Effectiveness of Implementing Instructional Module for Engine Performance to Improve Skill Competency

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ABSTRAK

The study aims to determine the effectiveness of the application of Instructional Module Engine Performance to improve student skill competencies. The study used a quasi-experimental research approach. The research subjects were students of the Mechanical Engineering Department of the Automotive Education Study Program, Faculty of Engineering, State University of Semarang who programmed the Engine Performance Practice course. Data were collected using test instruments to students, by giving pretest and posttest using Instructional Module engine performance. Effectiveness is measured based on n-Gain test results analyzed by t-test. The results of student performance tests using the Chassis Dynamometer test equipment that has used the Instructional Module engine performance show satisfactory results so it can be concluded that the Instructional Module engine performance is effectively used in the teaching and learning process. This is because students follow carefully during the learning process using the Instructional Module engine performance so that students understand well about engine power and torque and are able to operate the Chassis Dynamometer test equipment in accordance with the Standard operational procedure (SOP).

Keywords: *Instructional Module, Dynamometer, Engine Performance practice, Competency Skills.*

1. INTRODUCTION

The development of increasingly sophisticated technology affects the way teaching and learning in education. Practical learning, which involves laboratory space, also requires innovation to make it easier for students and increase their motivation in achieving planned competencies. Lecturers as educators have the responsibility to encourage and motivate students to improve their knowledge and skills, as well as develop a spirit of innovation, creative and critical thinking in everyday life. However, all of that cannot be achieved if lecturers still use conventional learning methods without applying innovative learning models, methods, and strategies. Therefore, lecturers also need to be innovative, creative, and insightful, and create a pleasant learning atmosphere in the classroom and learning environment to encourage teaching and learning interactions from various directions.

Supporting factors in the teaching and learning process include media and teaching materials [1]. Teaching materials or subject matter is a key element in learning and becomes the core of learning activities. This also applies to practicum learning, where the learning involves laboratory space in addition to the classroom. Therefore, innovations in teaching and learning are needed to facilitate students, increase their enthusiasm and motivation in achieving competencies in accordance with the planned learning objectives.

Competence is the ability possessed by individuals to adapt to various work situations. Learners need these competencies to do the job [2]. Competency describes what a person does at work at a particular level. It involves identifying the characteristics of knowledge and skills needed by individuals to carry out tasks and responsibilities effectively, thus achieving professional quality standards in their work.

The engine performance testing course in the Automotive Engineering Education Study Program is one of the face-to-face and practicum courses held in the laboratory. Practical learning of engine performance testing uses a Chassis Dynamometer in the performance testing laboratory, which has good structure and planning. In engine performance testing, there are steps that must be followed according to procedures to ensure the success of the test and prevent damage to the testing equipment. However, in its implementation, there is a major problem, namely the lack of supervision and control from the manager, which results in a slow

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practicum process and non-compliance with the predetermined time allocation. This hinders the achievement of competencies that should be mastered by students within the specified time.

Competence can be influenced by several factors, one of which is the condition of the work environment, in this case the work laboratory. The achievement of these competencies is related to the suitability and availability of practical laboratory facilities (equipment, materials, and space) whose numbers and conditions are always changing (increasing or decreasing) to the practical needs of students. Therefore, it is expected that the workplace or student practice laboratory must be in accordance with established laboratory standards.

Based on observations and experiences in the field, there are findings that the process of practical activities in the laboratory is not running effectively. The reason is the lack of process standards, facilities, and infrastructure needed for the implementation of practical learning in the performance testing laboratory. Students also do not have relevant guidelines in the testing process because there are no procedures or guidelines for the use and operation of equipment in the laboratory. In addition, the existing Engine Performance testing laboratory in the Department has not been optimally utilized to form student competencies. The lack of standard facilities, infrastructure, and instructions for the use of equipment for the Engine Performance testing laboratory causes students to be less competent in the practicum process. Students' lack of understanding of the practical work process of Engine Performance using a Dynamometer is also a contributing factor to the problem.

