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Teaching Methods in Engineering Education: A Case Study in Thailand

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Abstract: Teaching engineering students to learn "why" is as important as to learn "what". To do so there are several teaching methods that teachers may use to achieve this goal. Among several modern teaching methods such as active classroom, flipped classroom, problem-based learning and more, some or all may fit the nature of engineering disciplines. Therefore this study aims at understanding the student's point of view. We surveyed almost 400 undergraduate students at the Faculty of Engineering, Chulalongkorn University, Bangkok, Thailand to assess their views on different types of teaching methods and the effect of these methods on their learning outcome. The results show that flipped classroom is more difficult and less preferable than active learning and traditional lecture. In contrast, active learning is the most preferable, interesting and least difficult teaching method among students. Whereas among all technologies Course Ville LMS has the highest rate in term of both utilization and eligibility in active classroom.

Key words: Engineering education, teaching methods, active learning, flipped classroom, course ville LMS

INTRODUCTION

Moving forward to education 3.0, it is the role of teachers to find ways to promote imagination, creativity and innovation. Teachers implement different teaching methods like active learning, problem-based learning, evidence-based learning, flipped classrooms and all kinds of teaching methodsin university. In engineering schools in particular, past research works show that teaching methods affect student's abilities in critical thinking, logical reasoning and problem solving (Zeng, 2011). Nonetheless, it is essential to understand how students perceive different teaching methods and how each teaching method impact learners. In this study, we aim to compare the effectiveness of different teaching methods at the Faculty of Engineering, Chulalongkorn University a leading engineering school in Thailand. We surveyed almost 400 undergraduate students to learn about their views on various teaching methods that they have experienced.

Chulalongkorn admits approximately 1,000 engineering students each year to its engineering school. Although most classes are conducted in Thai language, some use English as a medium in both traditional and international courses. The faculty is also an adopter of the CDIO-Conceive, Design, Implement, Operate initiative (Sripakagorn *et a l.*, 2014; Maneeratana *et al.*, 2014). Since 2013. It is a leader in engineering education in Thailand with a strong team of faculty members. With its own in-house Learning Management System (LMS) Course Ville, it incorporates social network and various tools that answer student's needs (Temiyasathit *et al.*, 2016). With regards to facilities, several traditional classrooms were modified to become modern active classrooms fully equipped with necessary hardware and software that enhances engagement in the classroom. These rooms are very popular among teachers when they started offering classes that are in compliance with CDIO.

Regarding the teaching method we found three main methods used at the faculty active learning, flipped class and traditional lecture. We call a class an active one when there are more hands-on or practices in class more than lectures. For flipped it is when teachers assign students to study the given materials before they come to class for more details. The traditional lecture is simply the class that is a sort of one-way instruction from the teacher to students. Apparently, teachers are the ones who design how the class is going to be delivered. None the less it would be interesting to understand how students perceive and perform. Therefore, this study aims at discovering how students feel about each teaching method and whether it has effects on student's performance. To do so, we had distributed a set of online questionnaire to reach all undergraduate students in order

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to survey their views on the teaching methods used in the teaching of approximately forty courses. We conduct this survey as an activity in class called global awareness for technology implementation (Ota and Punyabukkana, 2016) at Chulalongkorn's Faculty of Engineering.

Literature review: United States and China, known as two big and powerful countries have put a lot of efforts into conducting numerous studies to enhance the efficiency of education (Zeng, 2011). Since education is the development of human capital a foundation vital in any country. Many teaching and learning methodologies have been developed to fulfill a desire of making the education stand at its best. Each method has its own respective strengths and weaknesses.

Previous studies showed that active learning is a good way to improve student's learning outcome. A research conducted in an undergraduate nursing environment suggested that active learning is useful for helping undergraduate students gain competency (Shin *et al*., 2015). Another research established at SoongSil University in Korea confirmed that active learning is superior to traditional learning (Park and Choi, 2014). Similarly, there are two more researches which showed that flipped classroom model is better than the traditional model (Flores *et al*., 2016; Nouri, 2016). On the other hand, there is a research which argued that traditional lecture and flipped classroom do not yield significant different results in terms of student outcomes (Murray *et al*., 2014) while another asserted that the effectiveness of active learning depended on the design of student's learning activities (Marusic and Slisko, 2014).

However, we found no recent studies on the effects of different teaching methods from student's perspectives. Therefore we choose to conduct a survey through the use of questionnaire in order to determine if student's views concur with that of the teachers.

