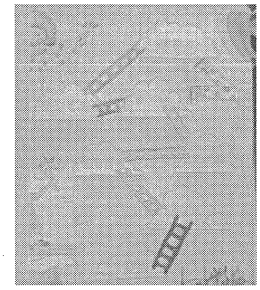
(5) Students try to design levels, by the teacher to assess the feasibility, as close to the main chemical Delivery Service in Green.

Keywords: effective teaching, fuel cell

"Fuel cell chemistry Takkyubin" contest checkpoints event photos

		
Electrolysis of water and collect the hydrogen	The fuel cell device	LED lights shine

Chemical Delivery Service checkpoints event photos

2nd day: Thursday, July 30th.

Applying Le Châtelier's Principle to Explain the Discoloring of Heart-shaped Paper Clips and the Flotation of a Steel Wool Ball

Chiung-Lan Wang

The Chemical Educational Resource Center (CERC) of Taiwan, R.O.C.
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Abstract

Ⅰ. Fill a beaker half full with water. Add a few crystals of solid potassium thiocyanate, a few drops of hydrochloric acid solution, and a few drops of hydrogen peroxide solution. Then put a heart-shaped paper clip to the beaker. The reaction releases ferric ion. The combination of ferric cation and thiocyanate anion changes the color of the solution to blood red. This is due to the formation of the thiocyanatoiron complex ion.

Ⅱ. Instead of water, fill another beaker half full with ethanol. Add a few crystals of solid salicylic acid, a few drops of hydrochloric acid solution, and a few drops of hydrogen peroxide solution. Then put a heart-shaped paper clip to the beaker. The oxygen atoms of the acid group –COOH, and of the –OH group on the salicylic acid together can form a complex with $Fe(H_2O)_6^{3+}$. That complex changes the solution to an intense violet color.

When using a steel wool ball instead of a heart-shaped paper clip, the reactions are more vigorously, and the energy released is exothermic.

Ⅲ. Prepare three beakers and fill solid sodium hydroxide, solid citric acid, and solid oxalic acid separately. The reactions with ferric ion, discolor the solution, and produce oxygen or carbon dioxide bubbles that float up the steel wool ball.

Keywords: *Le Châtelier's Principle, a heart-shaped paper clip, a steel wool ball, potassium thiocyanate, salicylic acid, sodium hydroxide, citric acid, oxalic acid*

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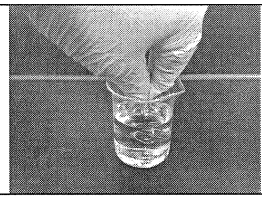
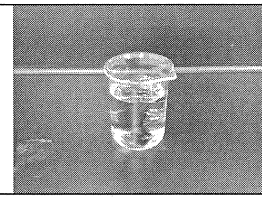
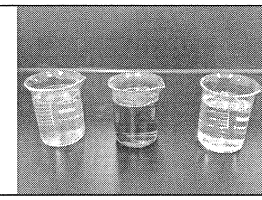
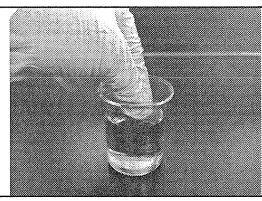
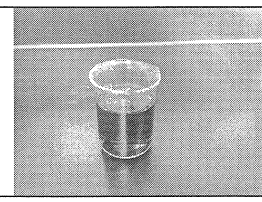
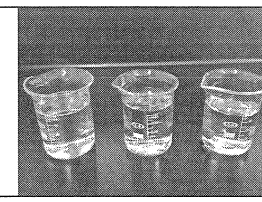
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>A heart-shaped paper clip flows blood red colour compounds.</td><td>A steel wool ball flows blood red colour compounds.</td><td>Left: add solid sodium hydroxide
Middle: add solid citric acid
Right: add solid oxalic acid</td></tr>
<tr><td colspan="2">Ⅱ.</td><td>Ⅲ.</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>A heart-shaped paper clip flows violet colour compounds.</td><td>A steel wool ball flows violet colour compounds.</td><td>Left: add solid sodium hydroxide
Middle: add solid citric acid
Right: add solid oxalic acid</td></tr>
</table>

Portable Teaching Aids for Learning Chemistry

Hsu-Mao Liao
National Tachia Senior High School, Taichung, Taiwan
nacl880626@hotmail.com

Workshop

Abstract

- **Micro-elctrochemical Etching (Electrochemistry)**
  An innovative teaching aid was developed to demonstrate electrochemical experiment via etching stainless steel bookmark with some drops of salt water for senior high school student in Taiwan.The portable etching aid can be adopted everywhere with a usb mobile power or a 9V battery. Each set of the experimental materials includes an etching stamp, a usb-connecting wire, and two stainless steel bookmarks.

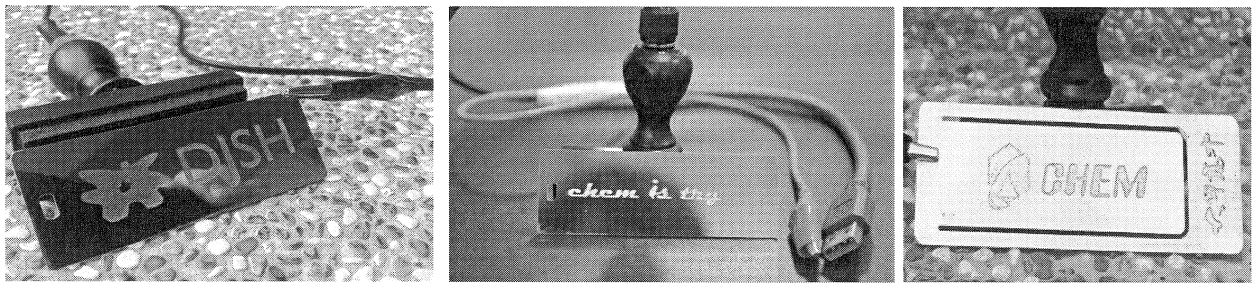


Fig.1 The etching stamp and metallic bookmark

- **Molecule poker (3D Molecular Model of Organic Chemistry for Mobile Learning)**
  The use of smart phones for science teaching has become increasingly popular in senior high school in recent years. This workshop is to show a set of e-teaching aids that was designed for teaching organic chemistry through virtual reality technology. The number of poker cards from ACE to KING was allocated for different functional groups, such as alkenes, alcohols, amines and the like. Each figure contains four colors, which represent four kinds of molecules in the same functional group. Students can slide the molecule on the touch monitor by scanning the QRcode on the card. In addition to introducing the molecule poker, I also hold a board game named "Functional Group PaPaGo" that intends to promote learning of organic chemistry.

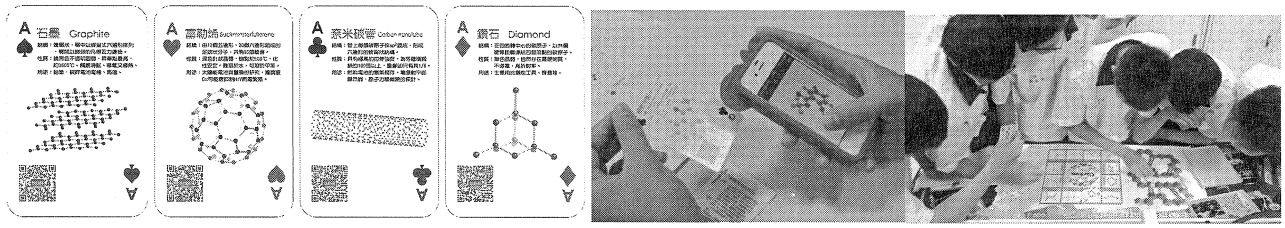


Fig 2 The appearance of the molecule poker and board game

Material：

- 200mL, 0.5M Sodium sulfate solution (Na_2SO_4，pre-prepared by Organizers)、moble Power for smartphone (pre-prepared by participants).

Educational experiments using commercial batteries

Menggenqimuge, Masahiro Kamata

Department of Science Education, Tokyo Gakugei University, Tokyo 184-8501, Japan
masahirok@nifty.com

This paper presents two kinds of educational experiments which use commercial batteries. One is to illustrate how cations and anions move through electrolytic solution when voltage is applied. The components used in the experiment are a) two coin-type cells (CR2032), b) a sheet of filtering paper soaked with 1.0M $CuCl_2$ aqueous solution, c) six sheets of filtering paper soaked with 0.2M $NaNO_3$ aqueous solution, d) a register, and e) a current indicator using an LED. When all these components are piled in series and held together with a metallic clip as shown in Fig.1, electric current starts to flow and copper ions move toward the cathode. Typical result is shown in Fig.2. When certain length of pH paper is used instead of the sandwiched filter paper, it is possible to show how H^+ and OH^- move.

