Validity of Destructive and Non-destructive Testing Module Based on Industrial Needs

Banu Nursanni[1]*, Benyamin Situmorang[2], Erma Yulia[3], Andi Bahar[4]

{banunursanni@unimed.ac.id}

Mechanical Engineering Education, Faculty of Engineering, Medan State University, Medan, Indonesia

Abstract. The purpose of this research is to determine the suitability of learning modules for destructive and non-destructive testing based on industry specifications. The Borg and Gall research and development method was used for this research. As a reference in the module, development used the ADDIE development form, namely (1) demand analysis; (2) design and conclusion of learning objectives; (3) development in the form of creation modules; and (4) formative assessment. Module validation is carried out by material expert, learning design expert, and learning media expert. The data collection technique was carried out by distributing questionnaires to find out the industry's wishes and the validating of the material being tested. Benchmarks for evaluating the module expert agreement using a test questionnaire with defined scores: 5 (very good), 4 (good), 3 (good enough), 2 (less good), and 1 (very bad) which were examined by descriptive approach. The research findings validated the validity of material experts 89.6% of the time, design training experts 91.5% of the time, and equipment training experts 88.3% of the time. As a result, the modules that have been created are ideal for application.

Keywords: validity, module, material testing, destructive, non-destructive

1 Introduction

Higher Education as a place for learning process activities is expected to be able to produce technological innovations by improving the quality of human resources who have competitiveness and academic and professional abilities in their fields and have personalities by the demands of national education goals.

Improving the competitiveness of graduates in the business and the industrial world needs to synergize the university curriculum and needs. Universities are required to be more open to the world of business and industry, and vice versa, both in terms of attitudes and real actions, such as being a place for fieldwork practices and internships for students. On the other hand, the world of education is required to consolidate from the planning stage of learning to its implementation and evaluation so that the cooperation between the world of education and industry achieves the target.

Educated and skilled individuals are needed as university graduates in the Industrial Revolution 4.0 era. Universities must implement current educational and learning breakthroughs. Collaboration between universities and industry provides benefits in the form of increasing capacity in the field of research which is a priority for both parties, as well as finding solutions to problems faced by the industry to improve company performance, which will have an impact on the growing national economic [1]. This is following the university's vision and goals, where graduates can compete not only at the national level but also at the world level.

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According to Gaspersz [2], university graduates in Indonesia are unable to adapt to the current needs of the industrial world. As a result, the unemployment rate for university graduates has increased over time. Various efforts have been made to prevent and overcome these challenges, such as developing curriculum adapted to industry needs, providing practice equipment for students to use, and so on, including progress in the learning process.

One method for improving capabilities and competencies is through the learning process. Although learning is merely one of several techniques for improving competence, it is critical [3]. The learning process necessitates the use of a module as a learning aid both inside and outside the classroom; in other words, the module is a component of learning resources or physical vehicles that contain learning materials in the student's environment and can attract students' attention to learn [4]. According to Mustofa [5], a module in learning is a set of systematic learning activities based on a curriculum that is tailored to the skills that students will attain.

The learning module is the smallest element of the teaching and learning program, which is studied independently by students or taught to students (self-instructional) [6]. Learning modules are methodically and beautifully organized training resources that incorporate subject content, methodologies, and assessments that may be utilized independently to obtain the necessary competencies [7]. According to Goldschmid, a learning module is a type of organized learning activity unit that is meant to assist students in completing certain goals. The module is a type of computer package used for learning [8]. According to Vembriarto [9], a learning module is a teaching bundle that includes one unit of lesson content topics.

Based on some of the module's previous definitions, it is possible to deduce that a learning module is a type of instructional material that is packed methodically and aesthetically so that it is easy to study independently.

The Welding Material Testing course is a compulsory subject for Mechanical Engineering Education students with a weight of 3 credits. Information from the industry often fails (broken). Considering the reality in the field that there is a failure in the weld joint, the competence of graduates in the field of welding material testing must be improved, especially in destructive and non-destructive tests.

