Development of Instructional Package on Engineering Materials Testing Laboratory Using MIAP Learning Model for Technological University of Dawei

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***Abstract*- The purposes of this research were to develop an instructional package using MIAP: Motivation, Information, Application and Progress, to evaluate the quality of instructional package by experts. Find the efficiency of students by implement with student sampling group. The sampling group consists of fifteen under-graduate mechanical engineering students at Technological University of Dawei, Myanmar. The research tools employed in the study are the following: 1) E1/E2 criteria to evaluate the learning process efficiency, 2) an effectiveness index to examine students learning effectiveness, and 3) questionnaire with five-point Likert-scale to analyze students' satisfaction. The data were analyzed using the arithmetic average, the standard deviation and t-test for independence. The result showed that the MIAP learning model is found to be appropriate (average is 4.33 and S.D is 0.84) and the quality of instructional package on engineering material testing laboratory was higher than good level of 3.51 score. The process efficiency and output efficiency E1/E2 was 88.33/81 for tensile set and 94.67/84 for impact set which were above 80/80 set criterion. It was found that the research can be used effectively in the teaching of engineering curriculum and MIAP learning model can be beneficial for engineering students.**

Keyword: **MIAP learning model, Instructional package, Engineering Materials Testing Laboratory**

I. INTRODUCTION

Mechanical engineering course established for conducting students design and implementation of the mechanical machine and system. The specific knowledge and skill for design the mechanical parts are based on the properties of materials that students learn in strength of materials subject at Technological University of Dawei. The strength of material subject is constructed in the curriculum for learning material behavioral and mechanical properties. Material of mechanical properties are very important and some of material testing laboratory are tensile testing lab [1]: tensile strength, yield strength, ultimate tensile strength and fracture and also impact testing lab [2]: the energy absorbed of material. However, the general teaching methods are limited to teach on the engineering curriculum. Because, engineering students required specific knowledge and skill to apply in the real working. Therefore, the good teaching method, teaching plan and teaching media can improve the quality of student [3]. As the questionnaire survey results, the lecturers and demonstrators at T.U (Dawei) are required the effectiveness of learning model and teaching documents material package. In this paper, the research was seen as important part in the development of teaching model for the university. And that, the lecturers and demonstrators not only teach for the effectiveness of teaching but also use to demonstrate and operate of related with the theory and practical in the class. The students can operate the experiment testing machines in the laboratory.

In this paper, therefore this research was conducted with the objectives to develop instructional package on engineering materials testing laboratory using MIAP learning model. The developed instructional package consists of lesson plan, information sheet, operation sheet, lab sheet, exercise sheet, examination sheet and evaluation sheet, using the MIAP learning model [4]. Main objectives of this research are as follows:

1) Construct the instructional package of Tensile testing lab and Impact testing lab for the subject of Strength of Materials.
2) Evaluate the quality of instructional package and MIAP teaching method by experts.
3) Find the students' satisfactions (through) instructional package and MIAP teaching method.
4) Efficiency of instructional package for the process efficiency (E1) and the output efficiency (E2).
5) Compare learning outcomes between control group and sampling group.

II. LITERATURE REVIEW

The learning package design [5] was an effective instructional plan requires systematic planning to be taken into critical issues which may be referred to as elements of instructional designs. Instructional package design is the practice of creating instructional experiences which make the acquisition of knowledge and skill more efficient, effective and appealing. Engineering instructional package consists of: 1) Lesson plan, 2) Information sheet, 3) Operation sheet, 4) Lab sheet, 5)

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Exercise sheet, and 6) Evaluation sheet [5]. This designed instructional package can also be referred to as the systematical process to planning and validating instruction, a good package design should run from the preparatory level to the evaluation level.

The process used during development of instructional package was based on the ADDIE model [6], deriving its name from the five constituent phases: Analysis, Design, Develop, Implement, and Evaluate. The five main elements of ADDIE are found in Instructional Systems Development (ISD) models for instructional design. The five phases together also represent a dynamic, flexible guideline for building effective training and performance support tools as shown in Figure-3.1.