In addition, an educational experiment using zinc-air batteries will be presented in the workshop. Since a zinc-air battery uses the oxygen in the atmosphere as the cathode material, it is possible to demonstrate Faraday's law of electrolysis based on the volume of oxygen absorbed into the battery. The apparatus used for this experiment is shown in Fig.3

Keywords: electrochemistry, ion, lithium battery, zinc-air battery, Faraday's law

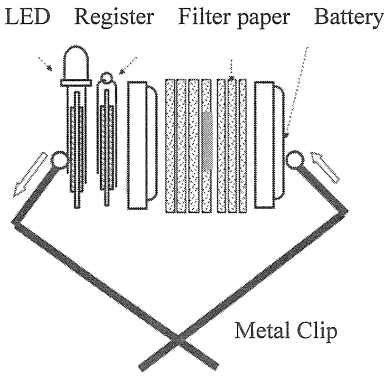


Fig.1 Electrolysis cell

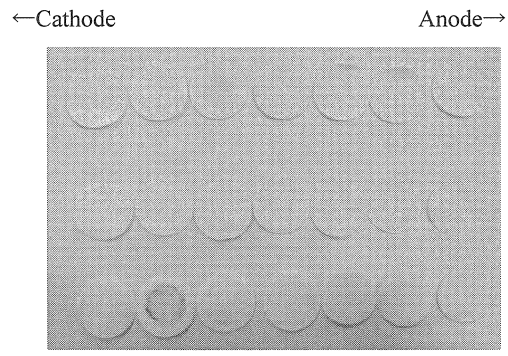


Fig.2 Typical results

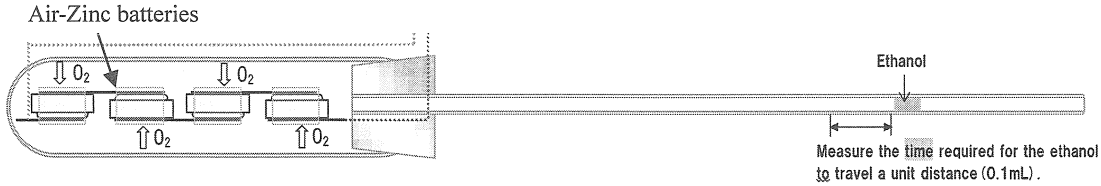


Fig.3 Apparatus to demonstrate Faraday's law

A Strategy of High School Chemistry Teaching : The Basic and Fundamental Content of High School Chemistry

HIRAI Toshio

Osaka Prefectural Nagao High School, Osaka 573-0102, Japan
hirai@nagao.osaka-c.ed.jp

The basic and fundamental content of chemistry in the Japanese course of study for senior high school has been studied. The purpose of this paper is to discuss the basic and fundamental content of high school chemistry and provide some ideas, which lead to a new strategy to teach high school chemistry.

Keywords: high school chemistry, basic and fundamental content, strategy of teaching

Explore the Effectiveness of Science Remedial Teaching for Fourth Grade Students via 3D Video Science Experiments

Chin-Cheng Chou[1], Li-Chi Chiu[2]

[1]*Department of Science Education, National Taipei University of Education, Taiwan*
[2]*YungAn Elementary school, Taichung City, Taiwan*
ccchou62@gmail.com

Abstract

Technological breakthroughs, such as three-dimensional (3D) movies and televisions, have gradually entered people's life, and in the future, 3D video teaching may be possible. In earlier years, 3D animations featured poor quality because of low animation pixels. However, current 3D technology can achieve full high-definition (HD) resolution that rivals the human retina. By showing 3D scientific experiments to learners, a learning experience similar to live learning sessions can be created. Scientific experiments have many purposes. Although 3D scientific experiments cannot improve the experiment operation skills of students, they can facilitate scientific thinking and reasoning and enable students to make observations and record them. We try to use the prediction-observation-explanation strategy in designing the 3D scientific remedial teaching materials. 3D video offer a different kind of visualization in learning science. In the study, we invited 21 low-performance elementary school students to participate the 3D scientific remedial teaching. After the course, the average score of the participants is higher than the average score of nonparticipants. The results shows that 3D scientific remedial teaching can help the low-performance students in leaning science. However, education workers must overcome the current lack of 3D video players in schools and deficiencies in preparing 3D scientific experiment videos. More detail finds will present in later.

Keywords: 3D video, Remedial Teaching, location, Scientific Experiment, Science Visualization

Enhancement of Scientific Concept and Literacy via the Designed Course of Energy-related Environmental Issues

Shih-Yeh Chen, Wen-Hua Chang, and Shiang-Yao Liu

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The depletion of resource is the inevitable situation we confront at the present and in the future. What resources of energy can be used and how we use them will be a crucial contributor that influences the fate of human beings. This study investigates the effects of a course about energy-related environmental issue. The 11-week course designed by employing CloudClassRoom (CCR), which is a web-based instant response system, was administered to 66 ninth-grade (ages 14-15) students in Taiwan. Student learning outcomes were measured with a pre- and post-test by a scientific concept test, as well as a scientific literacy questionnaire including Communication, Positive interdependence, and Self-esteem scales. Student engagement in the course was recorded in the CCR database. Results revealed statistically significant gains from pre- to post-test on the scientific concept test ($p < 0.001$) and the scientific literacy questionnaire ($p = 0.002$). From the results, we concluded that the CCR incorporated course has potential to enhance students' scientific concept and literacy. Further analysis for students with achievements of different levels and orchestrating of the energy-related environmental course are discussed.

Keywords: cloud class room (CCR), energy, environmental issues, scientific literacy

Food Chemistry in the Daily Life: Tackle Hidden Hunger (Deficiency of Vitamins and Minerals) in Chemistry Education

Show-Yu, Lin

Department of Natural Sciences, General Education, Aletheia University, Taipei, Taiwan
sylin8@yahoo.com.tw; au4329@mail.au.edu.tw

Abstract

Educating public about food chemistry in daily diet is an important mission in chemistry education. Food chemistry has become significant due to an estimated high rate of chronic deficiency of essential vitamins and minerals (micronutrients) which known as hidden hunger and it appears in both poor and rich countries. Hidden hunger was an unknown and unnoticed problem but has been intertwined with many personal factors, such as understandings of and attitudes towards vitamins/minerals. The purposes of this study are to explore the status of hidden hunger of participants by applying accessible online nutrition tracker, to probe their understandings of vitamins/minerals and their attitudes toward vitamin/minerals from self-developed questionnaires, and to discuss how to tackle hidden hunger in chemistry education. We found that hidden hunger was serious issue for participants' in both the quality and quantity. Besides, their understandings in vitamins are better than those in minerals, and their attitudes toward vitamins and minerals are positive. Lastly, some suggestions will be provided effective assistance approaches or interventions in chemistry education need to be employed in individual, communities and countries to tackle hidden hunger.

Keywords: Food Chemistry, Hidden Hunger, Vitamins, Minerals, Chemistry Education

Interesting "Canmistry"
A Set of Chemistry Experiments By Aluminum Cans

Hsin-Tzu, Hsu[1] ; Tein-Tsai, Chang Chang[2]
[1] *The Chemical Educational Resource Center (CERC) of* Taiwan, *R.O.C.*
[2]*Fudan High School*
x9020010x@gmail.com

These experiments are designed for convenient operation in the chemistry class at senior high school. For enviromental protective reason, we using a normal beverage can as experimental material to operate the following experiments.

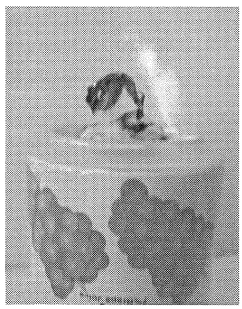
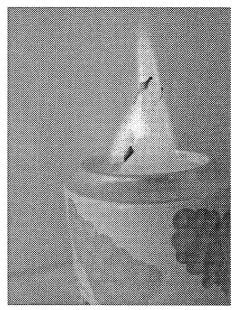
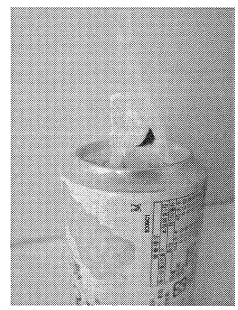
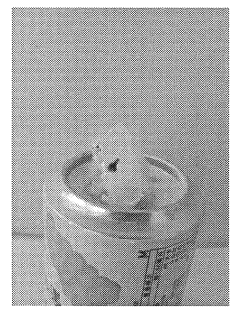
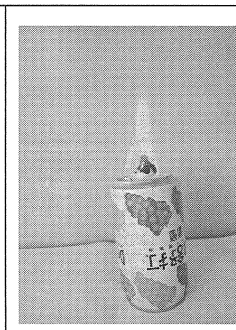
1. Howl's fire evil: Flame test
2. The flower of copper: Redox reaction

Two different experiments can be displayed at the same class by using the identical can.

