Development of E-learning Course for Engineering Mechanics by MIAP Teaching Method

Tin Zar Lat[1], Sakda Katawaethwarag[2], and Sayam Kamkhuntod[3]
King Mongkut's University of North Bangkok, Faculty of Technical Education,
Department of Teacher Training in Civil Engineering, Bangkok 10800 Thailand.
[1]Graduate student: tinzarlatt09@gmail.com; s5802032820025@email.kmutnb.ac.th
[2,3] Assistant Professor

***Abstract*- Teaching method and e-learning course are considered vital teaching tools for engineering mechanics. The purpose of this study is to develop e-learning course using the MIAP teaching method in TU (Dawei). The research tools employed are the following: 1) the documents for teaching tools 2) e- learning and 3) laboratory equipment. The student sampling groups included 10 fifth year students as a trial group and 30 second year students as a real group. The process efficiency (E1) and output efficiency (E2) were 89.31/89.00 and the success of the study was after-study higher than before-study at 0.05 statistical significance. And then, the results from the data also revealed that the satisfaction of the students for the quality of the MIAP teaching method was at good level ($\overline{X}$ = 4.37, SD = 0.54). In conclusion, from the above results, the e-learning course and MIAP teaching method can be applied efficiently in the learning and teaching of engineering mechanics.**

Keyword: **E-learning, MIAP, Engineering mechanics**

I. INTRODUCTION

In engineering mechanics subject, plane truss and portal frame are very important for the engineers who are concerned with structure. They are usually used to form bridges, buildings and to support the roofs because they are very strong.

This course includes mainly the analysis of the internal forces and deflections of plane truss and portal frame. These internal action of engineering mechanics subjects are not easy to understand for students. Most of them get bored and not interest to learn on this subject. Therefore, many researchers and lecturers researched and tested to motivate their interested, tested how to teach and how to prepare for this subject to improve more understanding on it.

Some author expressed that the engineering laboratories have always an important role for the engineering education which is inconceivable without it [1], [2]. Therefore, the experiment sets are needed to improve the students' visualization of the mechanic's principles and the conceptual understanding of the engineering mechanics, and to improve their motivation.

In Technological University (TU), Dawei, all of the teachers have taught the lecture using the white board or traditional boards. Thus, they take many time in writing and copying on their note books that waste the time in teaching and learning. And they have taught the lecture with their own style without the systematic teaching method. Therefore, some are good and some are not good in teaching part. Most of them are lack to motivate the students on their teaching part.

In previous study, MIAP teaching method improved in teaching and learning process. As the first step is to get the students motivated to learn [3]. Increased motivation results in better learning [4]. Therefore, motivation is very important in teaching and learning process. Although, there are many kinds of teaching methods, this MIAP teaching method is suitable for engineering mechanics subject and TU (Dawei).

And the e-learning satisfy for the differentiated students with various capacities and background [5]. According to the related literature reviews of the e- learning course, it was found that academic achievement of the learning and the satisfaction of learner based on electronic media were high as well. Thus, to support the lectures and students in Technological University (TU), Dawei for developing teaching and learning, used the electronic media and MIAP teaching method. By using the electronic media, the teachers and students can save time, more interesting, connecting with the sight and understanding in class room teaching and learning process. This e-learning course and MIAP teaching developed the students a strong desire to learn the engineering subject.

The overall goal of engineering education is to prepare students to practice engineering and, in particular, to deal with the forces and materials natures [6]. Thus, the engineering laboratories have always been an important part of professional and higher undergraduate education [1]. In TU (Dawei), most of the subjects have taught through theoretical lessons so the students are weak in practical skill. Therefore, how to ensure teaching quality required systematic thinking and design of the processional course teaching [7]. In 2016, Technological University received many experiment set for laboratory but until now anyone doesn't use this equipment for teaching and learning process.

 DOI:10.14416/c.fte.2017.11.068

This research used the experiment sets with systematic teaching method and e-learning for the engineering mechanics to improve the understanding and interesting of the students in TU (Dawei).

A. Objectives of the research

1) To develop the systematic teaching method and learning process.