MATERIALS AND METHODS

Questionnaire: The questionnaire was designed for the purpose of analyzing the relationship between teaching methodology and its effectiveness. It was distributed to engineering students at Chulalongkorn University online, using Google form. There are three sections as follows:

Section A: Solicits personal information from the participants who can choose to remain anonymous. The required answers are their GPA, major, gender, age group and year of study.

Section B: Contains questions pertaining to subjects or courses the participants has taken and wish to share their experiences. We ask for their course grade, the semester they took the course, number of students in class, frequency of quizzes or practices, technologies used, number of classes per week and number of hours per class.

Section C: Examines the participant's opinion on the identified subjects, using Likert scale (Joshi *et al*., 2015) ranging from 1-5. We target our questions to the difficulty of the content whether the content is of interest, the efforts and time they spent on the subject, etc. Most importantly we ask the participant to identify whether the course is of active learning, flipped or traditional lecture type. We also inquire the participant's opinion about the materials used in class, physical classroom, the equipment and the setting of the classroom.

RESULTS AND DISCUSSION

Survey results: We received 366 responses from 2nd-4th year undergraduate engineering students from a total of approximately 3,000 at the Faculty of Engineering, Chulalongkorn University. Figure 1 reveals stude's favorite teaching method among the three types, active learning, flipped classroom and traditional lecture. This score reflects student's preference for each teaching method in which flipped classroom is the least favorable. Some students mentioned that they felt they had to learn the same materials twice, once before the class and once during. One responder used the term "re-teach" when teacher goes through the same materials as shown on the videos that they watched before class. Many also complained that flipped classes were too time consuming.

Figure 2 illustrates student's perception on how each teaching method makes students more interested in the subject. From the score, active learning earns highest scores from the participants.

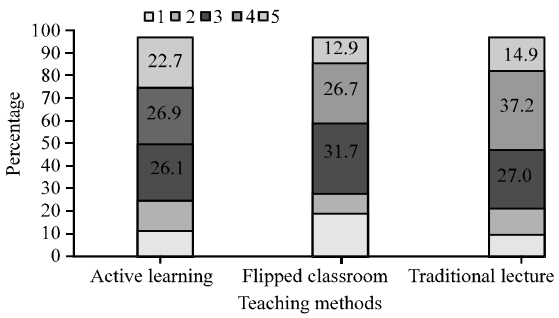

Fig. 1: Score of preference for each teaching method

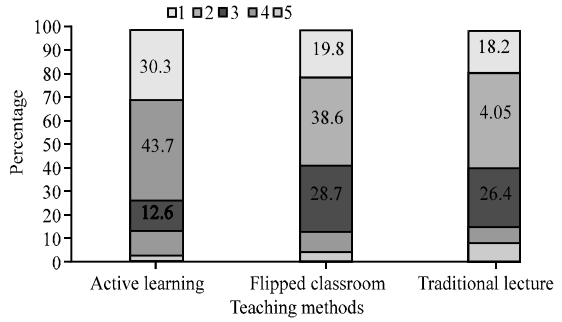

Fig. 2: Score of interest in teaching for each teaching method

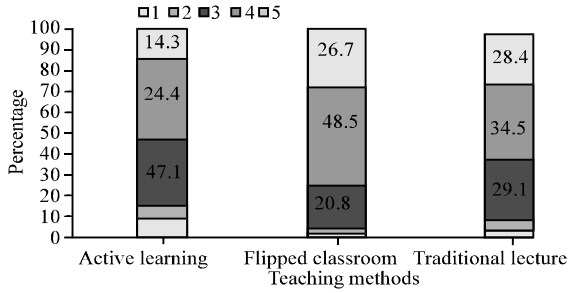

Fig. 3: Score of difficulty for each teaching method

Students confirmed that active classes are "engaging", fun, stimulating and make them look forward to coming to classes.

Figure 3 presented student's perception on the level of difficulty they feel toward each teaching method. The result suggests that flipped classroom is the most difficult one to obtain good grade with 75.2% of the students rated the difficulty at 4 and 5. On the contrary, active learning is the least difficult method with only 38.7% of the students rated the difficulty level from 4-5.

A few respondents expressed that when some of the subjects utilized active class method the exams tend to be more difficult because the contents they learned in class through activities would not appear straight forward on the exams. Rather, the questions on the exam tend to be of the analysis or application style which they find more difficult and hard to predict.