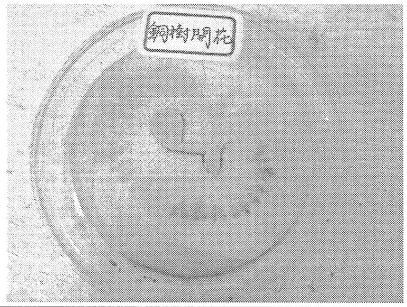
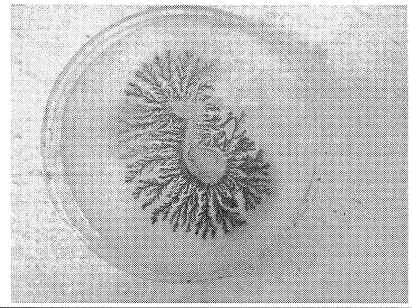
After the explaination of basic concepts, a set of experiments can be demonstrated to activate students to scientific curiosity. Teacher can guide students to identify problems. By discussion between the class, students can understand the principle behind the experiments better.

Keywords: canmistry, flame test, redox reaction

1. Howl's fire evil: Flame test

				
$CuSO_4$ $Ca(CH_3COOH)_2$ C_2H_5OH	NaCl $Ca(CH_3COOH)_2$ C_2H_5OH	$BaCl_2$ $Ca(CH_3COOH)_2$ C_2H_5OH	KNO_3 $Ca(CH_3COOH)_2$ C_2H_5OH	$Ca(CH_3COOH)_2$ C_2H_5OH

2. The flower of copper: Redox reaction

	
front	back

Watch online video & answer contest with prizes by MOOCs

Chang,Ya-Wen[1]

[1] *The Chemical Educational Resource Center (CERC) of Taiwan, R.O.C.*
Chem02@mail.kshs.kh.edu.tw

Watch online chemistry experiment viedos and answer contest with prizes for all of Taiwan senior high school students , combined with Junyiacademy MOOCs platform to promote teaching resources by CERC.

Students can specify the teacher as a coach , to provide guidance and encouragement to complete the activity.After watching all of videos, systematic random out of question , answer 5 questions per section , get lottery qualifications.Teachers can understand students' learning situation through the platform, hope that through multivariate assessment , improve learning benefits for students

Through Junyiacademy MOOCs backend platform, collect all of Taiwan senior high school students learning the feedback information as a guide to future research and development of chemistry learning videos .Best of all is to encourage students to learn chemistry concepts and principles by this activity.

Keywords: Junyiacademy MOOCS (Junyiacademy Massive Open Online Courses)

http://www.junyiacademy.org/

watch vedio page

http://goo.gl/Lkisdp

contest page

Development of oxygen sensor applicable to science experiments in primary and secondary science education
-Characteristics of air battery and application as oxygen sensor-

Mitsuo Takahashi[1], Yuji Tateizumi[1], Yukie Sonobe[2], Kenichi Goto[3], Yorikazu Nouchi[3], Seiichi Hayash[4], Hiroshi Iida[5], Keiichi Iwaki[6], Kazuyuki Odaira[7], Takayuki Ito[8], Katsuhito Miki[9], Yoshihiro Hada[10], Norimichi Kawashima[10], Shosuke Teratani[11], Shizuo Matsubara[12].

[1]*Department of Chemical Science and Engineering, Tokyo National College of Technology, 1220-2 Kunugida-machi, Hachioji, Tokyo 193-0997, Japan*
[2]*Junior High School of Ochanomizu University, 2-1-1, Otsuka, Bunkyo-ku, Tokyo, 112-8610, Japan*
[3]*Department of Curriculum Research, Curriculum Research Center, National Institute for Educational Policy Research, Kasumigaseki 3-2-2, Chiyoda-ku,Tokyo 100-8951, Japan*
[4] *Takaoka Minami High School, 3-4-2, Toide-machi, Takaoka-city, Toyama,933-1104,Japan*
[5]*The Comprehensive Education Center of Shizuoka Prefecture, 436-0294, Japan*
[6]*Toyama pref. General Education Center, 525 takata, toyama city,930-0866, Japan*
[7]*Niigata Prefectural Education Center, 100-1 Sowa, Nishi-ku, Niigata, 950-214, Japan*
[8]*Science Education Center attached to Hokkaido Education Research Institute, 42, Bunkyodai-Higashimachi, Ebetsu, Hokkaido 069-0834, Japan,*
[9]*Higashikawa town Higashikawa Dai San Elementary School, Higashi-go Minami1, Higashikawa-cho, Kamikawa-gun, Hokkaido 071-1458 Japan*
[10]*International Institute for Science and Education. International Pacific University. 1-1-7, Sakuragicho, Naka-ku, Yokohama, TOC Building 16F, 231-0062, Japan*
[11]*Emeritus Professor, Tokyo Gakugei University, 4-1-1 Nukuikita-machi Koganei-shi,Tokyo 184-8501, Japan.*
[12]*Toin University of Yokohama, Kurogane-cho 1614, Aoba-ku, Yokohama, Kanagawa 225-8503, Japan*

In the field of primary and secondary science education, we have developed an easily prepared, safe and inexpensive oxygen sensor that anyone can easily use. Focusing on an air battery, we examined whether it satisfies the function as an oxygen sensor. We determined the conditions applicable to a practical science experiment, and we then produced an oxygen sensor for use as educational material based on these results. As natural quest-type experiments using the oxygen sensor, we introduced the experiments of monitoring oxygen consumption in respiration and disposable warmers.

[1] M. Takahashi, T. Ishiji, N. Kawashima, *Sensors and Actuators B*, 3865, pp. 1-7, (2001).
[2] M. Takahashi, *Toranjisuta Gijutsu*, Vol.12, 199-201, (2003).
[3] M. Takahashi, *Chemistry & Education*, Vol.54, No.6, 326-329, (2006).
[4] M. Takahashi, M. Yamaguchi, T. Ishiji, N. Kawashim, *IMCS 11 The 11th International Meeting on Chemical Sensors*, p.186, July 16-19, Brescia, Italy. (2006).

Keywords: *oxygen sensor, air battery, disposable warmer*

Synthesis of Solid Oxygen Bleach: Granular Sodium Carbonate Peroxyhydrate

Masayoshi Nakano, Takeshi Wada, and Nobuyoshi Koga*

Department of Science Education, Graduate School of Education, Hiroshima University, 1-1-1 Kagamiyama, Higashi-Hiroshima 739-8524, Japan
*nkoga@hiroshima-u.ac.jp

Sodium carbonate peroxyhydrate ($Na_2CO_3 \cdot 1.5H_2O_2$:SCP) is the major component of household oxygen bleach of solid type, which is an adduct of sodium carbonate and hydrogen peroxide.[1] When dissolved the compound in water, the resultant solution is an alkaline solution of hydrogen peroxide and exhibits strong oxidizing ability. For preventing SCP from the decomposition during storage, SCP is usually granulated. Chemical functions of the household SCP can be subjected as suitable teaching materials at different levels of chemistry learning.[2] In this study, for using as an introductory experiment for studying different chemical functions of granular SCP, a simple method of granular SCP synthesis in student laboratory was developed.

Needle-like SCP crystals are obtained by the reaction of 10%–H_2O_2 (aq) and saturated Na_2CO_3 (aq) (Figure a). The SCP crystals are granulated and coated with Na_2CO_3 layer by spray-drying saturated Na_2CO_3 (aq) on the granulated SCP (Figure b). Through the laboratory experiment, students are aware of the components of SCP and the structural characteristics of the granular SCP. The knowledge becomes a basis for studying the chemical functions of the granular SCP. In this presentation, the detailed synthesis method of granular SCP is introduced and the utility of the laboratory experiment is discussed.

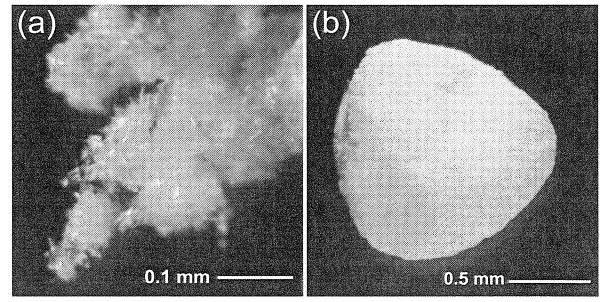


Fig. Synthesized SCP (a) crystals and (b) granule.

[1] T. Wada, N. Koga, *J. Phys. Chem. A.*, **117(9)**, 1880-1889(2013).
[2] T. Wada, N. Koga, *J. Chem. Educ.*, **90(8)**, 1048-1052(2013).

Keywords: Consumer chemistry, Oxygen bleach, Inorganic synthesis, Sodium carbonate peroxyhydrate

Experimental Approach to the Chemistry of Detergents at Junior High School

Mami Kakisako, Kazuyuki Nishikawa, Masayoshi Nakano, Kana Harada, Tomoyuki Tatsuoka, and Nobuyoshi Koga*

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Chemistry of daily use detergent can be a promising teaching material for integrating students understanding of different chemical phenomena and relating chemistry studies to their daily lives. Various learning programs using daily use detergent have been proposed at different levels of chemistry larning.[1,2] In this study, a guided inquiry in laboratory course at junior high school and introductory chemistry course at high school was developed using daily use detergent and mineral water, which aims at instructing the chemical functions of each component compounds in the detergent.