2) To evaluate the satisfaction of e-learning course for engineering mechanics subject in teaching and learning process.

3) To evaluate the efficiency of experiment set in engineering mechanics by testing with student sampling group.

B. Hypothesis of the research

1) The success of the study is after-study higher than before-study at 0.05 statistical significance.

2) The process efficiency (E1) and output efficiency (E2) is equal or higher than 80/80.

3) The students' satisfaction on e-learning course and MIAP teaching method is at good level.

C. Research scope

1) Scope of Sampling group

The population and selection of the sampling group are shown in Fig.1.

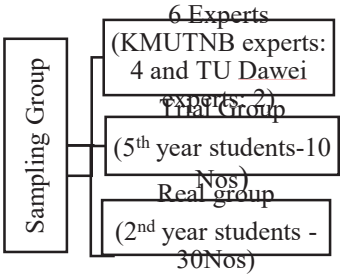

Figure 1. Research scope of sampling group.

2) Scope of e-learning course and MIAP teaching method is shown in Fig.2.

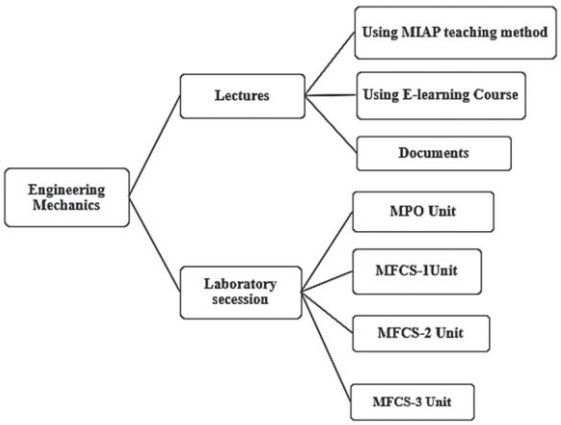

Figure 2. Scope of engineering mechanics using e-learning course and MIAP teaching method.

In this research, MFCS-1 unit to study the member forces of the statically determinate truss, MFCS-2 unit to study the member forces of determinate truss and overdeterminate truss, MFCS-3 unit to study the deformation of determinate truss and MPO unit to study the deflections of portal frame were used to demonstrate in teaching and learning process.

II. LITERATURE REVIEW

A. E-learning Course Development

E-learning is all forms of electronic supported learning and teaching, which serve as specific media to implement the learning process [8], [9]. Nowadays, there are many learning processes to help students learn and get other skills, such as lecturing, discussion, practice, demonstration, simulation, projects, etc. [10- 12]. Generally, the teaching and learning has focused on the interaction between 1) the leaners and teachers, and 2) the learners and the contents. Electronic media are able to deliver content with text, images, audio and video, allowing students to respond to learning immediately, which other media cannot accomplish [3]. Thus, the e-learning tools are virtual teaching tool for educational practice, and evaluation process [13]. This research used e-learning in teaching of engineering mechanics subject to get more understanding of subject contents, to motivate the students' interesting and to improve teaching and learning process.

B. MIAP Teaching Method

The teaching methodology is to motivate the students at their learning and to improve learners' performance [3]. The MIAP teaching method is the experiential learning

 DOI:10.14416/c.fte.2017.11.068

method that is operated by teachers, includes four steps as shown in Fig.3.

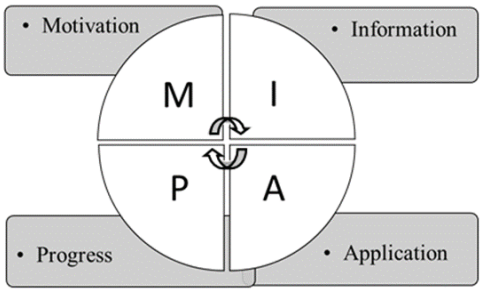

Figure 3. MIAP teaching method

The details of the MIAP teaching method is as follows: [14]

1) Motivation: (M) The aims of this step are to encourage students to take an interest in, and solved the problem: to encourage students to learn and lead the students into the subject with that intention. This intention and motivation should be maintained throughout the lesson to keep the students engaged, and therefore, improve learning retention.