MIAP teaching approach [7] is a process experiential learning that is operated by teachers through these four steps: 1) Motivation 2) Information 3) Application and 4) Progress. The aim is to enable learners to acquire knowledge and skills in accordance with the set course objectives and improve their professional competency. MIAP is an appropriate for professional activity management in teaching and learning processes. The MIAP learning process refers to a four-step process based on the principles of education experience. The learning model includes four steps can express as follows: [8]

1) Motivation (M): The aims of this step are to encourage students to make an interest in, and solve the problem: to encourage students to want to learn and lead the students into the subject with that intention. The intention and motivation should be maintained throughout the lesson to keep the students engaged, and therefore, improve knowledge 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 understanding 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) Process (P): The final step is to monitor and 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.

MIAP can improve achievements of the learners and they are highly satisfied with their learning as well. This learning model of MIAP based on student-centered learning can be developed in teaching that learners have participation in the classroom and their learning effectiveness is the best.

III. RESEARCH METHODOLOGY

This research is an experimental research as shown the main research process in Figure-3.1. This procedure followed seven steps. First, the student groups were classified for sampling and control groups. Course description analysis was done and subject was selected Strength of Material by the mechanical engineering curriculum. This research created the research tools, and it included the evaluation of appropriate forms of teaching. The questionnaires were also used to determine the quality of teaching package. After that, expert will evaluate the quality of teaching package design. Next, the learning outcomes of control group and sampling group were compared. Implement the data assessments is select the sampling students to apply teaching package with MIAP learning model and find the process efficiency and output efficiency [8]. Data analysis and conclusion is concluded all of documents and work done for research objectives.

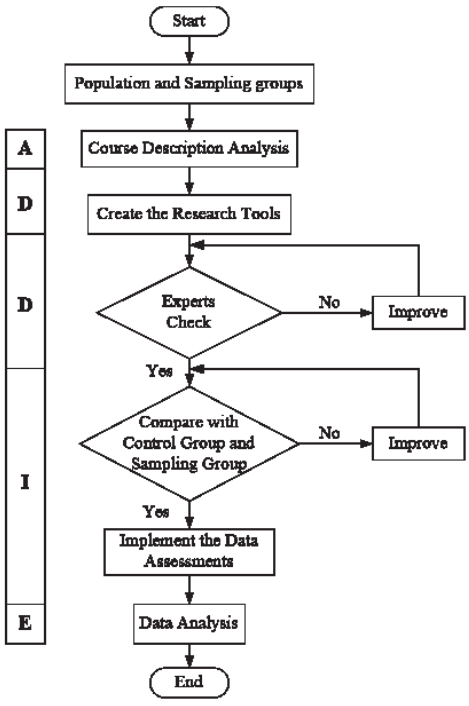

Figure-3.1 Research Methodology

This research is to study the learning achievement of students using MIAP learning. Therefore, this research was done by the following steps:

A. Determination of population and sampling group

The population was undergraduate students of Mechanical Engineering, Department of Mechanical Engineering, and Technological University of Dawei.

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The student groups were classified by purposive sampling method as follows:

a) 15 students of control group (T.U, Dawei) was compare to compare with sampling group for the learning outcomes of examination sheet.

b) 15 students of sampling group (T.U, Dawei) was to determine process efficiency (E1) and output efficiency (E2)

B. Course description analysis

Course description analysis of the specific subject is Strength of Material subject (ME-31014) of Mechanical Engineering curriculum, Department of Mechanical Engineering at Technological University of Dawei.

C. Create the research tools

Research tools as shown in Figure-3.2 consist of questionnaire, instructional package, power-point presentation and learning test are measured of students' efficiency. [3] Evaluation of appropriate forms of teaching were checked by experts and questionnaire about the study was completed by the students.

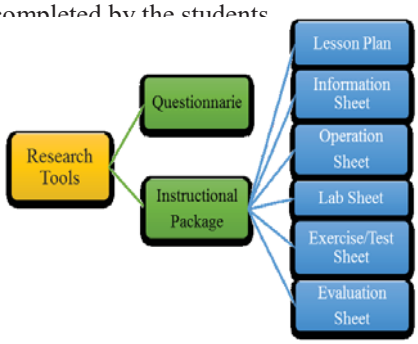

Figure-3.2 Research Tools

1) *Lesson plan* is developed from the behavioral objectives of instructional package on engineering material testing laboratory as shown in Figure-3.3. The teaching focused on learning participation and activities in the classroom by following from activity plan. Anurak Mekpayom [3] conducted that lesson plan consists of competence list, job analysis, theory behavioral objective and practical behavioral objective.