The laboratory exercise was constructed by three steps of experimental approach to the detergent and mineral water: (1) discrimination of four different water samples involving hard water, (2) Inquiry of the causative substances that impede foaming when mixing water sample and soap (Figure 1), and (3) Inquiry of the chemical functions of each component of daily use detergent such as alkaline and chelating agents. Through the laboratory exercise, students experience the chemical phenomena occurring during the interaction of water sample and detergent, and understand the phenomena using phenomenological models. The significance of the developed laboratory exercise is discussed by reviewing our teaching practice for the students at junior high school and high school classes.

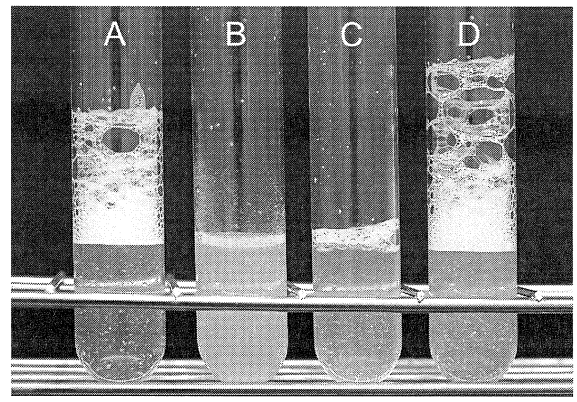

Fig.1 Comparison of foaming of different water samples by a soap (A: Pure water, B: Hard mineral water, C: Soft mineral water, and D: Tap water).

[1] N. Koga, T. Kimura, K. Shigedomi, *J. Chem. Educ.*, **88(9)**, 1309-1313(2011).

[2] T. Wada, N. Koga, *J. Chem. Educ.*, **90(8)**, 1048-1052(2013).

Keywords: Laboratory experiment, junior high school, detergent, mineral water

Gamma-PGA Production by *Bacillus subtilis* in Solid-state Fermentation

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Abstract

In this research, we devoted to studie the γ-polymer of the amino acid glutamic acid (Gamma poly-glutamic acid, γ-PGA) production by solid-state bacterial fermentation process. Gamma PGA is greater constituent of the Japanese food natto and potentially used in health food, cosmetics medicine and cancer treatment [1]. To optimize solid-state fermentation conditions generate the largest amount of γ-PGA from fermented beans is significant for large-scale production. We fermented soybeans and red beans by *Bacillus subtilis (natto)* and analysis the quantity of γ-PGA separately. The sticky filamentous-like bacterial fermented product collected by filtration and centrifugation process. The SDS-PAGE analysis and FDNB derivative test indicated that a great quantity γ-PGA existed in the fermentation product. The purified γ-PGA prepared by High Performance Liquid Chromorgraphy (HPLC) for further analysis.

Base on our experiment data, the fermented red beans forms the largest number of γ-PGA, which is a better source for solid-state fermentation. Furthermore, 6 hours hydrolysis time recovered the most γ-PGA product from the fermented red beans and formed 10kDa molecular weight γ-PGA. The skin test indicated that the relative small γ-PGA absorbed by dermis efficiently, might suitable to additive of cosmetics for moisture purpose.

[1] K. Shimizu, H. Nakamura, M. Ashiuchi, *Applied and Environmental Microbiology,* **73,** 2378-2379 (2007).

Keywords: Gamma-PGA, Solid State Fermentation, Natto

Contemporary High School Students Expectations toward Chemistry Learning in Taiwan- a Pingtung Example

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Abstract

As one of the chemistry faculty in a public university in Taiwan, I always learned from my colleagues complaining about the degraded interest from students in learning chemistry nowadays. The performance of chemistry learning is getting unacceptable from the high school graduates. Many of the freshman also express chemistry is one of the most difficult and unhappy subject to learn in her/his academic pursuit. To understand part of the reasons causing the phenomena, a design of a study into high school class is carried out. In this study, we have invited a subject into the classroom of a high school in Pingtung area, the subject collects semi-structure interview results from his eight classmates concerning the chemistry learning in their school. The feedbacks are category into two divisions including favored conditions versus real situations. The interview items are related to the classroom chemistry learning, such as teacher's characters, subject contents, classroom activity, grade evaluation, surrounding connectivity, future trend, etc.

Our results show students prefer teachers with more interactive characters rather than just following the guidelines of the textbook, teaching content better related to daily lives, more hand-on activities, multi-dimension evaluation rather than paper-pen exam, more connections of chemistry to their prospects and emphasis of chemistry on sustainability, especially on food safety. With the correlation of our findings to the real classroom, we can renovate our contemporary chemistry teaching curricula to align with the expectations of the pupils. Enhancement of the learning outcomes and the interests of the chemistry from our students can also be expected.

Keywords: chemistry, education, learning enhancement, sustainability.

Purple sprout as a new teaching material in chemistry and biology

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The compound of anthocyanin, which is included in most plants, is well known as a color changing substance depending on the pH of the solution in the text book of elementary and junior-high school. In order to use anthocyanin as a teaching material for the pH measurement, purple sprout, instead of purple cabbage, was selected as a plant from which anthocyanin should be extracted[1]. This is because (1) only ten days are necessary to get purple sprout (shown in Fig. 1) from the seeds and (2) the amount of the extracted anthocyanin is 1.6 times compared with the corresponding one of purple cabbages. Moreover, dried purple sprout is kept without rot for a long time at room temperature (Fig. 2). This indicates that purple sprout is an adequate teaching material not only for cultivation in biology, but also for the chemical experiments, that is, the extraction of anthocyanin from the sprout and the observation of color change depending on pH or metal ion of the anthocyanin solution. The experiments using purple sprout have been undertaken at a junior-high and high school.

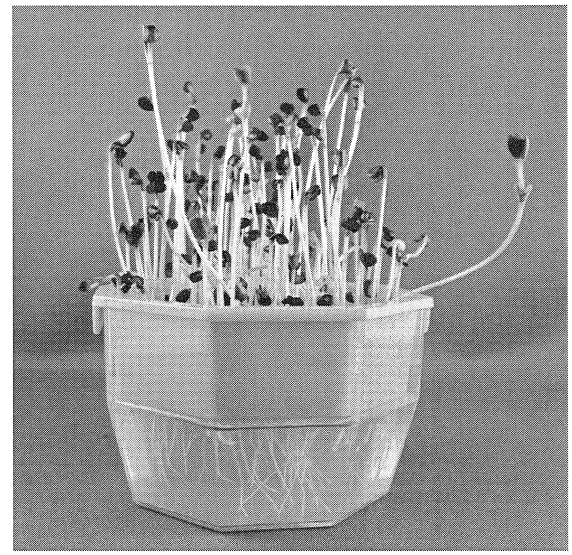

Fig.1 purple sprout

Fig.2 Dried purple spout

[1] A. OHASHI, *Journal of Science Education in Japan*, **39(1),** 11-18 (2015).

Keywords: Purple Sprout, Anthocyanin, pH, Ion, Inter-disciplinary research

Teaching , learning and using spectroscopy with DVD spectrometer

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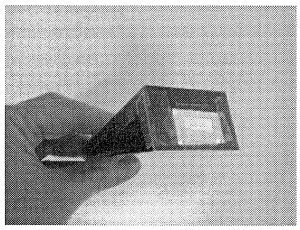
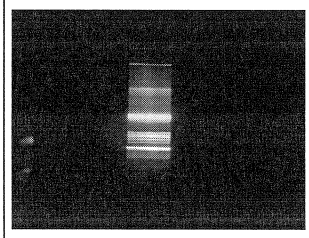
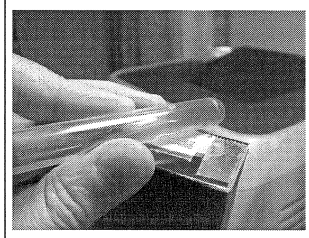
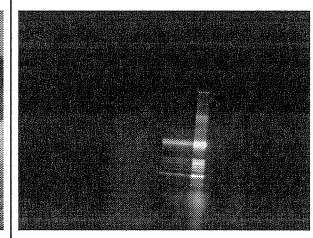
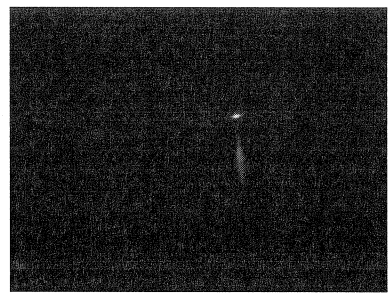
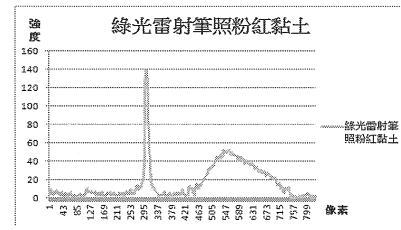
Abstract

DVD spectrometer is a quite versatile and low cost tool to teach spectroscopy. Herein we demonstrate the use of DVD spectrometer to teach light absorption with chlorophyll solution from spinach. The simple apparatus could also demonstrate light fluorescence with laser diode shining on Play Doh.