2) Information: (I) This step is the actual delivery of the content to the students. As part of this, the content should be sorted and separated into smaller chunks, appropriate for what the students are able to absorb and retain.

3) Application: (A) To make sure the students have a better understand of the content, they practice using the new knowledge to solve specific problems. At this stage, the learners need to be checked, and given the opportunity to use the knowledge in the process of finding a solution to a problem, ensure the students have understood the lesson, and to review their knowledge.

4) Progress: (P) The final step is to monitor and evaluate the achievement of the objectives. If the objectives are not achieved, the instructor will need to make adjustments until the students properly understand the content, and complete it.

The aim is to enable learners to acquire knowledge and skills with the experimental sets to improve their professional competency [15].

C. Engineering Mechanic with Experimental sets

In second year civil engineering students learn the behavioral of materials and structures of the basic concepts of Engineering mechanic. The students calculate the displacements and stresses that structures undergo when subjected to design loads with theoretical formula. The students did not believe that the knowledge they gain would be useful in designing, analyzing, and building a real structural. After they analyze the structural behavior in the laboratory room, this showed them that the actual behavior of the structure matches the theoretical concepts they learned earlier [16]. The laboratory is an essential for virtual understanding of engineering students. Thus, this engineering mechanics subject and experimental set are cannot be separate in teaching and learning processes. And they got at high performance in learning of students using the MIAP and e-learning course [3].

Therefore, in this research, MIAP teaching method and e-learning and experimental set were chosen for engineering mechanics subject to improve the teaching and learning skill in TU, Dawei. This teaching method approach from teacher-center method to students-center method.

III. RESEARCH METHODOLOGY

This research followed Klinbumrung et al. research procedure [17], includes the usage of e-learning course, sampling group, collecting and analyzing the data as shown in Fig.4. Firstly, analyzed the course description of engineering mechanics. Secondly, e-learning course and the MIAP teaching method were evaluated and constructed in teaching and learning. Finally, the data of real group were collected and the results were analyzed. Research methodology was divided as follows:

A. Sampling this research

This research included the experts and students as the sampling group of the research.

The research tools were created and evaluated by 6 experts:

- 3 experts (1st group) to check the IOC values of teaching, and learning contents.
- other 3 experts (2nd group) to evaluate the quality of teaching media.

And the research tools were also tested with the trial group of 10 students before applying to the real group of 30 students.

 DOI:10.14416/c.fte.2017.11.068

Figure 4. A Summary of Research methodology.

B. Research tools

The research tools and their objectives of learning and teaching in this paper included:

1) Documents:
   - Information sheet and Operation sheet for information (I).
   - Lab sheet and Exercise sheet (Multiple choice, Fill in the blanks and Problems) for application and progress (A and P)
   - Examination sheet (Multiple choices, Fill in the blanks and Problems) for progress (A and P).
2) E-learning course (power point, video file) to motivate
   the students and give the information (M and I).
3) Laboratory equipment (4 units) for motivation, information, application and progress (M, I, A and P) as shown in Fig.5 to Fig.8:

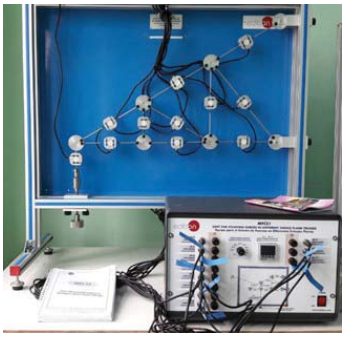

Figure 5. Unit for studying forces in different single plane trusses (MFCS-1unit).

Figure 6. Unit for studying forces in an overdeterminate truss (MFCS-2 unit).

Figure 7. Unit for studying deformation of truss (MFCS-3 unit).

Figure 8. Deflection measurement of portal frame unit (MPO unit).

4) IOC results

The IOC results were evaluated to use as the teaching tools for this research by 1st group of experts. The consistency of Index of item Objective Congruence (IOC) between 1) the contents and behavioral objectives, and 2) the behavioral objectives and problems was evaluated by 3 experts. And the accepted value must be over standard IOC value 0.5.