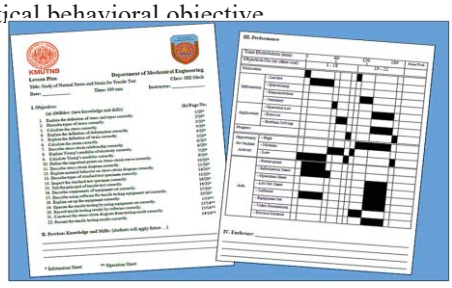

Figure-3.3 Lesson Plans

2) *Information sheet* is a document [3] that defined information or content, detail of distinctly information with pictures and sort information in order to cover the learning objectives and generate student's knowledge. The information sheet comprised two sub-topics are tensile testing lab and impact testing lab as shown in Figure-3.4.

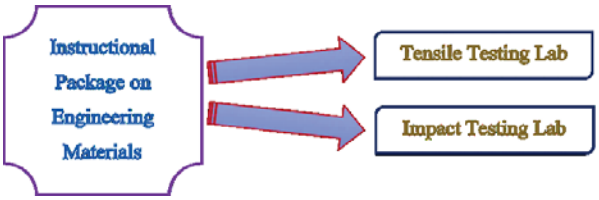

Figure-3.4 Topic of instructional package on engineering material testing laboratory

3) *Operation sheet* is document [3] that show how students can do each steps of operation for the job, as shown in Figure-3.5. It composes of: 1) Step of operation and picture, 2) Description of operate/do this step, 3) Tools/material using for this step, and 4) Caution or technique to think this step.

Figure-3.5 Example of Operation sheets for teaching

4) *Lab sheet* is designed as shown in Figure-3.6 in order to specify a job for students. The objective of such test was to evaluate students' skill while they work [3]. Lab sheet has two main functions: 1) help teachers be able to assign order job for many students at the same time and to make the assignment job clear, 2) help students to be able to repeat assignment job by themselves when they have any doubt.

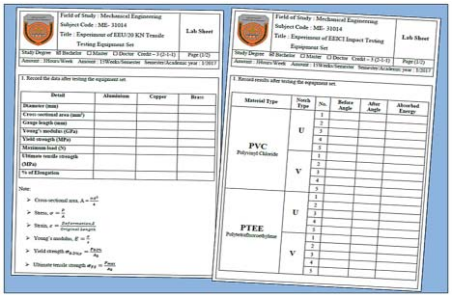

Figure-3.6 Example of Lab sheets for teaching

5) *Exercise/Test sheet* is a document [3] for learning to measure and it consists of attitude test, achievement test, exercise sheet and examination sheet, as shown in Figure-3.7.

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Figure-3.7 Example of Exercise sheets for teaching

6) *Evaluation sheet* is a document for note student's working behavior in field of: 1) capacity, proficiency, 2) work-quality, and 3) work habits. For evaluating student's working skill.

D. Statistical Analysis

1) Index of item objecting congruence (IOC)

The examination sheet was evaluated by 3 experts to find Index of item Objective Congruence (IOC) value. 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 as shown in formula (1) [9]:

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

Where:

- IOC is index of item objective congruence between objectives and tests.
- Σ R is score summary from experts.
- N is number of experts.

2) Process Efficiency (E1) and Output Efficiency (E2) Assessments evaluated by 3 experts

The analysis of collect data was done statistically using several models described as follows:

The efficiency of the proposed lesson plan was calculated using the E1/ E2 criteria [10-11], where E1 is a percentage of the average score students obtained during the instruction (exercises) and E2 is calculated the final result (examination). Calculation of the E1/ E2 efficiency is described in equations (2) and (3) as follow:

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

Where:

- E_1 is the efficiency of the learning process.
- x_1 is the average score of all the students obtained from the exercises.
- N_1 is the total score of the exercises in the lesson.

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

Where:

- E_2 is the efficiency of the learning outcomes.
- x_2 is the average score of all the students obtained from the examination.
- N_2 is the total score of the examination in the lesson.