			
DVD spectrometer	Spectra from fluorescence lamp	Chlorophyll solution from spinach	Chlorophyll solution light absorption

		
Green laser diode and Play Doh	Fluorescence spectra from DVD spectrometer	Fluorescence spectra converted by ImageJ

Keywords: Learning, Spectroscopy, location, DVD spectrometer

The Colors Made by Polarizer

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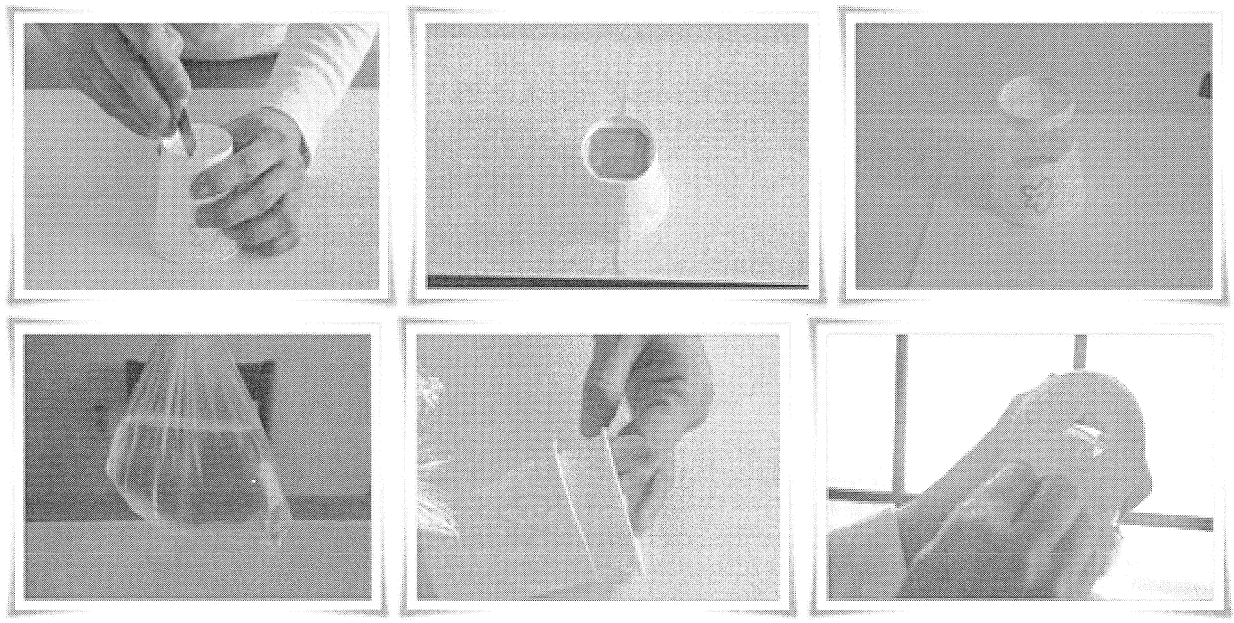
Red, green, blue colors is hidden in the white light. The light passing through the polarizer vibrates in one direction, and then the color of the light can be determined whether it passes or not. If you place the plastic bag filled with water between the polarizer, you can observe the red, green and blue color light passing through it and the actual color on the other end.

When the sugar water is placed instead of plain water, the degree of color changes is observed differently. Higher the concentration of sugar in water, higher the degree of color changes. Using this principle, we can check the degree of sugar concentration in the water. The liquid can also show colors in the color TV.

To learn the principle of the color made by the polarizer, we can make a " Color-Learning Cup " using a paper cup and a polarizer. Let's make a color "Color-Learning Cup".

Colors appear in the cups when you rotate them. The water between polarizer determines the color. Computer monitors or TV monitors show colors by liquid crystal between the polarizer. The longer the distance of water the light passes, the more the light will diffract. According to the angle of diffraction, the color varies. Sugar water is the role of LCD.



Make a square hole on the bottom of the paper cup with a cutter and tape the polarizer on it. Insert the water bag between the two cups with polarizer. You can see the colors in them.

Microscale experiment for elementary school science using grape peel as natural acid-base indicator

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Anthocyanin, one of the natural pigments, is red in an acidic, purple in a neutral, and bluish green in a basic aqueous solution. Therefore, it can be used an acid-base indicator. This pigment is rich in purple peels of grape such as kyoho, a kind of Japanese grape [1]. Many elementary school students like grapes, and it is of great interest to investigate the teaching materials on elementary school science using them. In this study, a microscale experiment on classifying everyday aqueous solutions such as lemon juice, vinegar, aqueous sugar (sucrose), aqueous table salt (sodium chloride), aqueous baking soda (sodium bicarbonate), and aqueous ammonia into acidic, neutral, and basic has been proposed using kyoho peels and a 6 well plate (see Figure) for elementary school science. Three kyoho peels were put in 100 mL hot water for five minutes. This mixture was filtered to prepare an anthocyanin solution, namely a natural acid-base indicator. Ten drops of every aqueous solution were put into the cell in a 6 well plate, and successively the anthocyanin solution was added up to a quarter of the depth of each cell. Instantaneously, solutions in cells1 and 4 turned red, and those in cells 5 and 6 turned bluish green. On the other hand, those in cells 2 and 5 kept purple. Practical lessons were also performed for elementary school students using these materials. All students that took this lesson performed experiments steadily. The questionnaires on this lesson suggested that many students admired this experiment. In conclusion, these results reveal that our practical lesson is useful for elementary school science.

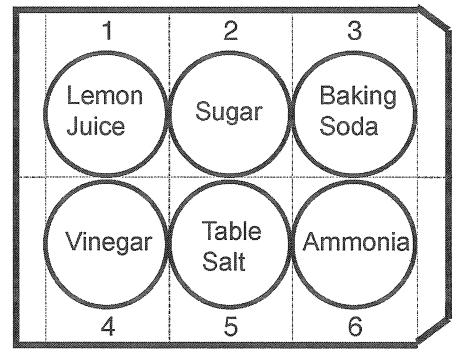

Fig. 6 well plate and aqueous solutions

This work is partly supported by JSPS KAKENHI [a Grand-in-aid for Scientific Research (C) from Japan Society for Promotion of Sciences], Grand Number 24501072.

[1] Tetsuo Nakagawa, *School Science Review*, **79(286),** 108 (1997).

Keywords: Microscale experiment, acid-base indicator, anthocyanin, practical lesson

Can Nanoscience Activities Increase Students' Attitude Towards Chemistry Lessons? Viewpoint from Malaysian Secondary Students

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Abstract

In Malaysian education system, chemistry is one of the compulsory subject need to be taken by the science stream students. In recent years, the enrolment of students taking up pure science subjects particularly chemistry has dropped significantly. Students' attitude is identified as one of the possible treat for students to be less interested in learning chemistry. Indeed, attitude towards learning certain subjects is frequently viewed as a mirror which reflects students' interest in learning any particular subject and it influences students' learning of the subject. As such developing a positive attitude towards learning chemistry is relatively important in the chemistry class. Nanoscience has been widely discussed by the researches and educator as an effective teaching approach in delivering chemistry concepts. Following this claim, in this study, attempt was made to investigate the effectiveness of nanoscience activities in increasing secondary school students' attitude towards chemistry lessons. One-group pre-test post-test design was used to measure the changes in the students' attitude before and after the treatment using Attitude Towards Chemistry Lessons Questionnaire (ATCLQ). A total of 80, Form Four (16 years) have undergone the treatment. A paired-samples t-test was applied to analyze the changes in the attitude. The post-test mean ($M = 4.06$; $SD = 0.35$) appears to be higher than then the pre-test ($M = 3.27$; $SD = 0.43$) and the differences between the means scores were significant ($t = -12.69$, $p < 0.00$). Result shows that significant differences were noticed in all the constructs of the questionnaire: chemistry theory lessons; chemistry laboratory work; beliefs about school chemistry; and behavioral tendencies to learn chemistry with the post-test scores appears to be higher. This study suggests nanoscience would be a viable approach to improve students' attitude towards chemistry.

Keywords: Attitude towards chemistry, Chemistry education, Nanoscience activities

Differences the interpretation of science news reports between experts and junior high school students: an example of biodiesel

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The research questions of this study are:

1. Do junior high school students change their opinion on a given science based issue (biodiesel) after watching a news report on the topic?
2. Are junior high school students able to gain a better understanding of biodiesel issue when information is presented in a news report?
3. Are junior high school students' and expert interpretations of scientific information presented in a news report similar?

The researchers selected three news reports on biodiesel issue. A questionnaire was given to 33 junior high school students before and after watching the report, and scored on a 3-point Likert scale reflecting their inclination to recommend the use of biodiesel to their family. A chi-square analysis was conducted on the results of the perception and understanding of the issue before and after watching the news segment. The researchers then conducted interviews with two experts. The "cultural diamond" framework (Huang, 2008) was used to compare the differences of the perception of biodiesel between the students and experts.