- The IOC results between the contents and behavioral objectives by the 1st group of 3 experts as shown in Table I.
- The IOC results between behavioral objectives and exercise problems by the 1st group of 3 experts as shown in Table II.

In Table I and II, the total items were 33 numbers. Although the results of 32 items were higher than standard

 DOI:10.14416/c.fte.2017.11.068

IOC value 0.5, 1 item result was less than standard IOC value 0.5 as shown in Table I.

TABLE I The IOC Result Between the Contents and Behavioral Objectives By The 1st Group Of Experts

Item	No. of behavioral objectives	Number of items (IOC results greater than 0.5)	Number of items (IOC results less than 0.5) *correction need
MFCS-1 Unit	8	8	0
MFCS-2 Unit	7	6	1
MFCS-3 Unit	8	8	0
MPO Unit	10	10	0
Total	33 items	32 items	1

One content of MFCS-2 Unit in Table I needed to be improved. After this content had been improved to meet the objective, it was sent to evaluate again by experts.

TABLE II The IOC Result Between the Behavioral Objectives And Exercise problems By The 1st Group Of Experts

Item	No. of behavioral objectives	Number of items (IOC results greater than 0.5)	Number of items (IOC results less than 0.5) *correction need
MFCS-1 Unit	8	8	0
MFCS-2 Unit	7	7	0
MFCS- Unit	8	8	0
MPO Unit	10	10	0
Total	33 items	33 items	0

And the IOC results of behavioral objectives and exercise problems in Table II didn't need to be improved. After that, the evaluated teaching tools were applied in trial group before the investigation of real group to analyze the success of the teaching and learning process.

C. Data collection

Data collections to analyze the results were divided into two parts:

1) Results from experts (2nd Group of experts)

The quality of teaching media was evaluated by two experts of the King Mongkut's University of Technology North Bangkok and one expert of Technological University (Dawei), in Myanmar for 5 levels. And this evaluating result of teaching media was collected and analyzed.

2) Results from students

The e-learning course using MIAP teaching method was applied with 10 fifth year civil engineering students as a trial group and 30 second year civil engineering students as a real group at the Technological University, Dawei in Myanmar. Only the data and results of real group were collected and analyzed. The process efficiency (E1) of exercises during learning process and output efficiency (E2) of post-test were collected and analyzed to be higher than 80/80.

And the pre-test and post- test results were collected and analyzed with t- test. Finally, the results of students' satisfaction after studying of e-learning course and MIAP teaching method was collected and analyzed with the average, standard deviation as the levels specified for the quality of teaching media.

Figure 9. Learning activities of trial group.

Figure 10. Activities of real group in learning and teaching.

IV. RESEARCH RESULTS

The results of e-learning course using MIAP teaching method on engineering mechanics from 30 students and 3 experts (2nd group) were divided into two parts as following:

A) Results from Experts

The evaluation results of quality of teaching media by the 2nd group of 3 experts as shown in Table III.

TABLE III The Results of the Evaluation Of The teaching Media By The 2nd Group of Experts

Items	Topics	Average $\bar{X}$	S. D	Level
1	Content and continuity	3.67	0.38	Good
2	Image, language and	4.07	0.11	Good

 DOI:10.14416/c.fte.2017.11.068

	sound			
3	Font and color	4.11	0.43	Good
4	Test after finished lesson	3.67	0.38	Good
5	Lessons sequences	4.13	0.23	Good
	Total Average	3.88	0.31	Good

In Table III, the evaluated quality of developed MIAP teaching method and e-learning course for engineering mechanics subject by 3 experts (2nd group of experts) is at Good level. According to the results, these qualified teaching tools can be applied in teaching and learning process.

B) Results from students

1) the comparisons between pre-test and post-test results as shown in Table IV.

2) the results of the process efficiency and output efficiency as shown in Table V.

3) the results of the students' satisfaction of the e-learning course with MIAP teaching method as shown in Table VI.

TABLE IV The Comparisons Between Pre-Test and Post-Test Results In Teaching and Learning Process

Items	Pre-test	Post-test
Full score	17	17
Average score	5.6	15.13
S. D	2.429	1.7
t-test	t = 18.325, sig. = 0.00 (2 tail)	

The post-test score is higher than pre-test score as shown in Table IV. According to the t-test results, the success of the study was after-study higher than before-study at 0.05 statistical significance.

