

# Activity-based Teaching on Fuel Technology Class for Industrial Chemistry Students

Satit Phiyanalinmat

Industrial Chemistry Department, ChiangMai University, HueyKaew Road,  
Muang District, ChiagMai 50200 THAILAND  
satit.phy@cmu.ac.th

**Abstract** - The research aimed to improve the students' engagement on Fuel technology class 209331 by using various activities in the classroom and on internet. It included the field trip at Biogas production plant. The previous teaching consisted of 80% lecturing with 20% report. By using the same content by activity-based teaching, it was divided into 3 main sections. It consisted of group presentation, filed trip and CMU moodle on the internet. It could decrease the lecturing time to 20% with the activities to 80%. This followed teach less, learn more. The new teaching was evaluated by 4 sections: student participation, learning behavior, motivation and attitude using statistical analysis. Based on the highest score of 3 from assessment, the student participation and learning behaviour, they obtained the average scores of 2.08 and 2.38, respectively. Compared to the highest score of 5, they got the average score of 4.10 and 4.26 for the student motivation and attitude, respectively. The results showed that the activitied-based teaching- new teaching, it increased the students' attention to class and their participation using E-mail and social networking to search the related knowledge. Additionally, the students accepted the different ideas of their classmate and learnt extensively from class presentation. The student motivation improved self-development and with the positive attitude to learn new activities. They finally become the active learners by the activity-based teaching to follow 21st Century skill.

**Keywords** - Activity-based teaching, Undergraduate education, Active learners

## I. INTRODUCTION

The fast change in the modern world during 2000 - 2016, it needs 21st century skill of the students to achieve in the real life outside the university [1],[2],[3]. There consists of critical thinking, creativity, collaboration, and communication skill (or 4C). The traditional method or lecture-based teaching, it had one lecturer standing in the front of the class and tried to cover the class content within the limited time. It was the monologue method. So the learning outcome and the knowledge retention, they were both low. The students forgot the easily.

The activity-based teaching has provided new method to motivate student with engagement and gain more students participation [4],[5],[6]. The activity-based teaching for Fuel Technology 209341 class was designed with the group's presentation after brainstorming. Because the doubtful ideas came from the previous content did not

meet the update content. For example, the price fluation of fuel market, energy crisis and renewable energy with fuel innovation are the very hot issues to teach and learn both students and the lecturer. Another one, it is the field trip to Energy Research Development Institute(ERDI) located at Maehe campus in ChiangMai University. The class content was designed and the activities were carefully applied to fulfil the update issues and adopt the new technology. The students' behaviour was additionally to assess on the class activity. This procedure was relevent to the previous report [7]. After each activity, the learning outcome was analyzed by questionnaire or observation [8]. The expectation of the activity -based learning and teaching will change the students to be the active learner as in Fig 1.



Fig 1. The skill of active learner

The objective of the research was to implement the new teaching method as Activity-based teaching to Fuel Technology 209331 class. The assessment in the class after teaching, it gave the important guideline to change the teaching method and develop the new content. The assessment consisted of questionnaire and then statistical analysis to evaluate the students' learning outcome. It will be a pilot project to change the teaching toundergraduate level in Chiangmai university.

## II. RESEARCH METHODOLOGY

The research methodology started with the students brainstorming to select the topics for presentation as shown in Fig 2. There were 31 students registrated this semester. And another activity involved the field trip at

Biogas production located in Energy Research and Development Institute (ERDI) as shown in Fig 3. After each activity, the students' assessment proceeded and evaluated with discussion and comments.

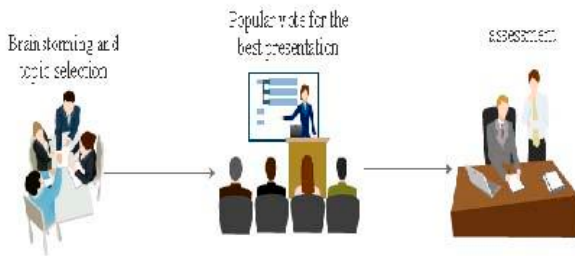


Fig 2. Activity-based planning on presentation

All 15 pairs presented 15 topics with the Rubric scoring to qualify the content and communication skill of the presentation. After each period of presentation, the comment and in-class photos were posted and shared as the feedback. It spent 4 periods from 5 Nov. to 12 Nov. 2015. Each period with the classmate assessment, the 4 popular votes obtained the award-winning. After presentation, the report was submitted to score. Another one was the summative assessment like the quiz and homework.