To improve student competence in the field of destructive and nondestructive testing, a module that can be used in the learning process of welding materials testing courses as a guide for students in analyzing the quality of welded joints by the needs of the business and industrial worlds must be developed. They want information on the quality of welded connections made with various types of welding wire. Destructive and non-destructive testing can provide information on the quality of the welded joint. Students who graduate from the Mechanical Engineering Education Department should be able to examine the quality of welded joints using destructive and non-destructive tests.

On the basis described above, it is considered important to develop a destructive and non-destructive test module. which can improve student competence in analyzing welded joints, considering that so far this module has not been available.

2 Research Method

2.1 Research Approach and Method

This research employs the R & D technique, with module development carried out utilizing Gagne's ADDIE development model (analysis, design, development, implementation, and evaluation) [10].

The module's validity is determined through three stages: analysis, design, and development. Material expert in the field of materials testing, learning media experts, and learning design expert are the topics of the validation trials in the production of this module. Students enrolled in welding material testing courses at the Mechanical Engineering Education Department, Faculty of Engineering, Medan State University is the module's intended users. The competency of subjects who are specialists in testing welding materials, typically lecturers in charge of welding materials testing courses, are picked as material experts. Educational Technology Lecturers are chosen as learning media experts and learning design experts based on their experience in learning media technology and learning design. Figure 1 depicts the research approach.

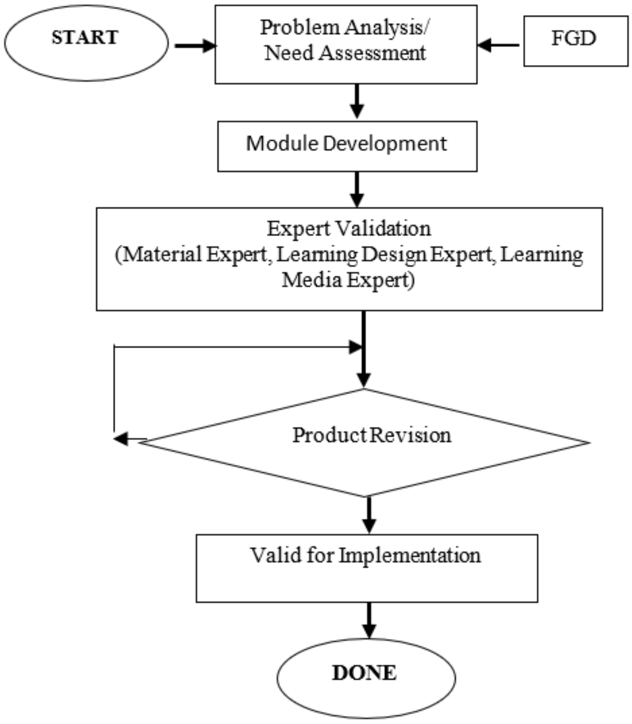

Figure 1. Procedure of Conducting Research

2.2 Data Collection Technique

The data collection methods in this research were qualitatively analyzed, and the data collection instruments developed in this research were related to the data collection techniques used at each stage of the research, namely: (a) a list of questions in the form of a questionnaire used for observation; and (b) the development stage and expert validation used a questionnaire from the Learning Object Review Instrument (LORI) version 1.5 [11] with a Likert scale.

2.3 Data Analysis Technique

The data were analyzed utilizing descriptive analytic approaches, namely by examining quantitative data received from expert test questionnaires and field tests and then interpreting it qualitatively. The next stage is to examine the data after it has been collected. To evaluate the questionnaire results, used the formula to calculate the score of each sub-variable:

$$\bar{X} = \frac{\sum X}{N}$$

where:

$\bar{X}$ = courseware eligibility score
$\sum X$ = total score for each sub-variable
N = number of sub-variables

Based on the above calculation, the percentage range and qualitative criteria can be determined, as shown in Table 1.