TABLE V The Results Of the Process Efficiency and Output Efficiency Of The Research Tools

Item	No. of students	Full score	Total score	Average score	Efficiency %
Exercises	30	34	911	30.37	E1= 89.31%
Post-test	30	17	454	15.13	E2= 89.00 %

The results of the process efficiency and output efficiency on the research tools as shown in Table V, E1/E2 are 89.31/89.00 which is greater than 80/80.

TABLE VI THE Results of the Students' Satisfaction Of E-learning Course and MIAP Teaching Method

List of assessment	Average $\bar{X}$	S. D	level
1. The lesson content lead to understanding.	4.77	0.43	Very good
2. Dividing the content into sub-topics enhance more understanding for students	4.43	0.5	Good
3. Lesson presentation is in appropriate order.	4.47	0.57	Good
4. Illustration partially enhance better understand in the content	4.73	0.45	Very good
5. Length of content appropriate for students	4.30	0.53	Good
6. Students can review and understand the content.	4.60	0.5	Very good
7. Screen design is beautiful and appropriate.	4.03	0.56	Good
8 .Image is appropriate for the content.	4.17	0.65	Good
9 .Sound composition is appropriate.	3.87	0.57	Good
10 .Font size and color of the characters used are clearly defined.	4.27	0.64	Good
11 .Examination score report motivates students more willing to learn.	4.40	0.56	Good
Total Average	4.37	0.54	Good

In Table VI, after studying, all the results of the students' satisfaction on e-learning course and MIAP teaching method are at good and very good level. This mean that the students satisfied on this learning and teaching method.

V. CONCLUSION

According to the development of e-learning course for engineering mechanics using MIAP teaching method, the results of the process efficiency and output efficiency E1/E2 are 89.31/89.00 which was greater than standard value 80/80. The success of the post-test score was also greater than pre-test score of 0.05 statistical significance. And the students' satisfaction of e-learning course using MIAP teaching method in engineering mechanics subjects was at good level ($\bar{X}$ = 4.37). Not only the lesson contents lead to understanding but also illustration partially enhance better understanding in the content. The e-learning and MIAP teaching method motivated the students more willing to learn on the engineering mechanics subject.

 DOI:10.14416/c.fte.2017.11.068

Therefore, this teaching method and e-learning course are suitable to use for engineering mechanics subjects and other engineering subjects.

ACKNOWLEDGMENT

The researchers would like to thank all the experts and students who helped and supported this project. I would like to special thanks to my parents, Thailand International Cooperation Agent (TICA) which supported me to get the graduate, my Advisor and also co-Advisor. And this research was supported by King Mongkut's University North Bangkok.

REFERENCES

[1] A. B. S. Z. G. Pandermarakis1, D. S. Passa, G. D. Mitsopoulos, *The role of engineering education laboratories at a thesis level.*

[2] K. D. e. i. g. Romanas V. Krivirtov # s al. 35, Kaunas LT- 44029, Lithuania Jonas Krivickas Kaunas Technical College Tvirtov # s al. 35, Kaunas LT- 50155, Lithuania, *Laboratory Instruction in Engineering Education*, No.2 Published in Australia, vol. Vol.11, 2007.

[3] H. Wiphasith, R. Narumol, and C. Sumalee*, A Model Developing e-Learning for M.5 English Language Teaching Using Cooperative Learning, Scaffolding and MIAP Learning Process (e-CL ScafMiap)*.

[4] Martin Ebner[1], Institute of Structural Concrete, Graz University of Technology, Andreas Holzinger[2], Institute of Medical Informatics, Statistics and Documentation (IMI), Graz University, Engelgasse 13, A-8010 GrazAustria, *E- learning in Civil Engineering: The experience applied to a lecture course in Structural Concrete.*

[5] Thithima ChuangChai and Supitcha Cheevapruk, *A Development of Electronic Media for 336269 Logistcs I,* College of Industrial Technology, King Mongkut's University of Technology North Bangkok.

