Development of Instructional Package on Engineering Mechanics LaboratoryUsing MIAP Learning Model for Technological University of Dawei

Su Mon Shwe, Anan Suebsomran
Department of Teacher Training in Mechanical Engineering, Faculty of Technical Education,
King Mongkut's University of Technology North Bangkok, 10800, Bangkok, Thailand.
E-mail: sulaysulay896@gmail.com and anan.suebsomran@gmail.com

Abstract- **This paper aims to develop the instructional package on engineering mechanics laboratory using MIAP learning model, to evaluate the quality of instructional package by experts, and to find the efficiency of instructional package. The research procedures are arranged into six main topics. Firstly, this work analyzes the two topics on engineering mechanics laboratory. Secondly, this study develops the instructional package on these topics, thereafter, creates research tools for that. Afterwards, the quality of instructional package is evaluated by experts and developed tools are tested with sampling group. Finally, this research collects and analyzes the results of sample group. The selected topic used in this research are "Shear force and bending moment in a cantilever beam" and "Deflection of curved bars" that related to the two equipment on the engineering mechanics laboratory. The sample group used to find the efficiency of instructional package was 15 undergraduate students studying in the fifth year of mechanical engineering at Technological University of Dawei in Myanmar. The research results were that the quality of instructional package on engineering mechanics laboratory was at good level and the process efficiency (E_1) and output efficiency (E_2) was higher than the criteria of 80/80. In conclusion, the instructional package on Engineering Mechanics Laboratory using MIAP learning model could effectively support both theoretical and practical lessons for the students, with their satisfaction results.**

Keywords: Instructional Package, Engineering Mechanics Laboratory, Shear force and bending moment in a cantilever beam, Deflection of curved bars, MIAP Learning Model

I. INTRODUCTION

Mechanics of materials [1] is a basic engineering subject that includes fundamental concepts such as stresses and strains, deformations and displacements, elasticity and inelasticity, strain energy, and load-carrying capacity. These subject is widely used in various fields, especially in the construction of machines and structure of all kinds. In all mechanics courses, solving problems is an important part of the learning process. For this research, the selected topics from strength of materials subject derived from mechanics of materials are "shear force and bending moment in a cantilever beam" and "Deflection of curved bars". These topics are related to the two equipment on engineering mechanics laboratory. Each content topic of this subject composes of the theory with many calculation steps that are difficult to analyze. If the students are learning only theory, they would get bored and lack of the interest on the topic. Meanwhile, the students would not be able to understand the principle of the subject very well and consequently they would be lack of experimental skills. Furthermore, students might have the problems that affect the learning achievement. There is many testing equipment for engineering mechanics laboratory at Technological University (Dawei). From the questionnaire survey results, the instructional package with a learning model which can effectively support both theoretical and practical lessons is needed for engineering mechanics laboratory at Technological University (Dawei).

Nowadays, there are many learning processes to support effectively both theoretical and practical lessons. In this paper, the development of instructional package using MIAP learning model is presented on engineering mechanics laboratory. The MIAP learning process [2] is an educational framework which is designed to improve learners' performance. The first step is to motivate an interest of the students about with learning topic by teachers. That gives a strong desire to learn. Then it provides opportunities for learners to use their knowledge in problems solving, and to achieve success in learning.

A. Research Objectives

1) To develop the instructional package on engineering mechanics laboratory using MIAP learning model for Technological University (Dawei).

2) To evaluate the quality of instructional package on engineering mechanics laboratory by experts.

3) To find the efficiency of instructional package on engineering mechanics laboratory by implementing with student sample group.

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B. Research Hypothesis

1) The quality of instructional package on engineering mechanics laboratory is at good level or higher than 3.51 score.

2) The process efficiency (E_1) and output efficiency (E_2) is higher than the criteria of 80/80.

II. LITERATURE REVIEW

In this paper, the MIAP learning model is presented and it consists of four learning steps that are the Motivation (M), Information (I), Application (A) and Progress (P) [2] as shown in Figure 1.

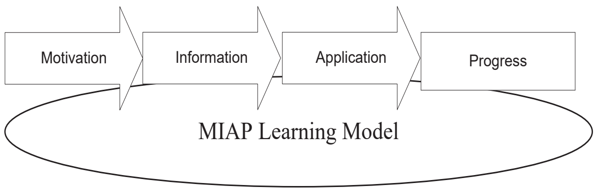

Figure 1. The MIAP learning model

The detail of MIAP learning process is following:

1) Motivation (M): The aims of this step are to encourage students to take an interest in, and solve the problem: to encourage students to want to learn and lead the students into the subject with that intention.
2) Information (I): This step is the actual delivery of the content to the students. Therefore, they will study content/information related to problems.
3) Application (A): To make sure the students have a better understanding of the content, they practice on real work/ exercise. At this stage, every student has opportunity to work by themselves. Teachers must observe, inspect, record student behavior and give student advices when necessary.
4) Progress (P): The final step is to evaluate of 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.

