Development of Water Turbine Trainers in Energy Conversion Machinery Courses

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ABSTRACT

Most energy conversion machine courses are carried out with the delivery of theory, discussion, and field observations. Therefore, it is necessary to utilize technology that has been developed by applying it to a learning media to support understanding in the energy conversion machine course. A trainer unit in the form of a laboratory-scale Pelton turbine has been designed and built to meet the needs of energy conversion machine learning media. With the existence of unit trainers equipped with modules, it is hoped that they can provide real experience in learning. So that students can understand the concept of energy conversion machines more easily and carry out learning more effectively, interestingly, and efficiently. Developing a Pelton turbine trainer uses the Research and Development (R&D) model. Research procedures carried out in the development of module model textbooks include: (1) the pre-development stage, (2) initial product development, and (3) product application. Product trials were carried out in small groups and large groups. The data collection technique was carried out using a questionnaire. Followed by validity and reliability tests. The data obtained were then analyzed using descriptive analysis techniques, which were presented in the distribution of scores and percentages for the predetermined assessment categories. Based on the results of the research that has been carried out, the following results are obtained: (1) The trainer unit developed is in accordance with the needs as a learning medium in the Energy Conversion Machinery course, and (2) The Pelton turbine trainer unit is valid and suitable for use in the Mechanical Engineering course.

Keywords: *Learning Media, Water Turbine Trainer, Energy Conversion Machine.*

1. INTRODUCTION

In Indonesia, there are several levels of education, one of which is higher education. Law of the Republic of Indonesia Number 2 of 1989 concerning the National Education System Article 16 paragraph 1 states that higher education is a continuation of secondary education, which is carried out to prepare students to become a society with academic and professional abilities who can apply, develop and create science, technology and arts [1].

In realizing these educational goals, many obstacles must be faced, including the lack of use and application of technology in the learning process [2]. So far, learning has been mostly done by means of lectures and discussions without using instructional media [3][4]. Sometimes, this causes its own difficulties because some learning materials are difficult to understand if only studied with lectures or discussions. Therefore, it is necessary to use technology in the development of learning media so that educational goals can be achieved. The 21st-century teachers need high-quality professional development experiences in response to changes in their field that can improve student learning and school quality [5][6][7].

The function of learning media is very important considering the era of rapid technological development as it is now. By utilizing technology in learning media, the world of education will still be able to keep abreast of technological developments so that it will not be left behind [8]. Some of the benefits of using learning media are: (1) it makes it easier for educators to learn; (2) able to provide real examples in learning; (3) learning is not monotonous; (4) creating active learning; (5) offset the five senses that play a role in the learning process; (6) increase students' interest in carrying out learning; (7) facilitate students' understanding of the material being

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studied; and (8) assisting the theoretical approach with real reality [9].

Research conducted by Rusmawan [10] shows that the percentage of students' sensory potential in participating in the learning process is 75% through sight, 13% through hearing, 6% through touch, 6% through feeling, and 3% by smell. Likewise, Darwanto's research [11] states that experience can increase knowledge, and 75% of this knowledge is obtained through sight, and 25% is obtained through hearing. From the results of this study, it is increasingly clear that learning media is a very important requirement in learning because by looking at interesting media, students will easily understand learning material so that educational goals can be achieved.

The Energy Conversion Machine course is a course that contains basic knowledge about energy conversion engines [12], including knowledge of work and power from various forms of energy, applicable laws, working principles, calculation of the amount of power and others related to turbines, gasoline motors, diesel motors, and cooling machines [13]. During learning, the energy conversion machine course is carried out with the delivery of theory, discussion and field observations. Therefore, it is necessary to utilize technology that has been developed by applying it to a learning media to support understanding in the energy conversion machine course.

The trainer unit in the form of a laboratory-scale Pelton turbine, was designed and built to meet the needs of energy conversion machine learning media. With the existence of unit trainers equipped with modules, it is hoped that they can provide real experience in learning. So that students are able to understand the concept of energy conversion machines more easily and carry out learning more effectively, interestingly and efficiently.

2. METHOD

2.1. Research and Development Model

The Instructional design is a system and considers learning to be a systematic process. This systematic way of working always refers to the general stages of the learning development system [14]. The research and development model used is the ADDIE model. The ADDIE model was chosen because the research and development procedure is suitable for developing instructional learning media. Another advantage of the ADDIE model is that the development steps are simple and there are trials so that the media development results are reliable [15]. The ADDIE model has developed into various types of other development models [16], such as the ICARE model, the Dick and Carey model, the ASSURE model, and other models [17].

The research procedure was carried out based on the ADDIE model developed by Lee and Owens. The stages that will be carried out include (1) analysis, which includes needs analysis and final results analysis, (2) design, (3) development, (4) implementation, and (5) evaluation (evaluation) [8] [9].