[6] Lyle D. Feisel[1], Thomas J. Watson School of Engineering and Applied Science, Stats University of New York at Bingbamton, Albert J. Rosa[2], Department of Denver, *The Role of the Laboratory in Undergraduate Engineering Education*, Journal of Engineering Education, January 2005.

[7] Seven ministries, including Ministry of Education, the Central Propaganda Department, Ministry of Finance. *Several Opinions on Further Strengthening the Educational Work of the University Practice*. JSZ [2012]1.

[8] Paramaporn Suksai, *The Effectiveness and the Comparison of e-Learning Lessons Efficiency on the Principles of Digital Photography in Technology of Photography Course*, International Journal of Information and Education Technology, Vol. 6, No.8, August 2016

[9] D. Tavangarian, M. E. Leypold, K. Nolling, M. Roser, and D. Voigt, "*Is e-learning the solution for individual learning,*" Electronic Journal of e-Learning, vol.2, no. 2, pp. 273-280, 2004.

[10] M.Suwit and M. Orathai, *19 How to develop knowledge and skills, 4th ed*., Bangkok: Phappim, 2002, p. 161.

[11] W. Preyaporn, *Techniques and Methods of Vocational Education Teaching*, Bangkok: Pimdee, 2011, pp.114-118.

[12] S. Sarote, *Educational Innovation that Focus on Learner-Centered*, Bangkok: Book Point, 2003, pp. 31-32.

[13] Diana Laurillard and Patrick McAndrew, "*Virtual Teaching Tools: Bringing academics closer to the design of e-learning*," Interactive Media in Education.

[14] S. Suchat, "*Techniques and methods of Professional Teaching: MIAP"*, Bangkok: King Mongkut's University of North Bangkok, 2008.

[15] S. Sirisukbool, *Teachnique and MIAP Teaching Approach,* Bangkok, Thailand; King Mongkut's University of Technology North Bangkok Press, 1984, pp.45-47.

[16] M. Solis, A. Romero, and P. Galvin, *Teaching Structural Analysis through Design, Building, and Testing.*

[17] K. Klinbumrung[1], S. Tansriwong[2], S. Akatimagool[1], *The Development of Instructional Package on High-frequency Transmission Line Engineering using REPEA Learning Model*, [1]King Mongkut's University of Technology North Bangkok, 1518 Wongsawang, Bangsue, Bangkok 10800, [2]Chitralada Technology College, 604 Sanamsuepa, Sriayudhaya Rd., Dusit, Bangkok 10300.

Tin Zar Lat received the B.Tech Degree (Civil) from Technological University (Mawlamyine), Mon State, Myanmar in 2003. And she graduated the B.E (Civil) from West Yangon Technological University, Yangon Township, Myanmar in 2012. And she is studying M.E (Civil Engineering and Education) at Department of Teacher Training in Civil Engineering, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand. She is a lecturer at Department of Civil Engineering, Technological University (Dawei), Myanmar. Her research interests include the Structural Engineering in Civil Engineering and Education.

Sakda Katawaethwarag received the Bachelor of Engineering in Civil Engineering (First class honor, gold medal) from Rajamangala Instutite of Technology (RIT), Thailand in 1992, the Master of Engineering in Structural Engineering from Asian Institute of Technology (AIT) in 1995, and the Doctor of Engineering in Structural Engineering from Asian Institute of Technology (AIT) in 2011. He is currently an Assistant Professor at Department of Teacher Training in Civil Engineering, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand. His research interests include finite element, mechanics, and structural engineering.

Sayam Kamkhuntod received the Bachelor of Science in Technical Education (Civil Engineering) from King Mongkut's Institute of Technology North Bangkok (KMITNB), Thailand in 1999, the Master of Science in Technical Education (Technical Education Technology) from King Mongkut's Institute of Technology North Bangkok (KMITNB), Thailand in 2004 and the Doctor of Technical Education in Curriculum Research and Development from King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand in 2010. He is currently an Assistant Professor at Department of Teacher Training in Civil Engineering, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand. His research interests include Curriculum Research and Development, and civil engineering.

 DOI:10.14416/c.fte.2017.11.068