Table 1. Interpretation of Validity and Expectation of Learning Module Score Range 0-5

No	Score Interval	Interpretation	
1	1.00 – 2.49	Invalid	Low expectations
2	2.50 – 3.32	Quite valid	Enough expectations
3	3.33 – 4.16	Valid	High expectations
4	4.17 – 5.00	Very Valid	Very High expectations

Source: Sriadhi, (2018)

2.4 Module Validity

This module is stated to be legitimate if the responses collected from the questionnaire are on the criteria of "Very Good", "Good" and "Good Enough". The provision of benchmarks is a very important step for a researcher but is not yet commonly done. The benchmark or criteria for assessing data is something that has an important position and must be prepared before the researcher leaves to collect field data. Equivalent to the interpretation of feasibility with a limit of 2.50, because according to Sriadhi [12] in multimedia feasibility it can be stated that data stability, ease of processing data, and media reliability can be carried out if the analysis of the resulting data gets 50% of the feasibility carried out in processing research data.

3 Results and Discussion

The analytical results were acquired by completing a needs assessment using questionnaires and observations. Questionnaires were distributed to 30 (thirty) students who had completed the Welding Materials Testing course on destructive and non-destructive testing materials. The direct learning method was investigated at the Mechanical Engineering Education Department, Medan State University. Table 2 shows the outcomes of welding materials testing course observations.

Table 2. Welding Material Testing Course Observation Results

No.	Previous Learning Process	Answer	
1.	Learning objectives and competencies are based on the needs of students and the business and industrial world.		No

2.	Using evaluation sheet in assessing the learning process.		No
3.	Learning modules are available based on the needs of the business and industrial world.		No
4.	Learning activities consist of an introduction, presentation, and closing.	Yes	
5.	Conducting a preliminary test of student abilities.		No
6.	Lecturer manuals and student manuals are available.		No
7.	It is necessary to develop learning courses for welding materials testing courses that are oriented toward the needs of the business and industrial world.	Yes	

There are 4 (four) corporate and industrial parties participating. Table 3 shows the findings of the welding field questionnaire responses.

Table 3. Results of the Industrial World Needs Analysis Questionnaire

No.	Statement	Answer			
		Amount		%	
		Y	N	Y	N
1.	Students can identify weld joint defects.	2	2	50	50
2.	Students analyze the composition of welding electrodes.	3	1	75	25
3.	Students know the procedure for testing welded joints.	3	1	75	25
4.	Students know the procedure for sampling welded joints testing.	2	2	50	50
5.	Students can identify welding tools.	4	-	100	-
6.	Students can identify the function of welding tools.	3	1	75	25
7.	Students know the destructive testing procedure.	4	-	100	-
8.	Students know the procedures for non-destructive testing.	4	-	100	-
9.	The world of business and industry requires information on the strength of welded joints.	4	-	100	-
10.	The world of business and industry need welding electrode specification information.	4	-	100	-

The outcomes of the creation of destructive and non-destructive testing learning modules based on the demands of the business and industrial worlds are displayed in Figure 2 as learning analysis materials.