On 19 Nov. 2015, the field trip was held at Biogas production with the planing is Fig 3. It had pig waste and cow waste as the feedstock form methane production. The 4 groups had the presentation related to the field trip. There were Biogas production, Compressed biomethane gas (CBG) for vehicle, renewable fuel and Production management. All activities made the clear concept toward students from upstream to down-stream on biogas production. The topics were selected by students enabled them to knowledge retention. It did not contain in the previous teaching as the limitation of time and ERDI staff. The content on Fuel technology, it was always fragmented to the different subjects and it made students confused. They could not construct the knowledge themselves.

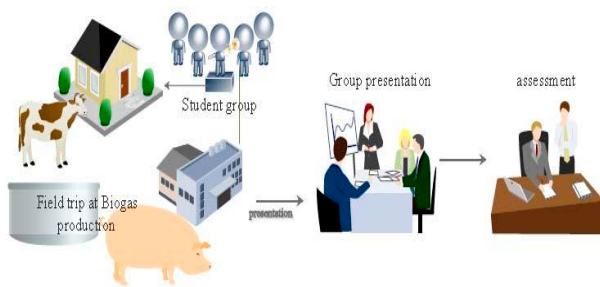


Fig 3. Field Trip activity at Biogas production

After the presentation, the slides were uploaded and shared on CMU online with KC moodle software. It allowed all students to learn and prepare themselves for the quiz and examination. Likewise, social networking as Facebook and YouTube, they were the educational tools for monitoring and giving the feedback due to the student behaviours and assessment throughout the class activity.

The Rubric scoring for presentation was applied. While quiz and the final examination with the in-class observation could give another results on the learning outcome. The score in this subject was divided into many sections as shown in Table 1.

TABLE I  
THE SCORE DIVISION IN THIS SUBJECT 209341

Activity	Score
1. Class attention	3%
2. Homework, Quiz, Short presentation	5%
3. Group learning activity 3.1 Pair presentation with the selected topic and ppt file submission, report 3.2 Presentation from Field trip (ERDI) + Report submission	10%
4. Examination	15%
Total	33%

### III. RESULTS AND DISCUSSION

This activity-based teaching was mainly applied for 31 students majoring Industrial Chemistry in 1st Semester, Academic Year 2015. A period of teaching, it took 1 hr 30 min on Monday and Thursday every week during Aug.- Dec. 2015. It had the 15 groups presentation and the field trip at biogas production at ERDI. The results came from questionnaire and observation with the direct feedback on Facebook. After presentation, the popular vote was announced and gave the award. It increased the students participation with communication skill. From student brainstorming, there were 15 topics in Table II. This gave student to interact with classmate freely. Apart from the course content, it contained only 3 topics, fuel combustion, internal combustion engine and the pollution from the combustion. But the new topics got more attraction to students' curiosity, for examples, Fuel business in Thailand, Fuel pricing, Energy innovation, Fuel innovation, recent news on Fuel-Energy, Fuel development. The content of new topics involved interdisciplinary as economics, business, creativity, management. It boardened the student learning. And it updated to current situation both in Thailand and worldwide. Some students had negative opinion as it did not follow the main content in the previous year of this subject. The contrast ideas in the class activity depended on the student perception and teaching method [9]. It meant that student had adapted learning behaviours to the design activity which was the main objectives in the class activity.

TABLE II  
THE LIST OF 15 TOPICS FOR 15 PAIRS  
PRESENTATION

Date	order	Topic
5 Nov.2015	9	Fuel business in Thailand
	12	Air pollution control after fuel combustion
	14	Fuel pricing
	1	Gaseous fuel Combustion
9 Nov.2015	15	Recent News on Fuel – Energy
	8	Energy innovation
	11	Fuel usage in the combustion engine
	2	Liquid fuel combustion
12 Nov.2015	4	Pollution from gaseous fuel combustion
	5	Pollution from liquid fuel combustion
	13	Quality control for Fuel-Energy
	3	Solid fuel combustion
16 Nov. 2015	6	Pollution from solid fuel combustion
	7	Fuel innovation
	10	Fuel development plan

Note The order of the presentation was in random from the drawing lots.

