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Development of Roll Welding Table as A Learning Tool for Welding Engineering Practices

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ABSTRACT
In the Bachelor of Mechanical Engineering Education Study Program, the Department of Industrial Engineering, State University of Gorontalo, there are several welding courses and one of them is a Basic Welding Engineering course such as SMAW (Shield Metal Arc Welding) welding which has several learning outcomes. In order to achieve this goal, a tool is needed that can be used by students in welding practices, especially in pipe welding. However, based on the results of observations at the Industrial Engineering Laboratory, State University of Gorontalo, there is not yet available a pipe welding learning tool that can be used by students in conducting pipe welding practicums in both 1G and 2G pipe welding positions. This study aims to develop a roll welding table as a learning aid so that it can be used in practicum courses for Basic Welding Engineering courses and to determine the feasibility of a roll welding table as a learning aid in practicum for Basic Welding Engineering courses. The results showed that based on the results of media expert validation calculations, the welding roll table as a teaching aid for welding engineering practicum obtained an assessment that reached 96.36% which based on the Likert scale was in the very feasible category, based on the calculation results of material expert validation on the roll welding table as a tool welding technique practicum learning aid, obtaining an assessment that reached 94% based on the Likert scale was categorized as very feasible, based on the results of calculating student responses,

Keywords: *Learning tool, Welding, Roll welding table.*

1. INTRODUCTION

Education according to SISDIKNAS Law Number 20 of 2003 Chapter 1 Article 1 which reads Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, as well as the skills needed by himself, the community, the nation and the State. Education is a learning process that humans go through in developing their potential, so that they can achieve the highest safety and happiness. According to Aswardi et al., in their research explaining that learning is a translation from English namely "Instruction" is defined as an interactive process between teachers and students that takes place dynamically [1].

To apply the learning contained in the SISDIKNAS Law, it is necessary to be supported by adequate facilities and infrastructure as well as appropriate learning media, one of which is learning aids. Research explains that learning aids are tools used by educators in conveying learning material [2]

In the Bachelor of Mechanical Engineering Education Study Program, Department of Industrial Engineering, State University of Gorontalo, there are several welding courses and one of them is a Basic Welding Engineering course such as SMAW (Shield Metal Arc Welding) welding. Based on the learning outcomes of the Basic Welding Engineering course, students are expected to be able to weld 1G, 2G, 3G and 4G butt joints in plate welding and pipe welding. In addition, students are expected to be able to analyze the results of SMAW (Shield Metal Arc Welding) and OAW (Oxy Asitilene Welding) welding joints. In order to achieve this goal, a tool is needed that can be used by students in welding practices, especially in pipe welding.

However, based on the results of observations at the Industrial Engineering Laboratory, State University of Gorontalo, there is not yet available a pipe welding

learning tool that can be used by students in conducting pipe welding practicums in both 1G and 2G pipe welding positions. This will have an impact on the learning process of the Welding Engineering practicum where students will experience difficulties in carrying out welding practices, especially in pipe welding practices and also in developing their potential.

This research aims todeveloping a roll welding table as a learning aid so that it can be used in practicum courses for Basic Welding Engineering courses and knowing the feasibility level of a roll welding table as a learning aid in practicum for Basic Welding Engineering courses.

2. METHODOLOGY

The implementation of this research was carried out from the preparatory stage to the drafting stage starting from September 2021 to October 2022 which will be carried out at the Laboratory of the Department of Industrial Engineering, State University of Gorontalo. In this study, the method used was Research and Development (R&D) [3]. Research and development methods or in English Research and Development is a research method to produce certain products and test the effectiveness of these products.