The results show:

1. The news report was important towards changing students' opinions on a controversial science issue.
2. The students involved in the study were mixed and not separated by grade, so it is hard to discern a strong signal. Differences in science aptitude may have confounded results.
3. The results of the student-expert responses to the news article are different: Students can only make a limited point of view in the school system, but experts can make different decisions for the characteristics of four different scientific backgrounds to enhance the diverse backgrounds of the readers of scientific literacy

Reference

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Keywords:Science News, Biodiesel

Considering New Teaching Materials Using Aurora

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Two years ago, our school made a program to observe auroras as the overseas training in charge of the science department.

There are two purposes of making this program. First, it is very important to observe or experience phenomena in nature which are hardly observed in Japan. Second, probability of auroras will be high in a few years ahead because the solar activity is to be very high.

I participated in this program carried out in last December with 13 high school students, and we went to Kiruna (Sweden) to observe auroras. Figure 1 shows the picture of an aurora at this time.

General Japanese chemistry textbooks are included contents called "chemical reactions and the light," and I considered that the experiences of observation auroras can be made use of in the lesson.

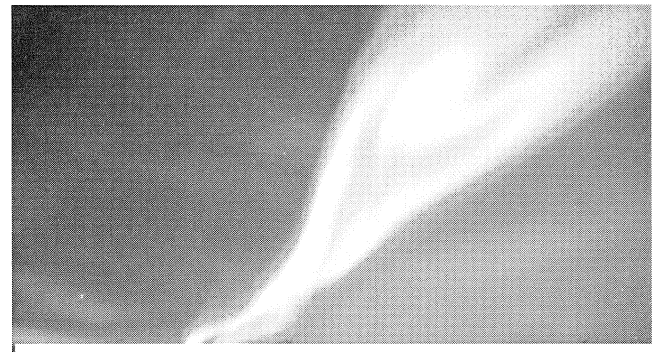

Fig1. The state of light emission from an aurora

The light emission from auroras is known to be a line spectrum and a band from atoms and molecules excited by various chemical reactions and those ions[1)]. However, the detailed mechanism is still not clear.

So it is expected that an aurora will be a new teaching material about the contents. I have a high degree of expectation of discussing the detailed contents on the announcement day.

[1] M. Ejiri, *Chemistry and Education Japan*, **49(2),** 78-79 (2001).

Keywords: Aurora, New teaching materials, Chemistry education

Radiation education using Natural Radioactivity

- A practical example in junior high school -

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Radiation education was added to the Courses of Study for junior high school science revised in 2008. Since most of junior high school teachers have no experience of teaching radiation/radioactivity in school science, they feel some difficulty about it. However, there exist many kinds of natural radioactivity around us. This means if we use them as teaching materials for radiation education, students can easily understand that some radiation/ radioactivity does exist in nature and we are living in such an environment with radiation. Furthermore, teachers can use natural radioactive materials such as mineral spring water in school without making the students too nervous.

Radiation education classes were held using natural radioactivity at local public junior high school through a partnership between university staffs and school teachers. Some of the scenes from the class are presented below, and the detail will be explained at the conference.

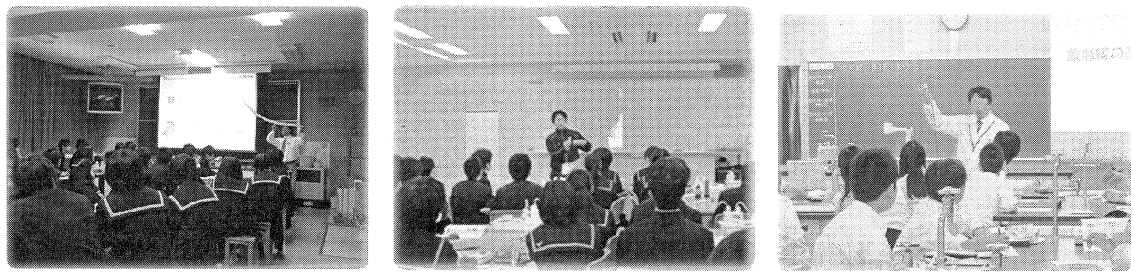

Photo. Cut scenes from the class

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Keywords: Radon222, Radon Mineral Spring, Natural Radioactivity, Teaching Materials Education, Cloud Chamber

"What is Malachite?": A Guided-Inquiry for Determining the Chemical Composition of Malachite in High School

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Malachite ($CuCO_3 \cdot Cu(OH)_2$) is one of well-known copper carbonate hydroxide minerals and also known as the main component of the green rust. The chemical composition of malachite can be determined by combining some simple qualitative and quantitative experiments,[1,2] as in the other inorganic compounds.[3–6] In this study, a guided-inquiry laboratory exercise in high school chemistry was designed for determining the chemical composition of malachite through students' activities.

Students expect the chemical components of malachite by considering the formation process of green rust and discuss the experimental methods to confirm the chemical components. The chemical components such as Cu^{2+}, CO_3^{2-}, and OH^- can be confirmed using preliminary experienced experimental techniques.

A postulated chemical composition of malachite is proposed as $xCuCO_3 \cdot yCu(OH)_2$. The quantitative methods to determine the unknown coefficients x and y are discussed among students. The gravimetric analyses for the mass loss processes of the reaction of malachite and acid and the thermal decomposition of malachite[7,8] are proposed by students. Besides, the redox titration for Cu^{2+} using the iodimetry is introduced by the instructor. Through practicing the determination of the malachite composition, students actively use their preliminary learned chemical knowledge and techniques and integrate their knowledge.

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[3] H. Tanaka, N. Koga, *J. Chem. Educ.*, **67(7)**, 612-614(1990).
[4] N. Koga, Y. Matsuda, H. Tanaka, *Chem. Educator*, **10**, 440-443(2005).
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Keywords: Guided-inquiry laboratory exercise, high school chemistry, malachite, qualitative analysis, quantitative analysis

Explore the Possibility of Storm Glass to be a Weather- Thermometer

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Abstract

A"Storm Glass" is a type of device with some evidences from its changes of the crystal shape for the weather forecast associated with solubility. The research indicated that the success of prediction were no better than random probability [1]. However, the operational variables of the research were on the basis of crystal shapes not for the precipitation height of the crystals. There was high relationship between the height of precipitation of storm glass and the temperature of thermostatic water-bath [2]. This report attempts to highlight two research questions: the first is that whether the storm glass has a potential for a weather-thermometer in our daily life or not. The heights of precipitation of storm glass were recorded and then be compared to the temperature on that day and the next day at the same time according to the data of Central Weather Bureau from August, 2013 to February, 2014. The results showed there was a high degree correlation between the height of crystals and the temperature of the air on that day (R^2 = .80) and the next day (R^2 = .80). It revealed that the storm glass indeed has a potential for a weather-thermometer in our daily life. Then the experiments were conducted to response the second question in term of finding out which one was better for a thermometer while changing the ratio of ethanol in storm glass solution without adding the total volumes. The results revealed that there were high degree correlation between the height of crystals and the temperature of thermostatic water-bath (R^2 ranging from 0.88 to 0.98). On the basis of the results, we can select three to five different ratio of water and ethanol at the same time to visualize the ranges of temperature of air to make a thermometer.

References

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Key words: storm glass, crystallization, thermometer

Development and Application of Experimental Activities on Nanostructured Superhydrophobic Surfaces

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Abstract

The science textbooks introduce High-tech information, but do not contain experiment associated with High-tech. The purpose of this study is to make students have an interest in science and to reduce the gap between textbooks and High-tech contents by implementing an experiment associated with High-tech in a school laboratory environment.

Superhydrophobic phenomenon is a topic that students are very excited in and it is widely used in daily life. SiO_2 nano-powder of 30-40 ㎛ size and vacuum chamber are necessary to make a good Superhydrophobic surface. But nanopowder of a small size and vacuum chamber are very expensive for schools to buy them. Therefore, the experiment was modified to be applied at school. The modified experiment requires SiO_2 nanopowder of a 80-100㎛ size, stearic acid, ethanol, eyedropper and hot plate. Superhydrophobic phenomenon is determined by surface roughness and surface energy. SiO_2 nano asperities make the surface rough and stearic acid lowers the surface energy.

The high-tech lab activities were applied to 120 high school students and talented students attending middle school. The survey was conducted using a modified questionnaire VOSTS. As a result, 85 % of students considered that development of science is very necessary and high-tech is related with our living very closely.