After the presentation from Table II, the questionnaire was carried out with the listing in Tabel III. The analysis of results plotted in Fig. 4, the highest score of 4.4, it belonged to Energy innovation and the lowest one of 3.86 to Liquid fuel combustion. The student liked the content of energy innovation which was very new to them. Opposed to liquid fuel combustion, it was very common and they knew before. Most of the presentation had score more than 4, they were Solid fuel combustion, Pollution from liquid fuel combustion, Pollution from solid fuel combustion, Fuel usage in the combustion engine, Recent News on Fuel–Energy. There were 5 groups with the score less than 4. They consisted of Pollution from gaseous fuel combustion, Fuel innovation, Fuel development plan and Quality control for Fuel-Energy.

TABLE III  
THE QUESTIONNAIRE FOR PRESENTATION  
ASSESSMENT

Item
1. The presentation content followed the topic.
2. The content linked the theory and application with the previous
<b>knowledge.</b>
3. After presentation, do you get more knowledge?
4. The presentation provided extensive information sufficiently.
5. The new learning from the presentation, it had theory and application with some consistency.
6. How much do you get more learning from the new learning method compared to the previous method?
7. The group presentation should be continued.

Note The score ranged from 5 as the highest to 1 as the lowest.

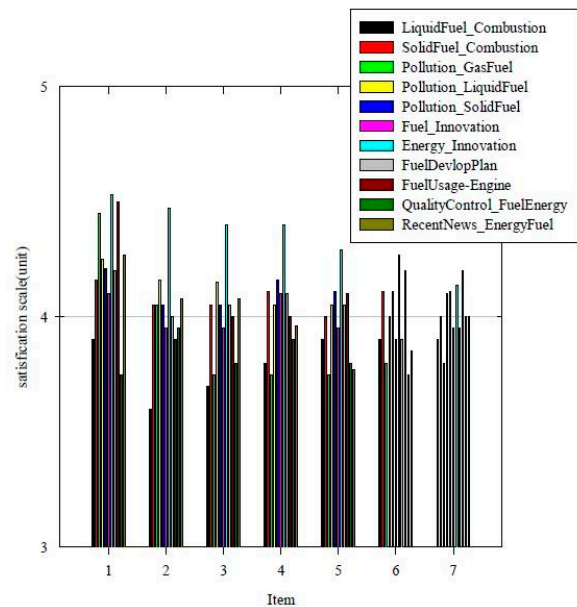


Fig 4. Result from Questionnaires after 15 presentations

In general, the score showed between 3 and 5 in Fig. 4, it indicated that most of the student satisfied with the group presentation from the new topics, content and the learning outcome. Some had learnt the new skill of public speaking. This also decreased teaching time of the lecturer significantly and enhanced the student-centered learning outcome, either. During presentation, the students gave more attention and questions as much as they wanted. Fig. 5, it was the best presentation won the award for the popular vote. And the students also posted the photo on Facebook in Fig. 6, too. This online activity, it motivated the quality of the presentation, participation and gave some suggestion for the next presentation in the active ways.



Fig 5. The award ceremony of the best presentation

Social networking as Facebook, it represented the active communication path for classmate and the lecturer. It shared the quick comment on the students's acitivity which was not available in the past. This research finding had the similar result as Demirbilek reported[10],[11]. Then, Facebook social networking was the powerful method to feedback on undergraduate class. The students preferred to update their activities so it improved learning behaviour.



Fig 6. Facebook for the student presentation and interaction.

Another activity occurred at ERDI shown in Fig. 7, the Biogas production was the main objective to field trip learning. This activity provided students to gain leadership and management. The student had to assign the car, lunch, time, safety, and on-site interview. The activity comprised of short talk and tour on the production site, water treatment and the compressed biomethane gas for vehicle uses. From the observation, students actively asked and shared their opinion with the speakers. Fig. 8, it showed the group presentation in the class and discussion afterward.