III. RESEARCH METHODOLOGY

The research procedure design is shown in Figure 2. The process started from the analysis of the two topics from strength of materials subject related to the two equipment on engineering mechanics laboratory. Next the instructional package was developed. Then, research tools were created and evaluated by three experts. After that, the tools were tested with the sampling group. The sampling group consists of control group and sample group. In this step, learning achievement was evaluated by comparing the average mean scores of examination sheets of the two groups. Finally, the data were collected and analyzed by the results of sample group to measure the efficiency and students' satisfaction for development of the instructional package using MIAP learning model.

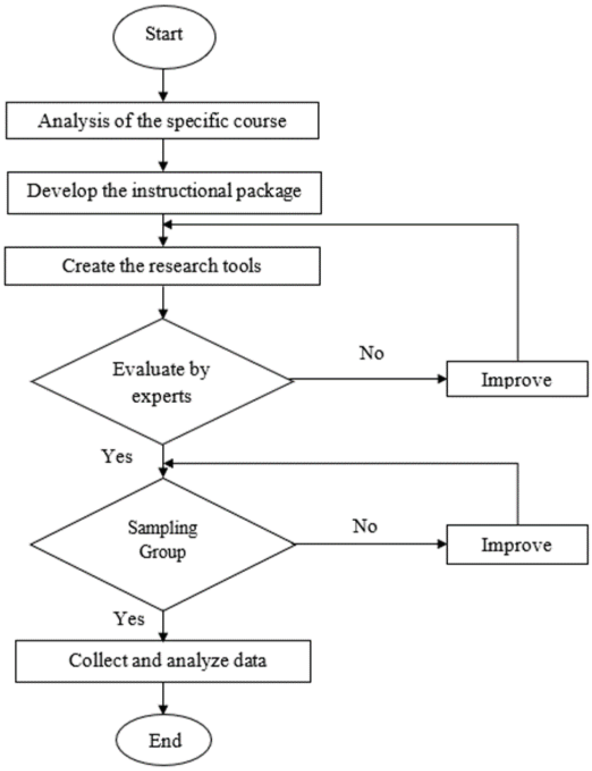

Figure 2. Research procedures

A. Analysis of the specific course

The content analysis consisted of two topics from strength of materials subject related to the two equipment on engineering mechanics laboratory in mechanical engineering at Technological University of (Dawei) as shown in Figure 3.

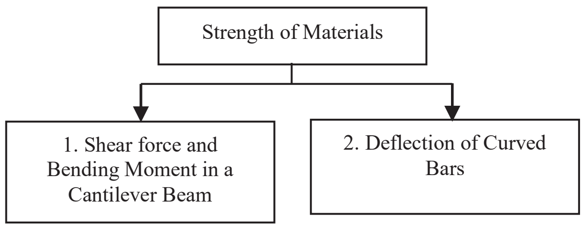

Figure 3. The content analysis on engineering mechanics laboratory

B. Development of instructional package

Instructional packages such as course description, topic listing sheet, task listing sheet, task detailing sheet, objective listing sheet, information sheet, exercise sheet,

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operation sheet, lab sheet and evaluation sheet were developed by applying the MIAP learning model.

C. Create the research tools

The developed research tools in this research contained 1) engineering mechanics equipment that were shear force and bending moment unit, and deflection of curved bars unit, 2) Lesson plans on two topics, 3) content sheets such as information sheet, exercise sheet, operation sheet, lab sheet and examination sheet, 4) Teaching media such as power point presentation and video presentation, and 5) questionnaire assessment for the students' satisfactions as shown in Figure 4.

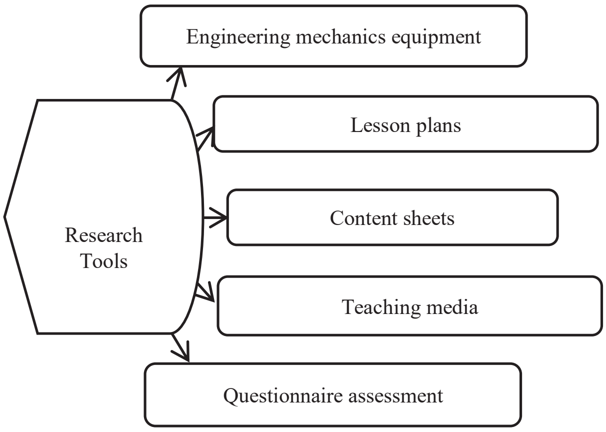

Figure 4. Research tools

D. Evaluation by experts

The quality of the developed MIAP learning model was evaluated by three experts from King Mongkut's University of Technology North Bangkok and the Technological University of Dawei. Index of item Objective Congruence (IOC) equation to estimate the examination sheets by experts was as shown in Equation (1). The accepted value must be over 0.5 whereas the criteria of score were 3 levels: +1 means that the test content is positively congruence with the objective, 0 means that it was uncertain whether the test content is congruence with the objective or determined content, and -1 means that it is positively certain that the test content is not congruence with the objective or determined content [3].