We also found that there are number of quizzes in many subjects. So, we asked students for number of quizzes in each subject and whether the quizzes help them spend less time to prepare for midterm or final exams. Figure 4 and 5 reveal no differences among them. Figure 6 demonstrates grade distribution for each teaching method classified by student's cumulative GPA (GPAX). We found that top students lean toward active learning

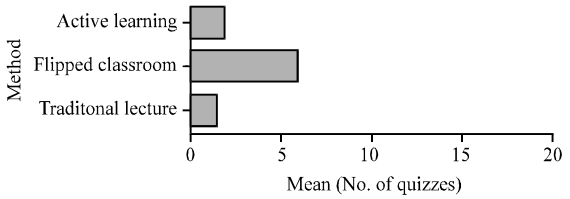

Fig. 4: Number of quizzes for each teaching method

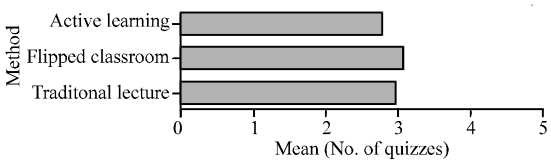

Fig. 5: Score of the time reduction for exam preparation by quizzes for each teaching method

more than the other two. Figure 7 is the results when we asked whether they understand the subject through each method than if they study the materials themselves. It showed that "good" students with GPAX of 4 felt that traditional lectures enhance their understanding better than other means.

It is interesting to learn from the participant's comments that they felt self-studying resulted in higher long-term retention rate. Note that self-studying does not mean that students do not attend classes. Rather, students come to class and study the materials before or after class by themselves. Figure 8-12 show the utilization of technologies used in various classes, from Blackboard, CourseVille (Chulalongkorn's LMS) Facebook group, clicker and presentation slides. The results indicate that slide is still most popular among teachers. For Learning Management System (LMS) CourseVille is more preferable to Blackboard. Additionally CourseVille, Clicker and Facebook group tend to be popular in active learning. Weobserved that the utilization of slides is lower in flipped teaching style. Figure 13-17 are responses when we asked whether each technology is suitable when utilized in the given class. The answers reveal similarity of proportion in the use of CourseVille and Facebook group. However, the use of clicker has the highest rate for active learning among every tool. Clicker is used only in very large class size with >300 students. Blackboard has the lowest score, as students said that its look and feel is rather outdated.

From the results explained in study 4, it is some what surprising to learn that students still prefer traditional lecture despite tremendous efforts that the teachers put toward active learning or flipped form. However, this may due in part to the imbalanced number of classes taught in

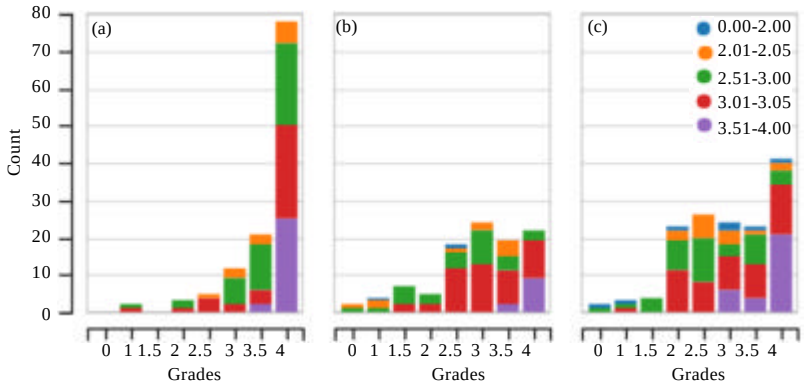

Fig. 6: Grade distribution classified by GPAX: a) Active learning; b) Flipped classroom; c) Traditional lecture

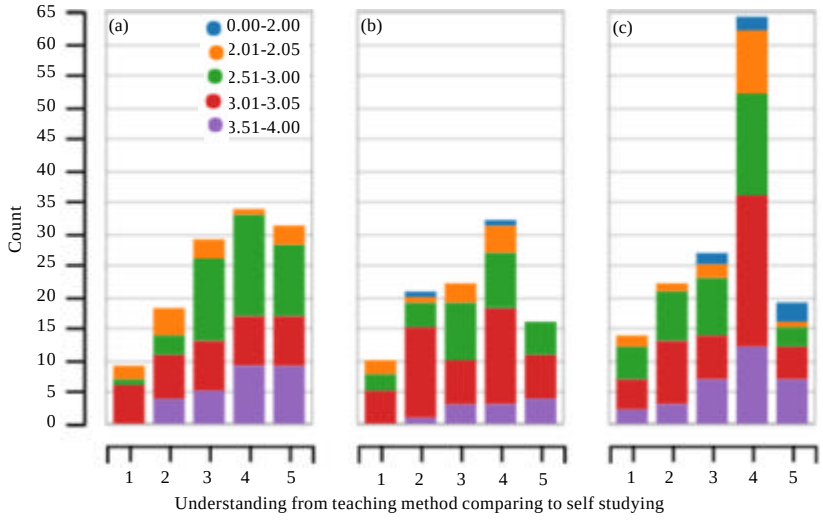

Fig. 7: Comparison of how much students understand the subject through each method comparing to self-studying: a) learning; b) Flipped classroom; c) Traditional lecture