Fig 7. Field Trip activity at ERDI , 19 Nov 2015.



Fig. 8 Group presentation on compressed biomethane gas(CBG)

Some presentation uploaded in CMU moodle and YouTube for students to revise after class and to prepare for the final examination. Group presentation after field trip, it was another way to improve communication skill and collaboration among classmate which was the important skill for 21st Century skill. This corresponded to the previous reports on Water Quality and Historical Geography class[12],[13]. The field trip motivated students' perception and learning. And some also constructed the knowledge from various subjects to Fuel Technology. In term of class management, it required some expense and location to meet the class content.

All activities finished, the 2 questionnaire to clarify the learning outcome and compare the teaching methods. It was carried out in Table IV for traditional teaching and Table V for the activity-based teaching.

TABLE IV  
THE ANALYSIS OF QUESTIONNAIRE FOR  
TRADITIONAL TEACHING

Item	mean	standard deviation
1. The lecturer controls the content alone without changes.	3.9	0.7
2. The students had to adjust the learning speed to meet the teaching speed.	3.63	0.88
3. The lecturer should update the content to follow the current situation.	4.03	0.62
4. The students want to participate in class learning.	3.9	0.6
5. Class design and teaching were determined by the lecturer only.	4.1	0.68

Note The score ranged from 5 as the highest to 1 as the lowest.

The highest score of 4.10 from Table IV, it came from class design and teaching. While the lowest score of 3.63, it was the relative speed of learning and teaching. The rest were about to control the content, to update the content and the student participation. All items had low standard deviation so it meant that it had very slight difference. So the traditional teaching needs some changes.

TABLE V  
THE ANALYSIS OF QUESTIONNAIRE FOR THE  
ACTIVITY-BASED TEACHING

Item	mean	standard deviation
1. Both students and the lecturer decided the topic Together.	4.34	0.66
2. The knowledge resource and verification are important from the lecturer and class.	3.86	0.95
3. Recently more resources is available compared to the past.	4.37	0.61
4. The students access to update information so it makes the students to be more active learner.	4.48	0.58
5. Collaboration work is important for students.	4.48	0.58
6. The students can produce slides and presentation more creatively.	4.47	0.57
7. The students gained more confidence to present and teach to class-mate.	4.2	0.62
8. The class presentation leads to problem-solving skill in the class activity.	4.37	0.55
9. It had more questions in the class than the traditional teaching.	4.54	0.66

Note The score ranged from 5 as the highest to 1 as the lowest.

From Table V, the highest score of 4.48, they were about the update information and collaboration. It showed that the pre-determined content is out-of-date and the student collaboration during preparation of the presentation was also important. Opposed to the lowest score of 3.86, it was the knowledge resource and the verification from the lecturer. The remaining items were also more than 4. All of them had standard deviation less than 1. It indicated that there was very small variation of the students' perception to the new teaching method. But they preferred the new one.

TABLE VI  
THE RESULT OF ACTIVE-BASED TEACHING

Title	mean	deviation	interpretation
1. collaboration of students	2.08	0.4	High
2. learning behaviour	2.38	0.32	High
3. students' motivation	4.1	0.13	High
4. students' attitude	4.26	0.16	High

Another result in Table VI, it showed the collaboration of student and learning behaviour of 2.08 and 2.38 score, respectively. It indicated that the active-based teaching satisfied student activity and changed learning style. In case of motivation and students' attitude, it gave 4.10 and

4.26 with low deviation. All of them showed high results. Active-based teaching will be another way to teach. The activity-based teaching requires some class design to meet the students' learning behaviours and nature of the classroom. But it is not suitable for the shy or inactive students and passive learners or very big class size. The careful adoption of activity-based teaching is mainly dependent on the class content and student preparedness with some facility to improve the class activity.