3) Students' satisfactions of teaching instructional package and MIAP teaching method

The experimental research based on the instructional package using MIAP learning model was implemented by sampling group at T.U (Dawei). After teaching in the classroom with MIAP learning model, the students' satisfaction was evaluated [5]. The instructional package was used to analyze statistically and evaluate the opinion of satisfaction. The rating scale of 5 levels was used to find the average and standard deviation. The activities and learning are shown in Figure-3.8.

Figure-3.8 Activities in learning and teaching

IV. RESEARCH RESULTS

The development of instructional package using MIAP learning model based on creative thinking competency and efficiency of students [5], the research result in this paper comprised objectives are as follows:

1. Construction of instructional package

The suitability of the development of instructional package using MIAP learning model as shown in Table I and Table II.

The result of Table I showed that the behavioral objectives of tensile set and impact set were divided into knowledge and skill domains. The result found that the confirmed behavioral objectives are good and match with subject. Knowledge domain and skill domain are assigned

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for various level to enhance learning outcome which evaluated by 3 experts. After evaluated, the average score of all of behavioral objectives in tensile set and impact set were higher than 0.5 average score.

The result of the evaluation showed that the package was designed and constructed according to its objectives and can use for this design and construction of teaching package.

TABLE-I The result of IOC for Behavioral Objectives from 3 expects

Package	Domain	Number of Objective	IOC	
			Average	S.D.
Tensile Set	1. Knowledge 2. Skill	15 7	0.93 0.86	0.12 0.25
Impact Set	1. Knowledge 2. Skill	10 4	0.97 0.92	0.06 0.15

The result of Table II showed that the questions of examination for tensile set and impact set were divided into knowledge and skill domains. In tensile set, knowledge domain was 15 objectives consist of information for six topics, exercise for four sections. And that, skill domain was 8 objectives consist of operation and lab sheet for three labs. In impact set, knowledge domain was 11 objectives consist of information for six topics, exercise for four sections. And also, skill domain was 4 objectives consist of operation and lab sheet for four labs. After evaluated, the average score of all questions of examinations in tensile set and impact set were higher than 0.5 average score. Therefore, this result can use for examination sheet.

TABLE-II The result of IOC for Questions of Examination from 3 experts

Package	Domain	Number of Objective	IOC	
			Average	S.D.
Tensile Set	1. Knowledge 2. Skill	15 8	0.77 0.88	0.42 0.28
Impact Set	1. Knowledge 2. Skill	11 4	0.84 0.82	0.37 0.34

2. Evaluation the quality of instructional package and MIAP teaching method by Experts

The quality of instructional package consists of lesson plan, information sheet, operation sheet, lab sheet and exercise sheet for MIAP teaching method are presented in Figure-4.1[5]. The result of the evaluation showed that instructional package was very good level with average score 4.67 (S.D. = 0.58) and the others issues are in good level in average score range 4.00 – 4.33 (S.D. = 0.58 – 1.15). The result showed that the quality of teaching package was a good level (mean average equal to 4.33).

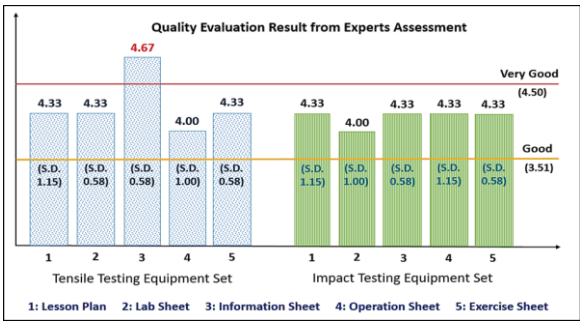

Figure-4.1 Quality evaluation result from Experts

3. Students' satisfactions of instructional package and MIAP teaching method

The students' satisfactions of teaching instructional package consist of environment of learning, learning activities, teaching and learning management, instructional package for MIAP teaching method are presented in Figure-4.2 [5].