The principle in learning objectives is for students to successfully master the competencies that have been set. The learning system using module facilities is one of the efforts to assist students in achieving competence, because given that the abilities possessed by each student in one class vary both from the level of intelligence, talent and learning speed. Success in learning is influenced by the use of learning resources or media used during the learning process. Thus the need for teaching materials in the form of modules in the learning process. Modules are teaching materials that are systematically designed based on the curriculum and packaged in the form of the smallest learning units and allow independent study in a certain unit of time so that students master the competencies taught[3]. Learning systems with module facilities have been developed both outside and inside the country, known as the Module Learning System (SBB). SBB has been developed in various forms with various names, such as Individualized Study System, Self-paced study course, and Keller plan, each of which uses different learning activity planning but has the same objectives, namely: (1) shorten the time needed by students to master the lesson task; (2) provide as much time as needed by students within the limits of what is possible to organize a regular education.

One of the benefits of the module is that it can improve student-centered thinking skills so that it can encourage students to actively participate in constructing knowledge, be able to overcome learning problems such as lack of interest, concentration, skills in critical and creative thinking. Furthermore, the results of research by Rahmawati, et al. [4] showed that based on the average learning outcomes of students who used modules were higher than students who did not use modules so that modules had a positive impact on learning outcomes. Learning modules have several benefits, including helping to achieve basic learning objectives, developing higher cognitive skills for learners [5].

Based on this, to improve student understanding in learning the practice of Engine Performance using a Dynamometer, it is deemed necessary to develop and implement an Instructional Module. It is intended that students have a clear guide or work guidelines in the Engine Performance course, can gain a better understanding of the Engine Performance material, procedures/work steps, and can carry out practice optimally. The purpose of implementing this Instructional Module is so that students can achieve and master the competencies that have been set within one semester. With the available guidelines, it is expected that students' understanding and skills in the practice of Engine Performance can be improved effectively.

2. LITERATURE REVIEW

A module is a teaching material designed to enable independent or group learning. This module is equipped with an evaluation of the learning material [6]. Learning modules are a series of systematic curriculum-based learning activities that are tailored to the competencies to be achieved [7]. Module is a tool or means of learning that contains material, methods, limitations, and ways to evaluate which are systematically designed and attractive to achieve the expected competencies according to the level of complexity [8]. Modules are teaching materials that have a use in improving the quality of learning. Modules are specifically designed according to the problems encountered in learning, so that they can provide effective solutions and assistance to students [9]. Modules aim to clarify messages, overcome time and space limitations, use various learning methods, increase learning motivation, allow interaction with the environment and learning resources, facilitate independent learning, and provide opportunities for students to evaluate their own learning outcomes [10].

Dynamometer is a tool used to determine the performance of a vehicle by measuring power and torque. According to the way of measurement, the dynamometer can be divided into two types, namely Engine Dynamometer (ED) and Chassis Dynamometer (CD). The measurement method with the (ED) type dynamometer is that the engine output shaft is connected directly to the dynamometer, while for the CD type, the power measurement is carried out through the vehicle drive wheels. The Chassis Dynamometer is used to measure engine output during acceleration and wheel power in steady-state operation at full load. These values are used to calculate the overall transmission efficiency for front- and rear-wheel drive vehicles [11]. evaluation of emission control technologies [12]

The ability of a combustion motor engine to convert incoming energy, namely fuel, to produce useful power is called engine capability or engine performance. The performance testing steps taken must be in accordance with the procedure. The steps must be carried out according to the procedure so that during the test no errors occur that cause the test to be unsuccessful or can cause damage to the testing equipment. The steps according to the procedure are (1) Preparing tools and materials according to the test procedure, (2) Placing the vehicle on a roller dynamometer, (3) Installing a strap to the back of the vehicle as a safety, (4) Installing an oil temperature cable, (5) Installing a mass cable from the dynamometer to the vehicle body, the mass cable can also be connected to the negative terminal of the battery, (6) Turning on the dynamometer by turning the switch on the dynamometer, (7) Turn on the computer that has been connected to the dynamometer, (8) Make adjustments to the movement of the vehicle wheels with a roller dynamometer, (9) Prepare the blower as a wind simulation, cool the temperature and cool the engine when the engine test becomes hot, (10) Ensure that the fuel condition is sufficient, (11) Open the LPS 3000 software on the computer, (12) Perform constant speed test, (13) Fill in the vehicle data that will be tested, (14) Select the new driving trial option, (15) Perform running test.