2.1 Development Procedures and Outcomes

Researchers can modify the ten stages according to the needs and goals of the researchers themselves.In this study, researchers modified the steps of R&D (Research And Development) [4]. This is considering the purpose of this research to product development and product validation. The steps taken by the researcher are shown in the following figure 1

2.2 Data Collection Technique

The data collection techniques used by researchers in conducting this research and development are three methods. The first method is observation which is a data collection activity carried out by researchers in the preliminary procedure chart, namely potentials and problems and data collection. Observation activities were carried out by researchers in observing learning aids in the Basic Welding Engineering course at the Industrial Engineering Laboratory. The second method is interview where the researcher performs data collection techniques by means of structured interviews.Sstructured interviews are interviews that have prepared research instruments in the form of written questions whose alternative answers have also been prepared. The third method is a questionnaire. This questionnaire aims to obtain an assessment from the validator, student responses regarding the learning aids that will be developed by the researcher. The results of the validator and students of the Mechanical Engineering Education Study Program will be used as a reference for whether the media is appropriate or not. In this questionnaire, it will be validated by two experts, namely material experts and media experts [3]

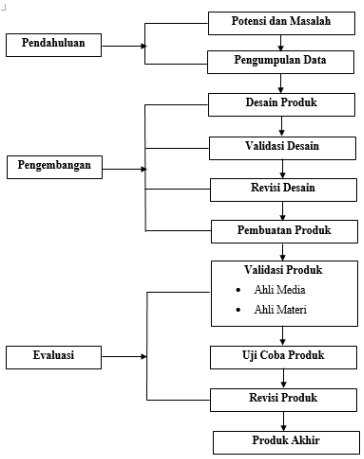

Figure 1. Development Steps That Will Be Done by Researchers

2.3 Data Analysis Technique

According to [5], explaining that data analysis is the process of searching and systematically compiling data obtained from interviews, field notes and documentation, by organizing data into categories, describing them into units, synthesizing, compiling into patterns, choose which ones are important and which will be studied and draw conclusions so that they are easily understood by themselves and others. This study uses qualitative descriptive analysis techniques and quantitative analysis. Qualitative analysis in research was carried out before entering the field, during the field and after completion in the field. The results of the data analysis are used as a reference to improve the roll welding table product as a learning aid for welding engineering practicum that will be developed by the researcher. Quantitative data in this development were obtained from the values given by the validator and student responses to the roll welding table product. Data from the questionnaire or questionnaire will be analyzed to get an overview of the tools to be developed. According to [6], suggests that to find out the final score rating for the item in question, the total value must be divided by the total ideal score. In this study, the validation questionnaire for roll welding table learning aids was obtained from media experts, material experts and student response questionnaires.

Next Step is to assess the feasibility of learning aids, then to see the percentage using the following formula:

$$P = \frac{\sum x}{\sum xi} \text{ x } 100\%$$

Where:

Information:

P = Number of percentages

$\sum x$ = Number of answer scores

$\sum xi$ =Total ideal score (number of item descriptions x number of scales)

3. RESULTS AND DISCUSSION

In accordance with the research method that isadopting Research and Development (R&D) research steps [7], which have been modified by researchers, the results are:

3.1 Product Design and Validation

The initial design of the product, which is drawn manually, is then printed on paperthen carry out the design process using editing software. The first step of the researchers was to design the frame of the roll welding table, then to design the components such as the chuck, box, pillow block, tachometer and dimer. After the initial design of the roll welding table practicum learning aid was completed, the researcher then carried out the design validation stage which was validated by Mr. Ir. Fentje A. Rauf, MT As a lecturer in the Basic Welding Engineering course at the Bachelor of Mechanical Engineering Education Study Program, State University of Gorontalo. The results of the assessment of design experts are shown in the following table.

Table 1. Design Expert Assessment Results

No	Aspek Penilaian	Skor Jawaban	Skor Ideal	Presentase	Klasifikasi
1.	Aspek Desain	41	45	91,11%	Sangat Layak
2.	Aspek Teknis	25	25	100%	Sangat Layak
	Total	66	70	94,28%	Sangat Layak