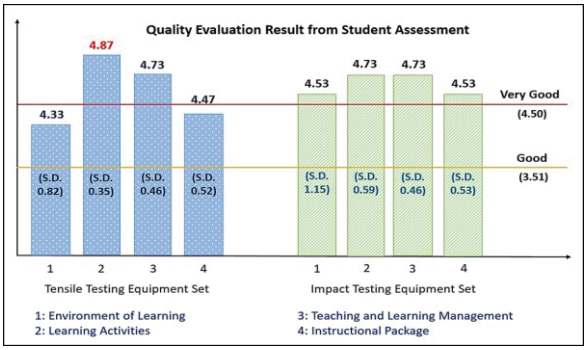

Figure-4.2 Quality evaluation result from Student

The satisfactions of teaching instructional package and MIAP teaching method was evaluated by sampling group. The students were satisfied to learn and taught by MIAP learning model at a very good level with average score 4.87 (S.D.= 0.35) and the others issues are in very good level in average score range 4.53 – 4.73 (S.D. = 0.53 – 0.46).

4. Efficiency of instructional package for the process efficiency (E1) and the output efficiency (E2)

The result of the efficiency of instructional package for the process efficiency (E1) and the output efficiency (E2) are presented in Table III. The result of Table III showed that process efficiency and output efficiency E1/E2 was 88.33/81.00 for tensile set and 94.67/84.00 for impact set which were above 80/80 set criterion. It was found that the research can be used effectively in the teaching of engineering curriculum and MIAP learning model can be used for engineering students.

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TABLE III Efficiency of the learning process

Package	E1/E2	Total Score	Total Average	Efficiency
Tensile Set	Exercise	40	35.33	88.33
	Examination	23	19	81.00
Impact Set	Exercise	30	28.4	94.67
	Examination	15	13	84.00

5. Compare the learning outcomes between control group and sampling group

The implementation of instructional package using MIAP learning model has been used in the teaching of engineering material testing laboratory topic, Strength of Materials subject, for each control group and sampling group [3].

Table IV showed that the scores measured learning outcomes of control group and sampling group for tensile set and impact set by evaluated the statistical t-test for independence with significance at the 0.05 level.

TABLE IV Compare mean difference between the learning outcomes of Control group and Sampling group

t-Test: Paired Two Sample for Means				
	Tensile Set		Impact Set	
	Control Group	Sampling Group	Control Group	Sampling Group
No. of students	15	15	15	15
Mean	**9.20**	**10.93**	**9.07**	**12.53**
Variance	1.45714	3.638095	0.20952	0.40952
t Stat	-4.24983		-	4
P (T<=t) two-tail	0.00081		20.98061	
t Critical two-tail	2.14479		$5.615E^{-12}$	
			2.14478	
t-test	** with significance at the 0.05 level			

As a result, t-test was not equal t-critical two-tail, this means that sampling group score was not equal control group score. The score of control group presented that the average means are 9.20 for tensile set and 9.07 for impact set. After studied with MIAP learning model, the score of sampling group showed that the average means are 10.93 for tensile set and 12.53 for impact set. The result showed that the average mean score of the sampling group is higher than the control group. This means that the learning achievement of students who learned from instructional package on engineering materials testing laboratory using MIAP learning model increased at a high level.

V. CONCLUSION AND DISCUSSION

This research presents the development of integrated learning model focused on the student-centered learning method [7]. The implementation of instructional package used MIAP learning model for studying on engineering materials testing laboratory, Strength of Materials subject.

The suitability of the development of instructional package using MIAP learning model evaluated by 3 experts was found at a good level. The result of the evaluation show that the appropriation of the objectives and MIAP learning model can be used effectively as a teaching model.

The quality of teaching instructional package assessed by 3 experts was at a good level. The students' satisfactions of instructional package consist of environment of learning, learning activities, teaching and learning management, instructional package for MIAP teaching method evaluated by students was also at a very good level. They gained knowledge and skill from the teaching processes.

The result of the efficiency of teaching instructional package for the process efficiency (E1) and the output efficiency (E2) are presented that efficiency was 88.33/81.00 for tensile set and 94.67/84.00 for impact set which were above 80/80 set criterion. The scores measured learning outcomes of control group and sampling group for tensile set and impact set by evaluated the statistical t-test for independence with significance at the 0.05 level. The result showed that the average mean score of the sampling group was higher than the control group. This means that satisfaction of the students towards the instructional package with MIAP was at a good level.

In conclusion, from all of above results, the development of instructional package on engineering materials testing laboratory using MIAP learning model can be successfully used to teach for engineering students, especially in Technological University of Dawei.

For future research, next step we will bring this model to develop e-learning or e-book for independent learning.

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