3. RESEARCH METHODS

This research uses a quantitative approach with experimental methods. The experimental method aims to see the effect of two or more variables. This research uses the Quasi-experimental Design. This quasi-experimental method has a control group so that it cannot function fully to control external variables that affect the implementation of the experiment. This approach aims to determine the effect of module application on student learning outcomes in the Engine Performance Practices course. The intended subjects were 20 students in the 6th semester of the Mechanical Engineering Department of Automotive Education Concentration, FT Unnes. The research design is shown in Figure 1.

O1	X	O2
O1		O2

Figure 1. Research design

In Figure 1, two groups are shown, namely the experimental group and the control group. O1 is the pretest and O2 is the post test, while X is the treatment applied in learning, namely the use of Instructional Module. The experimental group is given treatment in the form of Instructional Module while the control group uses conventional methods.

The data collection technique used in this research is the test technique. The tests given in this study are in the form of theory and performance tests to test engine performance using a Dynamometer tool. The test is used to collect data related to the ability of students before and after using the Instructional Module The test is carried out with the aim of knowing the extent of the effectiveness of the Instructional Module.

The instruments in this study used the Instructional Module of Engine Performance practice and test instruments. Before the research was conducted, the instrument was tested first then the results were tested using the instrument prerequisite test using the test content validity test.

The data analysis used is an inferential statistical analysis technique that aims to test the effectiveness of the product, namely the Instructional Module by calculating the difference in the average scores of different pretests and posttests between two different groups, namely the control and experimental groups through the t test. The analysis was carried out using the help of SPSS 20 for windows using a significance level of 0.05 (5%).

Before testing with the t test analysis technique, the prerequisite analysis must first be carried out to determine whether the data analysis for testing can be continued or not. In addition, it is also to fulfill the basic assumption that the data must be normally distributed. The data that has been collected is tested for normality.

The normality test is carried out to determine whether the data distribution of each variable is normally distributed or not. The normality test was carried out using the Kolmogorov Smirnov technique through SPSS 20 for windows assistance. The distribution of a research variable is said to follow a normal curve if the probability value is greater than 0.05, and vice versa if the probability is less than 0.05 it is declared abnormal.

4. RESULTS AND DISCUSSION

Based on the results of research data processing regarding the effectiveness of the product, namely the Instructional Module for Machine Performance practice in learning Machine Performance practice courses, the data is then described as follows:

4.1. Test of Average Pretest Score

Table 1. Test of difference in pretest mean score between control group and experimental group.

Group	N	Mean	SD	Mean Difference	t-test	P	Interpretation
Control Group	10	62.00	7.14	-1.500	-0.709	0.496	No difference
Experiment Group	10	63.50	7.47				

Table 2. Test of differences in posttest mean scores between control group and experimental group.

Group	N	Mean	SD	Mean Difference	t-test	P	Interpretation
Control Group	10	71.00	5.67	-14.500	-6.692	0.000	There is a difference
Experiment Group	10	85.50	2.83				

Based on the presentation of table 1, the average score of the pretest of the control group and the experimental group is -1.50 with a p value = 0.496 which is greater than the 0.05 significance level. This means that there is no significant difference between the learning ability of students before learning the control group and the experimental group.

Based on the presentation of table 1, the average score of the pretest of the control group and the experimental group is -1.50 with a p value = 0.496 which is greater than the 0.05 significance level. This means that there is no significant difference between the learning ability of students before learning the control group and the experimental group.

The results of this study show that student scores between the two groups both have relatively low scores. This is because the knowledge possessed by students is only in the form of basic concepts.

4.2. Test of Average Posttest Score

Based on the presentation of table 2 illustrates the average posttest value of the control group and the experimental group of -14.50 with a p value of 0.000. When compared to the significance value of 0.05, the p value shows the results of a significant difference between the control group and the experimental group.

In addition, based on the calculated t value of -6.692 greater than the calculated t value of -2.22 using a two-party test, it shows that there is a difference in the value of learning outcomes between the control group using conventional methods and the experimental group using the performance engine instructional module. This shows that there is an increase in the ability and performance of students after learning so that it can indicate that the use of engine performance instructional modules in teaching chassis dynamometer courses is a better teaching method.

4.3. Normality Test Results

Based on the results of the normality test conducted with the Kolmogorov Smirnov technique through the help of SPSS 20 for windows, the following results were obtained.

Based on table 3 above, the probability value of the experimental group of 0.198 and the control group of 0.78 is greater than 0.98. The results of the analysis can be concluded that each data is normally distributed

Table 3. Normality test results.