#### IV. CONCLUSIONS

The research was to implement the activity-based teaching for Fuel Technology class 209331. It increased the students' engagement and collaborative work including content. The new topics after brainstorming, it consisted of Fuel business, National energy plan, Renewable energy, Fuel pricing system, Energy Innovation, Energy News and Fuel innovation. These new topic expanded students learning and updated the current situation on energy and fuel which did not contain in the previous teaching. The advantage on this the new teaching also included classmate assessment and award winning for the best presentation. Due to field trip at Biogas production at ERDI, it enhanced student learning and perception on the biogas production better than the class lecturing. Students had constructed and linked the previous knowledge from their presentation as the visible evidences from active-based teaching. They also practised leadership and self-oriented learning skill to ensure 21st century skill.

#### ACKNOWLEDGMENT

SP would like to thank 21st Century skill on Pilot project for New teaching from Educational Quality and development section ([www.eqd.cmu.ac.th](http://www.eqd.cmu.ac.th)), Chiangmai University for the funding. The cooperation from 209331 Students (1<sup>st</sup> semester/2015) is greatly appreciated in the research with the department staff.

#### REFERENCES

- [1] L. B. Abbott, K. L. Launchbaugh, and S. Edinger-Marshall, "Range Education in the 21st Century: Striking the Balance to Maintain a Relevant Profession," *Rangeland Ecology & Management*, vol. 65, no. 6, pp. 647-653, Nov. 2012.
- [2] R. F. Lim, B. C. Hsiung, and D. J. Hales, "Lifelong Learning: Skills and Online Resources," *Acad Psychiatry*, vol. 30, no. 6, pp. 540-547, Nov. 2006.
- [3] W. B. Whalley, A. Saunders, R. A. Lewis, M. Buenemann and P. C. Sutton, "Curriculum Development: Producing Geographers for the 21<sup>st</sup> Century," *Journal of Geography in Higher Education*, vol.35, pp. 379-393, 2011.
- [4] J. Turns, R. Adams, A. Linse, J. Martin, and C. J. Atman, "Bridging from research to teaching in undergraduate engineering design education," *International Journal of Engineering Education*, vol. 20, no. 3, pp. 379-390, 2004.
- [5] J. P. Morton, "Learning to be a sport and exercise 'scientist': evaluations and reflections on laboratory-based learning and assessment," *Journal of Hospitality Leisure Sport & Tourism Education*, vol. 7, issue. 2, pp. 93-100, Nov.2008.
- [6] L. Eisen, N. Marano, and S. Glazier, "Addition to Activity-Based Approach For Teaching Aqueous Solubility, Energy, and Entropy," *J. Chem. Educ.*, vol. 91, no. 8, pp. 484-491, Aug. 2014.



- [7] A. E. Marteel-Parrish, "Teaching Green and Sustainable Chemistry: A Revised One-Semester Course Based on Inspirations and Challenges," *J. Chem. Educ.*, vol. 91, no. 7, pp. 1084–1086, Jul. 2014.
- [8] K. J. Carbonneau, S. C. Marley, and J. P. Selig, "A meta-analysis of the efficacy of teaching mathematics with concrete manipulatives," *Journal of Educational Psychology*, vol. 105, no. 2, pp. 380–400, 2013.
- [9] H.-Y. Lin, S.-S. Tseng, J.-F. Weng, and J.-M. Su, "Design and Implementation of an Object Oriented Learning Activity System," *Educational Technology & Society*, vol. 12, no. 3, pp. 248–265, 2009.
- [10] M. Demirbilek, "Social media and peer feedback: What do students really think about using Wiki and Facebook as platforms for peer feedback?," *Active Learning in Higher Education*, vol. 16, no. 3, pp. 211–224, Nov. 2015.
- [11] M. Hill and M. Hayes, "Do You Like it On The...?: A Case-Study of Reactions to a Facebook Campaign for Breast Cancer Awareness Month," *The Qualitative Report*, vol. 20, no. 11, pp. 1747–1762, Nov. 2015.
- [12] J. Enos-Berlage, "Development of a Water-Quality Lab that Enhances Learning & Connects Students to the Land," *The American Biology Teacher*, vol. 74, no. 7, pp. 471–478, 2012.
- [13] I. M. Keighren, "Teaching historical geography in the field," *Journal of Geography in Higher Education*, vol. 37, no. 4, pp. 567–577, Dec. 2013.