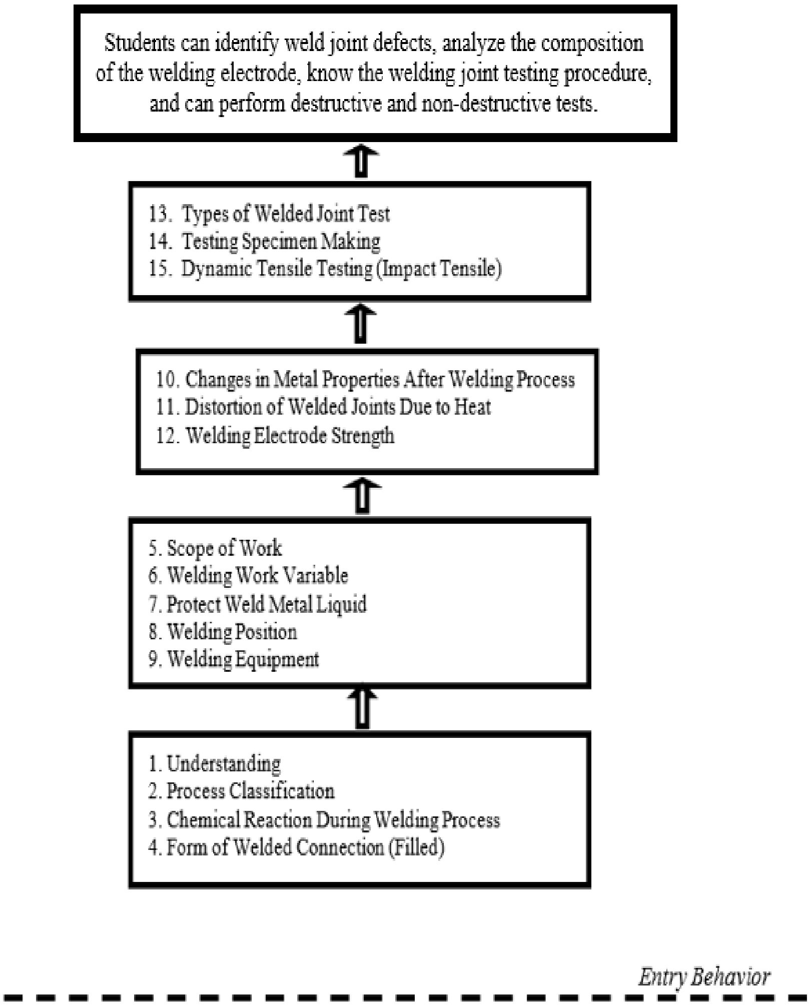

Figure 2. Learning Analysis of welding Engineering Materials Testing Courses

3.1 Development Results

Module development is based on the findings of requirements and learning analyses. Validation is then performed at this stage of development by material expert, learning design expert, and learning media expert.

Material expert validation consists of three aspects: learning material preparation, learning material presentation, and evaluation instruments. Figure 3 depicts the acquired results. The average score achieved from the three characteristics evaluated by material expert was 4.48 or 89.6%, placing it in the very good category.

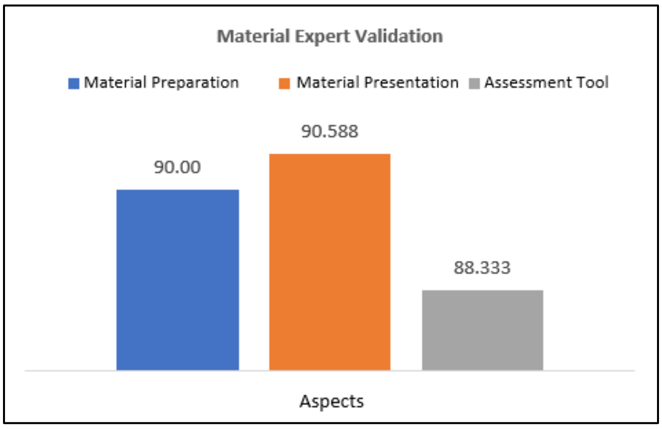

Figure 3. Material Expert Validation Average Results

3.2 Learning Design Expert Validation

The validation of learning design expert has been classified into four aspects: learning objectives, learning techniques, material preparation, and assessment tools. The graphic in Figure 4 depicts the assessment of the learning design expert. The average score given by learning design experts for 4 (four) parts of the evaluation is 4.58 or 91.6%, indicating that learning design experts validation assessment is extremely good.

3.3 Learning Media Expert Validation

Learning media expert validation has been split into three aspects: setting, cover, and visual illustration. The schematic Figure 5 depicts the evaluation of learning media expert. It received an average score of 4.42 or 88.4% from learning media expert and was classified as very good.