		Shapiro-Wilk		
	Class	Statistic	df	Sig.
NGain_Percent	Experiment	.861	10	**.078**
	Control	.880	10	**.098**

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4.4. Mean Gain Score

Table 4. T-test of mean gain score between control group and experimental group.

		Levene's Test for Equality of Variances		**t-test for Equality of Means**			
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**
NGain_Percent	Equal variances assumed	.001	**.975**	**-8.63**	18	**.000**	-36.06
	Equal variances not assumed			-8.63	17.39	.000	-36.06

Based on table 4 above, it is known that the significance value in Levene's Test for Equality of Variances is 0.975> 0.05 which indicates that the variance of N-Gain (%) data for experimental and control classes is the same or homogeneous.

Based on the Independent Samples Test output table above, it is known that the significance value is 0.000 <0.05, which indicates that there is a significant difference in effectiveness between classes that use the performance engine instructional module and conventional classes. Thus it is known that the use of the performance engine instructional module as teaching material is an effective teaching method and is able to improve student skill competencies in the engine performance testing course.

Based on the results of the research results that have been carried out illustrating the posttest values of the control and experimental groups have a calculated t value clearly shows that there is a significant difference in student performance which emphasizes that the use of engine performance instructional modules in teaching the engine performance testing course is a better teaching method.

This can be seen from the increase in understanding and competence of students' expertise in engine performance courses after using instructional modules. This is because students follow carefully during the learning process using the instructional module so that students understand well about engine power and torque and are able to operate the Chassis Dynamometer test equipment in accordance with the SOP. The results of student performance tests using the Chassis Dynamometer test equipment that has used the instructional module show satisfactory results so it can be concluded that the instructional module is effectively used in the teaching and learning process.

Module is a delivery system in the development of an educational system that provides benefits in improving the efficiency, relevance, and effectiveness of learning. By using modules, educators can facilitate learning that is structured, relevant, and empowers students to learn independently

The effectiveness of modules lies in their ability to facilitate independent and student-centered learning. Modules allow students to learn independently, adjust their learning pace, and get timely feedback. Thus, students can develop lifelong learning skills and gain a deeper understanding of the material studied.

In line with the results of the above research, research conducted by Puspitasari shows results where the use of printed modules is effective to be applied in supporting 21st century skills such as problem solving skills, critical thinking and creative thinking. In addition, printed modules can also be effective for improving student learning outcomes [10]. The results of this study are supported by the results of Alvien's research, showing that using the Engineering Drawing module the average student score increased higher. This data shows that the use of Engineering Drawing modules in the learning process effectively improves student learning outcomes [13]. The results of this study synergize with the results of Arfin's research, revealing that the use of learning modules is effective to be used as a learning resource in the learning process as seen in the results of the module effectiveness test that has been carried out based on student learning outcomes and shows an effective category [14]. This is also in line with the results of Pramita's research which found that the applied learning module has effectiveness in improving students' analytical thinking skills. This module not only affects analytical thinking skills, but also students' reading motivation and the interaction between the two [15].

In line with the results of Julius' research, he concluded that the use of modules is an effective learning approach. This can be seen from the learning outcomes of two groups using two different teaching methods, but the group taught using learning modules is significantly better than the group taught with the traditional lecture method [16]. Likewise, the results of research conducted by Sadiq found that teaching using modules is more effective in the teaching and learning process compared to teaching with conventional methods because in using modules, students are able to learn at their own pace independently [17].

5. CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that:

a. There is no significant difference between the mean pretest score of the course presented by the lecture method and the mean pretest score of the course using the performance engine instructional module.

b. There is a significant difference between the mean value of the posttest of the course presented with the traditional lecture method and the mean value of the posttest of the course taught using the performance engine instructional module.

c. There is a significant difference between the mean gain score of the two groups of respondents, namely the experimental and control groups. The experimental group taught using the module was significantly more competent than the control group taught using the conventional lecture method.

In connection with the above conclusions, several suggestions can be made, among others:

a. a. This research proves that using modules as learning guidelines is a more effective approach to teaching students of the Mechanical Engineering Department of Automotive Education Concentration. This method can be widely applied to other fields and courses because this approach has the ability to meet the diversified learning needs of students, especially in practical courses.

b. Teaching using learning modules is a more directed way of teaching so lecturers must be given sufficient training on how to design and implement instructional modules in the laboratory.

AUTHOR'S CONTRIBUTION

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