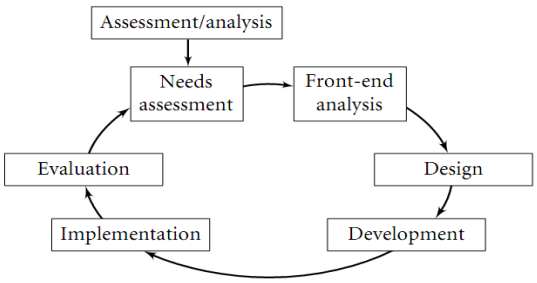

Figure 1 ADDIE Development Model.

2.2. Sampling and Data Collection

The test subjects in the research and development of water turbine trainers were students of the Department of Mechanical Engineering, State University of Malang. At the implementation stage, it takes 25-30 students who have taken the energy conversion course as a sample that represents the target [10].

Data collection is used to determine the feasibility level of the developed learning media. To collect meaningful data in media development, a data collection instrument was used in the form of a questionnaire [21]. The assessment questionnaire is based on a Likert scale with 5 rating levels [11]. Data analysis techniques from questionnaire scores using descriptive analysis techniques by calculating the percentage of answers [12].

$$V = \frac{TSEV}{S-max} \text{ x } 100\% \quad (1)$$

Information:
V = Validity
TSEV = Total score of each indicator
S-max = Expected maximum score

Table 1. Criteria for the Level of Validity

Level of Percentage	Level of Validity
75.01% - 100.00%	Very valid (can/eligible to use without revision)
50.01% - 75.00%	Valid (can/fit for use with small revisions)
25.01% - 50.00%	Invalid (can't/fit for use)
00.00% - 25.00%	Invalid (forbidden to use)

3. RESULTS AND DISCUSSION

3.1. Product Design Results

The product developed in this development research is the Pelton Turbine trainer unit in the Energy Conversion Machine course. The trainer is a laboratory scale trainer. The following are the results of products that have been developed.

Figure 2 Pelton Turbine Trainer Unit.

The Pelton Turbine Trainer has system functions, as shown in Table 2 below.

Table 2. Trainer Specifications.

No	Device	Function
1	Nozzle pipe	Directs the water flow
2	Turbine blades	Capture the flow of water
3	Cover box	Secures nozzle and runner
4	Governor	regulates the speed of the water that will be directed by the nozzle
5	Water pump	Raises the water to the reservoir
6	Reservoir	Stores the water reserves that will be stored out through the nozzle

3.2. Data Presentation

The trial aimed to determine student responses to the media that had been developed before being tested on a large scale. Student trials were carried out on Mechanical Engineering Education students at Malang State University who had taken the Energy Conversion Machine Course. Random trials on students against ten students using a questionnaire instrument with 24 items. The data collected is in the form of quantitative data regarding relevant aspects, completeness aspects, communicative aspects, visual aspects, technical aspects, effectiveness aspects, and up-to-date aspects.

Table 3. Assessment of Each Aspect.

No	Criteria	Number of Questions	Eligibility (%)	Interpretation
1	Relevance	5	75.33	Very valid
2	Completeness	3	72.22	Valid
3	Effectiveness	2	73.33	Valid
4	Up to date	2	71.67	Valid
5	Visual	2	71.67	Valid
6	Technical	6	72.22	Valid
7	Communicative	4	67.50	Valid
		Average	71.99	Valid

Based on these results obtained a score that is described in each aspect. So, for the relevant aspect, the number of 5 questions with a score of 10 students totalling 163 obtained an eligibility percentage of 75.33% or interpreted as feasible. The completeness aspect is the number of 3 questions with a score of 10 students totalling 95 with a percentage of 72.22% or interpreted as feasible. The effectiveness aspect of the number of 2 questions with a score of 10 students totalling 64 obtained a feasibility percentage of 73.33% or interpreted as feasible. The up-to-date aspect of the number of 2 questions with a score of 10 students totalling 63 obtained an eligibility percentage of 71.67% or interpreted as feasible. The visual aspect of the number of 2 questions with a score of 10 students totalling 63 obtained an eligibility percentage of 71.67% or interpreted as feasible. The technical aspect of the number of 6 questions with a score of 10 students totalling 190 obtained an eligibility percentage of 71.67% or interpreted as feasible. The communicative aspect of the number of 4 questions with a score of 10 students totalling 121 obtained a feasibility percentage of 67.50% or interpreted as feasible. From the elaboration of the score obtained, the average eligibility percentage was 71.99% or categorized as feasible. This means that the Pelton turbine trainer unit is suitable to be used as a support for learning the Energy Conversion Mechanics Course in terms of relevant aspects, completeness aspects, effectiveness aspects, up-to-date aspects, visual aspects, technical aspects and communicative aspects.

4. CONCLUSION

The learning media developed in this development research is the Pelton Turbine trainer unit in the Energy Conversion Machines course. The trainer is a laboratory scale trainer. The results of the study indicate that the Pelton turbine trainer unit is feasible to be used as a support for learning the Energy Conversion Mechanics Course in terms of relevant aspects, completeness aspects, effectiveness aspects, up-to-date aspects, visual aspects, technical aspects, and communicative aspects. This was obtained from group trials which produced a score of 71.99%.

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