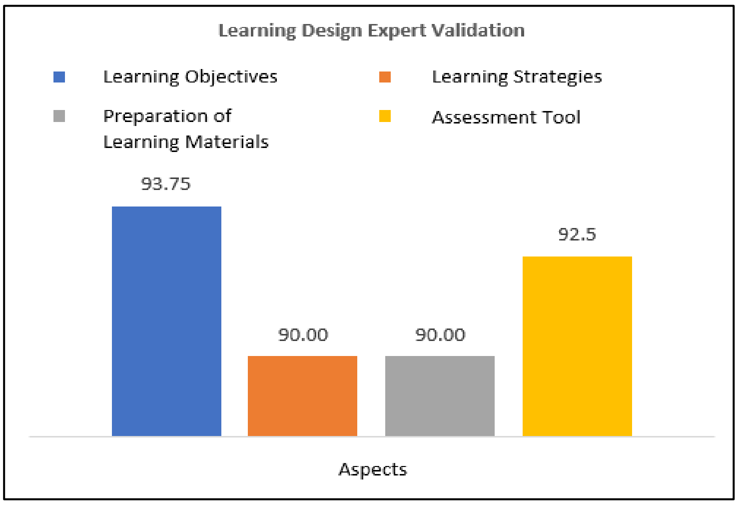

Figure 4. Learning Design Expert Validation Average Results

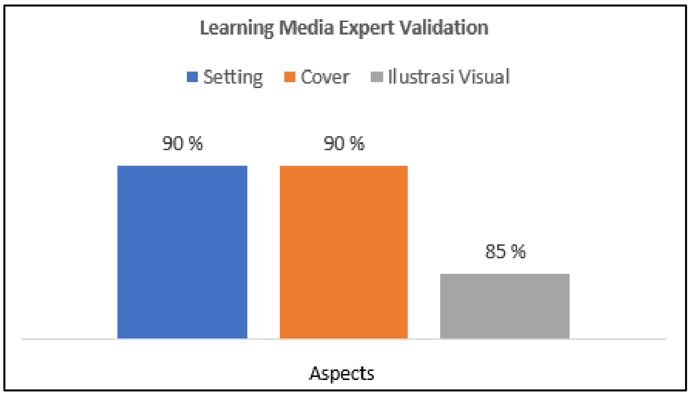

Figure 5. Learning Media Expert Validation Average Results

Table 4 displays the validation findings of material expert, learning design expert, and learning media expert.

Table 4. Validation Score from Experts

No	Expert	Average Score	(%)
1.	Material Expert	4,58	91,6 %
2.	Learning Design Expert	4,48	89,6 %
3.	Learning Media Expert	4,42	88,4 %

3.4 Discussion

The results of the development of destructive and non-destructive testing modules are based on industry demands, with the developed modules capable of increasing student competency. Students can detect faults in welded joints, examine welding electrode configurations, recognize testing procedures for welded joints, and conduct destructive and non-destructive tests. These are the competencies required by the factory, as evidenced by the questionnaire findings displayed in Table 3.

The validity test results from material expert, learning design expert, and learning media expert show that the destructive and non-destructive testing modules developed using the ADDIE development model meet the valid criteria, making them suitable for use in learning welding materials testing courses. The findings of this research are unquestionably consistent with those of Setyadi [13].

This research develops destructive and non-destructive testing modules that can be used to enhance teaching materials for lecturers, students, and industrial practioners to increase collaboration between industry and the world of education, particularly the Faculty of Engineering, Medan State University.

The process of developing these destructive and non-destructive testing materials still has some limitations, such as the subjects involved in the trial process, which are still very limited, namely the students of the Mechanical Engineering Education Department, Medan State University, with a total of 30 people, so the quality of the developed modules must be retested on the various subjects. As a consequence of the findings of this research, it is envisaged that this produced module would be implemented in the Mechanical Engineering Education

Department, Faculty of Engineering, Medan State University, and the industries in need in the future.

4 Conclussions

Based on the research findings and information on the module under consideration, it is possible to conclude that:

a. The results of the needs analysis show that so far there are no textbooks/modules/dictations for learning welding technology specifically to determine the strength of welded joints, necessitating the development of a welding technology learning module. The module development resulted in the design of the Welding Materials Testing module with the following materials: (1) identifying weld joint defects; (2) analyzing the composition of the welding electrode; (3) welding joint testing procedures; and (4) destructive and non-destructive testing.
b. The validity of the destructive and non-destructive modules based on industrial needs as a result of the development is declared valid to be implemented with a very valid level. This is evidenced by material expert validation results 4.58 (91.65); learning design expert 4.48 (89.6%); and learning media expert 4.42 (88.4%). According to the expert's assessment, the average value was 4.5 (90%), with very valid criteria included.

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