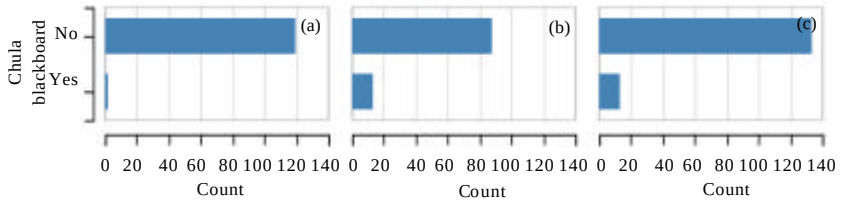

Fig. 8: Utilization of Chula blackboard for each method: a) Active learning; b) Flipped classroom; c) Traditional lecture

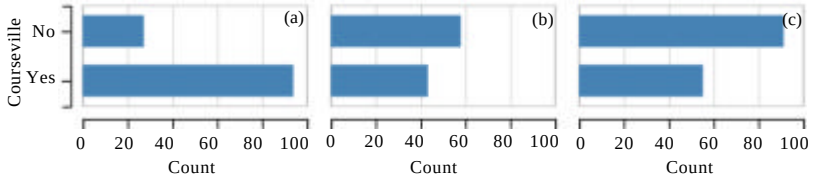

Fig. 9: Utilization of CourseVille for each method: a) Active learning; b) Flipped classroom; c) Traditional lecture

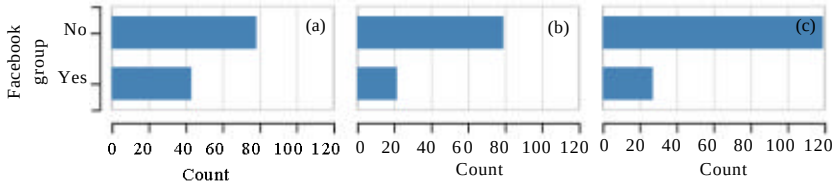

Fig. 10: Utilization of Facebook group for each method: a) Active learning; b) Flipped classroom; c) Traditional lecture

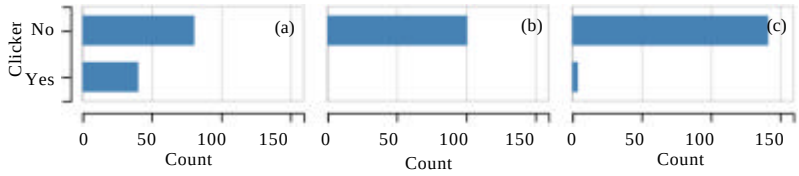

Fig. 11: Utilization of clicker for each teaching method: a) Active learning; b) Flipped classroom; c) Traditional lecture

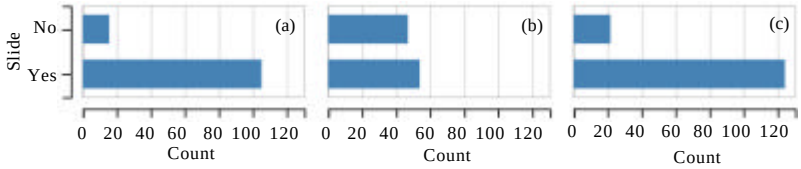

Fig. 12: Utilization of slides for each teaching method: a) Active learning; b) Flipped classroom; c) Traditional lecture

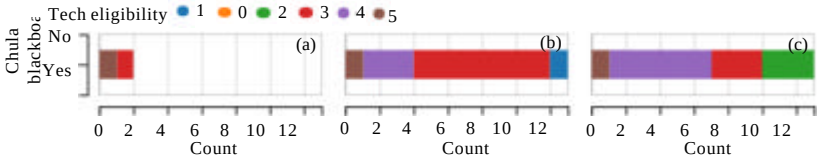

Fig. 13: Suitability of Blackboard for each method: a) Active learning; b) Flipped classroom; c) Traditional lecture