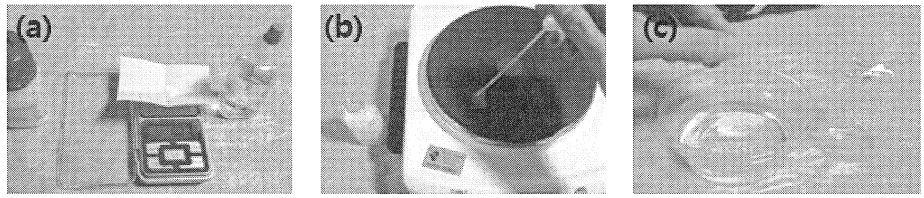
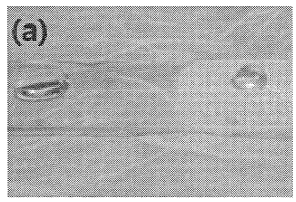


Figure 1. Experimental (a) Weighing in SiO_2. (b) Dropping and drying SiO_2 solution on glass. (c) immersing a glass in stearic acid solution.



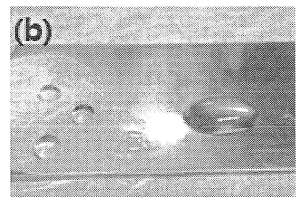


Figure 2. Superhydrophobic Surfaces (a) on glass. (b) on metal.

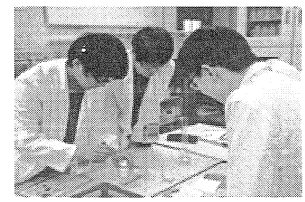


Figure 3. Application for High school Students

Keywords: Nano structured Superhydrophobic surfaces, Chemistry experiment.

Whose Respiratory Efficiency Is Best? Incorporating Sport into General Chemistry Laboratory through Discovery Learning

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Human's breathing brings us with interesting problems on life science. Whose respiratory efficiency is best? What differences of exhalation are between resting state and vigorous exercise, and between genders? To solve these problems, we developed novel experiments utilizing both normal and differential acid-base titrations to investigate the concentration of carbon dioxide present in the air exhaled under different situations.

In the incorporation of sport into general chemistry laboratory, students' respiratory efficiency of carbon dioxide exhaled under situations in resting state and vigorous exercise were 3.59% by v/v and 5.02% by v/v, respectively. The respiratory efficiencies for all, male or female students under vigorous exercise were better than under resting state; and there were significant differences in the average of the respiratory efficiencies between two situations. All students' respiratory efficiency under resting state focused on the range of 3.5-4.0% by v/v, whereas that under vigorous exercise strengthened to 4.5-5.0% by v/v. Male's and female's respiratory efficiency under resting state were 3.67% and 3.43% by v/v, respectively; and that under vigorous exercise were 5.28% and 4.46% by v/v, respectively. There were no significant differences in the average of respiratory efficiencies between genders either under resting state or vigorous exercise.

[1] Robinson, W. R. *J. Chem. Educ.* **2000**, *77*, 17–18.
[2] Vittimberga, B. M.; Ruekberg, B. *J. Chem. Educ.* **2006**, *83*, 1661–1662.
[3] Battle, G. M.; Allen, F. H.; and Ferrence, G. M. *J. Chem. Educ.* **2011**, *88*, 891–897.
Keywords: respiratory efficiency, sport, general chemistry laboratory, discovery learning

Science craft using chemical reaction between an aluminum plate and hydrochloric acid

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Science craft, which is called "Monozukuri" in Japanese, is often used in school science. Since Monozukuri helps students to understand about principles and laws in science, it is strongly recommended in the curriculum guidelines of school science in Japan. Science craft (e.g. model car driven by a small motor) is popular in the field of physics, but is limited in the field of chemistry.

Etching, which uses chemical reaction of acid and metal, is known as a metalworking technique and used not only in the field of artifice but also in the field of industry. We considered that this technique is useful for Monozukuri in elementary school science because sixth grades students in Japan learn that acid has property to dissolve some metal such as aluminum (figure.1). In this way, we have developed an activity for students to make their name plates by dissolving aluminum in hydrochloric acid (figure.2).

This Monozukuri was tried by 72 sixth grade students. After learning that hydrochloric acid can dissolve aluminum, students made their name plates. To measure educational effect, we carried out questionnaire survey at the end of class. As for the question "Did you enjoy making a nameplate?", 90% of the students' answers were positive ones. Judging from the students' answers on their worksheets, 70% of students are considered to have understood the mechanism of etching.

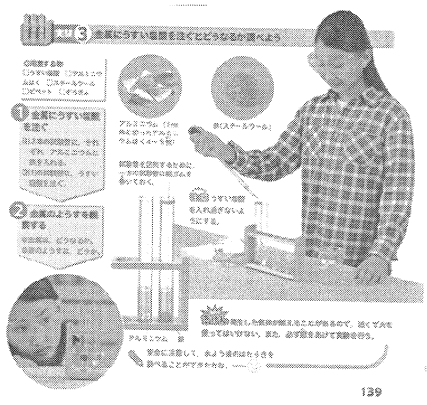

Figure.1 Japanese textbook for sixth grade students (Tokyo Shoseki, Japan,)

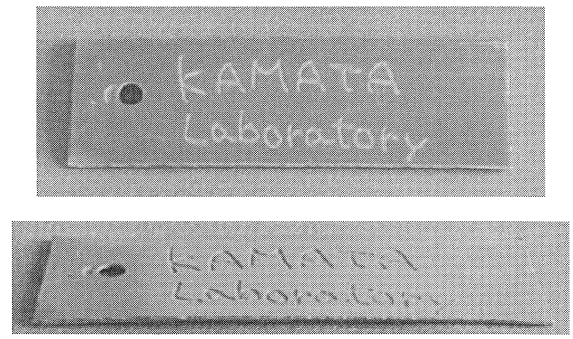

Figure.2 Developmental nameplate using etching with aluminum

Keywords: elementary school, science craft, Monozukuri, acid, metal, chemical reaction

Education and Medical Science Curriculum

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Education is fundamental to generate and keep a healthy society on all levels to meet the challenges the future will present us. Economic and healthcare requirements of aging populations are clear problems. Japan needs to harness its existing high potential making good use of its established educational and research facilities. This investment in education will undoubtedly pay dividends if the brightest minds of the future are enabled to achieve their full potential and must lead to future technological advances and problem solving. In efforts to meet these aspirations, here I describe the implementation of the Japan Science and Technology Agency`s Global Science Campus (GSC) project here at Keio University`s School of Medicine, a project designed with the aim to inspire highly motivated and talented high school students into becoming the next generation of world leading medical scientists. We attempt to achieve this through a carefully selected curriculum exposing students to certain concepts and ideas earlier so they can begin contemplation. In addition, a number of students are chosen upon merit to travel overseas, with this year`s destination having been Stockholm in Sweden for the first part of a bilateral student communication exchange, including visits to the Karolinska Institute and the Noble museum. Together with science our exchange seeks to promote cultural understanding and awareness of social issues including equality and inclusiveness. We hope these unique experiences as well as generating memories of warmth and friendship will provide students with insight and inspiration and propel them not only into becoming some of the next generation`s world leading medical scientists but allow them to see and guide them creating global scientists who understand what it means and how important it is to be a world citizen. Furthermore, a few students are chosen competitively to collaborate on research to submit for peer review in an internationally recognized journal and the opportunity to present their research at an International conference. While we wish we could offer these invaluable opportunities to all high school students we are limited because of the way resources are used but we hope our medical science curriculum implementation for high school students can serve as a model for the future. Science through the excitement and intrigue it generates, both fascinates as well as captivates minds with apparently limitless potential. Science also promotes understanding through logic and the appreciation of critical reasoning: Aristotle perhaps summarized this well "To say that that which is, is not or that which is not is, is a falsehood; and to say that that which is, is and that which is not is not, is true" [1]. Thus, in addition to the medical breakthroughs that will be discovered, we hope that our students can appreciate the simple power of the scientific method and in doing so educate others spreading these branches of knowledge from the GSC to family, friends and beyond into society and thus help to solve future problems across all levels helping to keep a healthy society.

[1] Aristotle, *Metaphysics*.

Keywords: Education, Curriculum, Medical Science, International, Global Science Campus

Radiation education project in Teacher Education Universities

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In Japan, curriculum guidelines for junior high school was revised in 2008, and radiation education was added in the guidelines. After TEPCO Fukushima Daiichi nuclear power plant accident, correct understanding of radiation is socially demanded.

For these reasons, training junior high school science teachers to be better at radiation education has become an urgent task in Japan. Since 2012, four Teacher Education Universities (Hokkaido University of Education, Aichi University of Education, Tokyo Gakugei University, Osaka Kyoiku University) have been engaged in the "HATO-Project". Under this big project Tokyo Gakugei University has managed a subproject; "Radiation education project". The objective of this project is to develop junior high school teachers of science who can teach radiation and radioactivity based on scientific perspective. In this project we have developed a curriculum and materials for radiation education, and have started two new subjects "Radiation Education I " and "Radiation Education II " for university students since 2014.

In "Radiation Education I ", students can learn about radiation systematically through lectures and experiments. In "Radiation Education II ", students designs a class of radiation education. And they actually try their designed classes in junior high school, and evaluate the effect of their teaching.

Details will be reported at the conference.