$$IOC=\sum R / N \quad (1)$$

Where, IOC is Index of item Objective Congruence between objectives and tests

$\sum R$ is Scores Summary from Experts

N is Number of Experts

E. Sampling group

Fifteen students of control group were implemented before teaching with the sample group to compare the learning achievement. Fifteen students of the sample group were employed to determine process efficiency (E_1) and output efficiency (E_2). Learning achievement after teaching by using MIAP learning model was evaluated by comparing the average mean scores of examination sheets of the two groups. All students included in the research were undergraduate students enrolling in the fifth year of mechanical engineering program at Technological University of Dawei in Myanmar.

F. Data collection and analysis

The data were collected by the exercise and examination results of sample group on two topics from strength of materials subject related to the two equipment on engineering mechanics laboratory. To find the efficiency of the instructional package, the data collected were analyzed as follows:

The efficiency of the proposed lesson plan was calculated using the E_1/E_2 criteria [4] as shown in Equation (2) and (3).

$$E_1= (x_1/N_1) \times 100 \quad (2)$$

Where, E_1 is the efficiency of the learning process (percentage of the average score obtained during the teaching)

x_1 is the average score of all students obtained from the exercises

N_1 is a total score of the exercises in the lesson

$$E_2= (x_2/N_2) \times 100 \quad (3)$$

Where, E_2 is the efficiency of the learning outcomes (percentage of the average score students obtained after the teaching)

x_2 is the average score of all students obtained from the final examination

N_2 is a total score of the final examination in the lesson

A standard level of the E_1/E_2 criteria was assigned at 80/80. Evaluation of the student satisfaction was done using mean and standard deviation through the satisfaction questionnaire with five-point Likert scale.

At the end of the teaching, students' satisfaction forms were collected by sample student group to measure their satisfaction with the instructional package using MIAP learning model. The activities in teaching and practice of students are shown in Figure 5.

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Figure 5. Activities in teaching and practice

IV. RESEARCH RESULTS

A. The results of evaluation by experts

1) The IOC evaluation results

Table I and table II show the results of IOC, which were evaluated by 3 experts. The average IOC results of two topics based on shear force and bending moment lab, and deflection of curved bars lab were higher than 0.5. It was found that the IOC results from not only content and behavioral objectives but also behavioral objectives and questions of examination sheet containing of the two topics were adequate and cover all the content.

TABLE I THE IOC RESULTS OF CONTENT AND BEHAVIORAL OBJECTIVES

		Shear Force and Bending Moment in a Cantilever Beam	Deflection of Curved Bars
Number of objectives		14	10
IOC	Total Average	0.95	0.97
	S.D.	0.12	0.11

TABLE II THE IOC RESULTS OF BEHAVIORAL OBJECTIVES AND QUESTIONS OF EXAMINATION SHEET

		Shear Force and Bending Moment in a Cantilever Beam	Deflection of Curved Bars
Number of questions		13	11
IOC	Total Average	0.95	0.88
	S.D.	0.13	0.26

2) The satisfaction of the instructional package

In this phase, the satisfaction of the quality of instructional package on engineering mechanics laboratory using this model was evaluated by experts. These assessments were presented in Table III. As mentioned in this table, the satisfaction of experts on five assessments was at a good level.

The IOC results and satisfaction of package described in table I, II and III were evaluated by 3 experts (*).

TABLE III THE SATISFACTION OF THE INSTRUCTIONAL PACKAGE BY EXPERTS

	Shear Force and Bending Moment in a Cantilever Beam			Deflection of Curved Bars		
Lists of Assessment	Avg.	S.D.	Level	Avg.	S.D.	Level
1. Lesson Plan	3.67	0.58	Good	3.67	0.58	Good
2. Lab Sheet	4.00	0	Good	4.00	0	Good
3. Information Sheet	4.00	0	Good	4.00	0	Good
4. Operation Sheet	3.67	0.58	Good	3.67	0.58	Good
5. Exercise Sheet	4.00	0	Good	4.00	0	Good
Total Average	**3.87**	**0.23**	**Good**	**3.87**	**0.23**	**Good**

Note. (*) Experts: Assoc. Prof. Dr. Sompoap Talabgaew, Ms. Chaw Wint Yee Zaw (Lecturer) and Mr. Aung Myo San Hlaing (Lecturer)

B. The learning achievement for development of instructional package with MIAP learning model

The learning achievement scores of control and sample groups were calculated by independence samples t-test. In table IV, the t-test results of the learning achievement for development of instructional package with MIAP learning model in two topics on engineering mechanics laboratory were shown. The mean of attitude of control group is not equal to the mean of attitude of sample group at 0.01 significant level. Consequently, the development of instructional package by using MIAP learning model can be applied for teaching in engineering mechanics laboratory effectively.