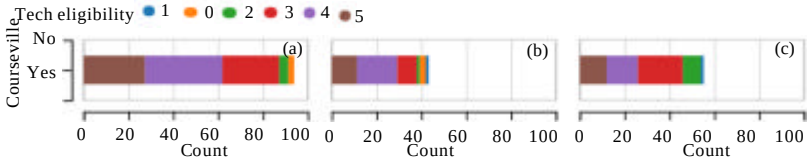

Fig. 14: Suitability of CourseVille for each method: a) Active learning; b) Flipped classroom; c) Traditional lecture

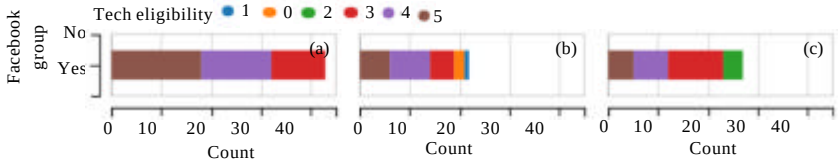

Fig. 15: Suitability of Facebook group for each method; a) Active learning; b) Flipped classroom; c)Traditional lecture

different methods. Still, number of classes with conventional lecture type dominates the rest. Another explanation is perhaps the nature of the courses. Many subjects in engineering are difficult because they demand deep skills in mathematics as well as other fundamental science like Physics. Therefore, demonstration and

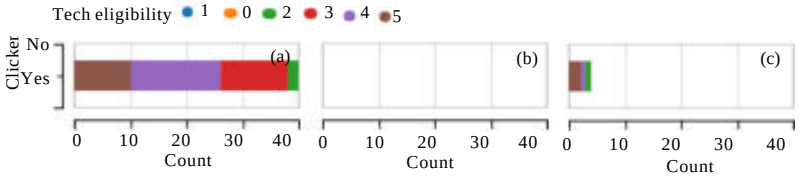

Fig. 16: Suitability of clicker for each method: a) Active learning; b) Flipped classroom; c) Traditional lecture

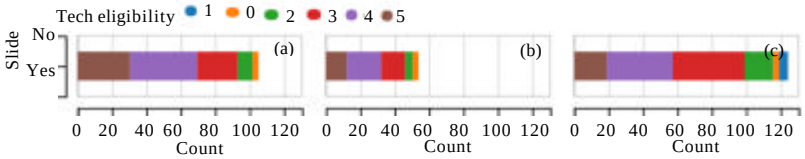

Fig. 17: Suitability of slide for each method; a) Active learning; b) Flipped classroom; c) Traditional lecture

guidance from the teachers are necessary. And when students require further explanation, the lecture setting would allow the interaction between the teachers and students better than other methods.

Another unexpected outcome revealed when the results suggested that students "understand" better when they attend traditional lectures. The majority of the students view that attending traditional lectures is more helpful to understanding the lesson as compared to self-studying. On the other hand, most students studying in flipped classroom and active learning tend to think otherwise. From further investigation, students said that the self-studying results in long-term retention of the knowledge.

All in all, active learning is more suitable for classes that are of practice type or project-based. Further comment on active learning is that peers help promoting friendly learning environment. Good students can help their friends because they can observe when their friends struggle. They also mentioned that the classes enhance their creativity and encourage knowledge sharing. And unknowingly, it helps improving their presentation skills at the same time. Furthermore, some students noted that they like active learning because it usually does not require preparation prior to class.

Different types of technology discussed have its own unique characteristic. We found that these technologies are seamless for students. However, user interface is a keyword when considering LMS and that explains why CourseVille is a favorite among students. For Facebook, as it is a social media that is most popular in Thailand, most students already have their accounts. Our lesson is to understand student's lifestyles and use it to benefit both teacher and students. At Chulalongkorn, clicker is used only in very large classes of perhaps over 100 students to collect data from students in order to understand student's understanding. Finally, naturally, slides are still used for most of the classes and they are distributed to students by any means mentioned above.

CONCLUSION

The objective of this study is to compare three teaching methods and the technology in an engineering school. We found that although students at Chulalongkorn felt that active learning is stimulating, however, the majority still prefer traditional lecture and believe that it fits more with engineering discipline. Further investigation should be conducted to gain insights into the decision on when to use active learning, traditional lecture or any other teaching methods. We understand that the efforts for the teachers to organize an active learning course is much higher than the traditional one. Therefore, teachers may be able to better balance their energy if they know how students perceive and perform.

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