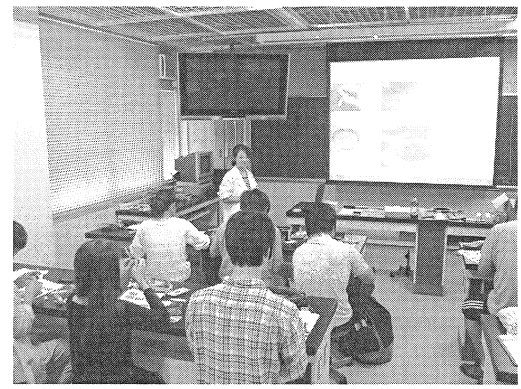

Fig. Scene from "Radiation Education I "

Keywords: radiation education, curriculum, teaching materials, teacher education

Part of this work was carried out with the aid of MEXT Grants for Strengthening National University Reforms, "Building a support system for advanced teacher education through university partnership: The HATO project / Teacher Education Renaissance".

HATO Project http://hato-project.jp/index.html (June 2015)

A comparative analysis of the chemistry curriculum between Korea and New Zealand focusing on the content of senior secondary school

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There are over 4 million students studying abroad, and this number is growing. The value of achieving an internationally qualification is becoming increasingly important as more students choose to travel abroad to further their education. Following this trend, students are seeking countries that can provide education appropriate for their future goals and career plans. In order to assess the qualifications of all these international students, a common academic ability qualification is needed. New Zealand has established a cross certification system for academic ability with other countries such as Germany, Thailand, and the United States. Based on their National Certificate Education Achievement (NCEA) academic ability certification, New Zealand compared their curriculum with other countries, established qualification standards accordingly, and implemented a mutual cross certification system. This study was to serve as a foundation for establishing a cross certification standard system for academic qualification at the high school level for chemistry curricula. A Terms of Reference for the project was developed and agreed on, followed by an exchange of information and documents between KICE and NZQA.

By comparison, the curriculum content for chemistry is a good fit because of the overlap in the content. Topics such as investigations in chemistry; atomic structure and the periodic table; the structure of the molecule and polarity; chemical combination; organic chemistry; reaction speed; chemical equilibrium; acid and base; and oxidation-reduction are covered in both the Korean and New Zealand chemistry curriculum. However, there are some minor differences. For example, molecule spectroscopy is included in New Zealand's curriculum, but not in Korea'.

Keywords: Chemistry curriculum, Korea, New Zealand

The classroom practice report of Basic Chemistry in Nagao high school

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The classroom practice report of Basic Chemistry is from April to July in 2015. Since my major is Hydrology, I mainly teach Earth Science instead of Chemistry. A high school teacher's license in Japan validates that it is possible for science teachers to instruct any major of science courses. The science class curriculum of the Nagao high school is here:

- 1st grade students for Basic Chemistry
- 2nd grade students for Basic Biology, Basic Earth Science and Basic Physics
- 3rd grade students for Biology, Chemistry, Earth Science and Physics

It was decided that I took charge of the 1st grade class this time. Therefore, my lecturing is Basic Chemistry in this year.

Our high school separates the 3 units of Basic Chemistry into a lecture (2 units) and a laboratory class (1 unit). Consequently, I can check every 1st grade student through the lecture class and we can prepare for a single subject. Although there is probably occurred a gap between the lecture and the laboratory, I observed the lab class every week and controlled the progress of them. The syllabus is set to finish all section of its textbook with a quiz, handouts, and workbook.

Keywords: Basic Chemistry, quiz, handouts

Development of science education program for alienated students

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Science teacher meetings in Seoul, has been promoting the Scientific and Cultural activities for alienated students continuously. As a result, the number of volunteers and participants who wish to the activities has increased. Now, the groups were contemplating what elements are essential for systematic activities. In addition, development of science education program for alienated students is required.

In this background, the researchers developed science education programs for alienated students, this program was operating in the local children's center. The local children's center where students gather to study science and culture of alienated areas.

The program consists of a science class, scientific publication activities, Scientific and Cultural activities. Science classes are conducted by teachers in experimental classes. After experimental classes 7-8 circuit is composed of students and teachers directly experiment to demonstrate the juniors. This is Scientific activities announced. Science and cultural activities were mainly operating on vacation with activities to explore the science and culture facilities located in their communities.

Students were able to reduce the gap between the level of science and culture alienated areas in the program. Also, problem solving ability of students increased. On the other hand, the participating teachers were also promotes a sense of accomplishment and satisfaction as a teacher. In addition, the growth of the science club students who work as assistant teachers is an important result of the program.

The future of Education, Scientific and Cultural activities in connection with marginalized local children's centers need to be activated in a more robust and diverse program, with constant attention.

Keywords: alienated students, science programs, scientific and cultural activities

Authentic Thinking with Argumentation in Science Class for Fostering Problem-Solving Ability

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Many science educators agree that fostering learners to solve problems through scientific thinking is one of important goals in science education[1]. Scientists' research activity reveals scientific thinking process and argumentation that science learners need to follow even though it cannot be easily applied to school environments[2]. In order to foster the abilities of scientific thinking and argumentation, the ATA (authentic thinking with argumentation) approach is proposed in this study. It is a learning model designed to promote learners participate in epistemic process such as reasoning, reflection, and discussion. To emphasize the authenticity of problem solving, the ATA uses daily issues as ill-structured problems. For learning scientific concepts, the ATA consists of reciprocal process, 'POE (prediction-observation-explanation) process and DOE (design-observation-evaluation) one'.

As an example, 'buoyancy' and 'design swimsuit for paraplegic patients' were integrated as a small-group activity of the ATA model. Participants were eighteen 9th students in a center for gifted learners. Data source were video-record of classes, audiotaped conversations, reports, and posters for advertisement of swimsuit. First analysis structuralized argument using 'Toulmin's Argumentation Pattern'. Second analysis traced negotiating process. Last, scientific validity of claim was verified by 'Claim-Evidence-Reasoning' tool. Participants specified the scientific concepts as the core premise for design. They evaluated claims, evidences according to validity, using analytical thinking. Also they extended concept of buoyancy from non-scientific model to scientific one. It was enable for participants who comprehended scientific model to establish functional aspects of swimsuit. After decision of function, they could consider various plan of attractive design using intuitive thinking. Researchers conclude that the ATA helps learners solve problems and learn scientific concepts through cooperative problem solving.

[1] D. Hodson, *Teaching and Learning about Science: Language, Theories, Methods, History, Traditions and Values*, Sense Publishers (2009).
[2] R. Driver, R, P. Newton, & J. Osborne, *Science Education*, **84(3)**, 287–312 (2000).

Keywords: Authentic thinking, Argumentation, Science Inquiry, Buoyancy

Making Electronic Textbook Linked with Computer Graphics for College Chemistry-experiment

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We are developing electronic textbook of basic chemistry-experiment for university students in which chemical reactions are shown by computer graphics (CG). The CGs of chemical reactions was made based on quantum chemical calculations and the Quick Time movie of the reaction path was produced which was combined with electric textbook of chemistry-experiment. The CGs include following reactions; 1) formation of di-atomic molecule by collision of two atoms such as hydrogen iodide, 2) hydroxylation of methyl chloride as a model of Walden's inversion where drastic change in structure takes place, 3) esterification of acetic acid and ethanol as an example of more complex reaction. The CG could simultaneously demonstrates the nature of the reaction such as structural change by the ball-and-stick model or the space filling model with electrostatic potential, and potential energy change by the reaction profile. The textbook displays picture of apparatus and flow-chart of small-scale experiment in addition to the CG. Therefore students were able to conduct experiment smoothly and safely while studying dynamical reaction mechanism by CG in the electronic textbook inserted in the Ziploc type plastic bag. The developed electronic textbook could be used to integrate the observable level experiment and the molecular world.

Keywords: Computer graphics, Visualization, Electronic textbook, Chemical experiment

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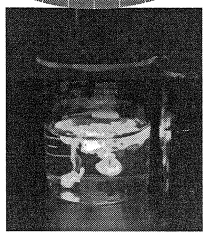

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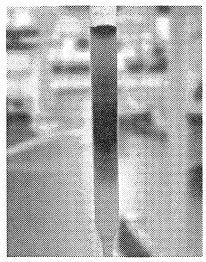

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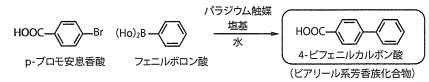
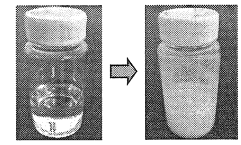


p-ブロモ安息香酸　フェニルボロン酸　4-ビフェニルカルボン酸（ビアリール系芳香族化合物）



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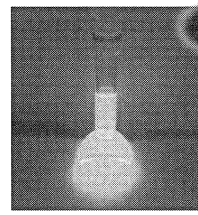

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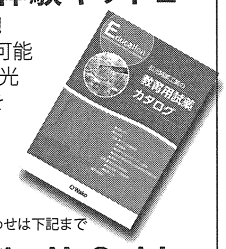

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