C. Evaluation results by sample group students

1) The efficiency of the lesson plan

The efficiency of the lesson plan in this study was examined by calculating (E_1) score during the teaching and (E_2) score after the teaching. The results revealed that the efficiency of the learning process (E_1) and learning outcome (E_2) are higher than the criteria of 80/80 as shown in Table V.

TABLE IV THE LEARNING ACHIEVEMENT FOR DEVELOPMENT OF INSTRUCTIONAL PACKAGE WITH MIAP LEARNING MODEL

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	Shear Force and Bending Moment in a cantilever beam		Deflection of curved bars	
	Control Group	Sample Group	Control Group	Sample Group
No. of students	15	15	15	15
Mean	**8.20**	**11.27**	**7.07**	**9.60**
Std. Deviation	1.207	1.580	0.961	1.056
99% Confidence Interval for mean difference	-4.492, -1.641		-3.553, -1.514	
t	-5.974		-6.873	
df	26.193		27.758	
Significant (2-tailed)	0.000 ($p \neq 0.01$)		0.000 ($p \neq 0.01$)	
statistically significant at the 0.01 level				

TABLE V THE EFFICIENCY OF THE LESSON PLAN EVALUATED BY STUDENTS

	Shear Force and Bending Moment in a Cantilever Beam	Deflection of Curved Bars
Assessment	**Percentage**	**Percentage**
(E_1) score during the teaching	90.44	95.7
(E_2) score after the teaching	86.67	87.27

2) Results of student's satisfaction

In order to assess the satisfaction of students on MIAP learning model, they were surveyed the topics described in Table VI. According to this survey, the satisfaction of students was at a high level.

TABLE VI THE EVALUATION OF SATISFACTION OF STUDENTS FOR THE MIAP LEARNING MODEL

	Shear Force and Bending Moment in a Cantilever Beam			Deflection of Curved Bars		
Assessments	**Avg.**	**S.D.**	**Level**	**Avg.**	**S.D.**	**Level**
1. Environment of Learning	4.40	0.51	Good	4.27	0.46	Good
2. Learning Activities	4.47	0.52	Good	4.60	0.51	Very Good
3. Teaching and Learning management	4.27	0.46	Good	4.40	0.51	Good
4. Instructional Package	3.80	0.41	Good	3.93	0.46	Good
Total Average	**4.23**	**0.47**	**Good**	**4.30**	**0.48**	**Good**

V. CONCLUSION AND DISCUSSION

This paper presented the development of the instructional package on Engineering Mechanics Laboratory. The teaching process applied the MIAP Learning Model. The research results and evaluation found as following:

1) The evaluation results of IOC and the satisfaction of the instructional package assessed by experts have reached high level.

2) The effectiveness of the instructional package with MIAP learning process was higher than the criteria of 80/80. Furthermore, satisfaction of students towards the teaching was also at good level.

Moreover, there is a statistically significant difference, at the 0.01 level of significance, between control and sample groups. In short, the instructional package on Engineering Mechanics Laboratory using MIAP learning model could effectively support both theoretical and practical lessons for the students.

By reviewing the obtained results described above, feedbacks from experts and students in the development of instructional package with MIAP learning model on engineering mechanics laboratory were at high level.

In addition, we got higher students' interests and enthusiasm in learning by applying the new learning model techniques. They are more active and willing to participate in classroom activities. After teaching the engineering subject with this model, the learning performance of students have enhanced. In this paper, only two topics from strength of material were tested on laboratory. Moreover, the MIAP learning model is a useful model and can also be employed as a tool for achieving the better results in teaching of variety of subjects.

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Su Mon Shwe graduated with the degree of Bachelor of Engineering (Mechanical) from West Yangon Technological University (WYTU), Yangon Region, Myanmar, in 2012. And she is a lecturer at Department of Mechanical Engineering, Technological University (Dawei), Myanmar.

Now she is studying M.S.Tech.Ed. (Mechanical Engineering) at Department of Teacher Training in Mechanical Engineering, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand. Her research interests include engineering mechanics, dynamics and fluid mechanics.

Anan Suebsomran received the B.S. degree in mechanical engineering from King Mongkut's University North Bangkok (KMUTNB), Thailand, in 1996, and received the M.Eng. and D.Eng. in mechatronics from the Asian Institute of Technology (AIT), Thailand, in 1999 and 2006, respectively. His research interests include robotics, mechatronics and controls system.

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