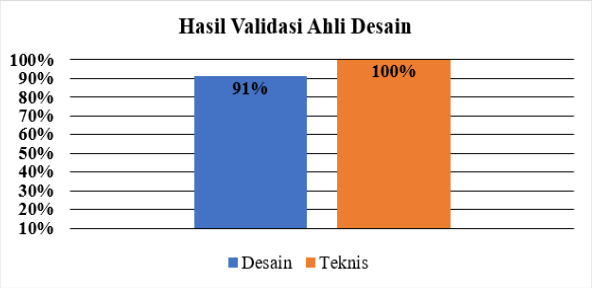

Figure. 2. Diagram of Design Expert Validation

3.2 Product Manufacturing

After the product design is approved and declared feasible to be made, then the researcher then carries out the product manufacturing stage based on the results of the design revision. The stages in making the product are making the roll welding table frame, painting the roll welding table frame, assembling the roll welding table components, installing the panel box as well as installing the roll welding table components, finishing/the final product of the roll welding table as a practicum learning tool welding technique, which was carried out at the Laboratory of Industrial Engineering, State University of Gorontalo. The tools and materials used in the manufacture of products are presented in Table 3.

Table 3. Product Manufacturing Tools and Materials

No	Tool	No	Material
1.	SMAW Welding Machine	1.	Hollow Steel (3 x 4 x 2)
2.	Grinding Machine.	2.	Iron Plate (3 mm)
3.	Drilling machine	3.	Dimers
4.	Measuring instrument	4.	*Chuck*6 inch lathe
5.	Welding Goggles	5.	*Pillow block*UCP 207 and UCP 211
6.	Gurinda Glasses	6.	5A transformer
7.	Ampere Tang	7.	*Diode*
8.	Vise	8.	*Elco*
9.	*ToolBox*	9.	*Tachometer*
10.	*Spray Guns*	10.	Drive Motor (DC)
11.	Solder	11.	Round Iron
12.	Compressor	12.	*Long Drat*
13.	Whiteboard marker	13.	Tin
14.	*Waterpass*	14.	Cable
15.	Gloves	15.	*Bearings*
		16.	Bolts (10,12 and 14)
		17.	Tinier
		18.	Paint (blue and black)
		19.	Epoxy Paint
		20.	Gurinda's Eye Cut
		21.	Electrode (welding wire)
		22.	Rubber Table Legs

3.3 Media and Material Expert Validation

The media validation instrument or questionnaire was given to a media expert, namely Mr. Sabuuti Mustapa as a welding instructor at the Gorontalo City Vocational Training Institute (LLK). This aims to provide an assessment of the roll welding table tool that has been developed by researchers. The results of the media expert's assessment of this tool are shown in the following table.

Table 4. Media Expert Assessment Results

No	Aspek Penilaian	Skor Jawaban	Skor Ideal	Presentase	Klasifikasi
1.	Aspek Desain	19	20	95%	Sangat Layak
2.	Aspek Teknis	24	25	96%	Sangat Layak
3.	Aspek kemanfaatan	10	10	100%	Sangat Layak
	Total	53	55	96,36%	Sangat Layak

Source : Data Analysis, 2022

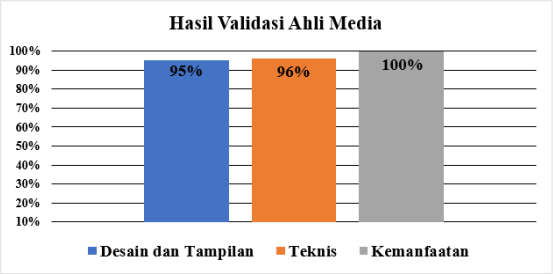

Figure 3. Diagram of Media Expert Validation Results Assessment Results

Material validation instruments or questionnaires were given to material experts, namely Ms. Esta Larosa, S.Pd., M.Pd as a teaching lecturer in the Bachelor of Mechanical Engineering Education Study Program, State University of Gorontalo. This aims to provide an assessment of the roll welding table tool that has been developed by researchers. The results of the material expert's assessment are shown in the following table.

Table 5. Material Expert Assessment Results

No	Aspek Penilaian	Skor Jawaban	Skor Ideal	Presentase	Klasifikasi
1.	Aspek Materi	20	20	100%	Sangat Layak
2.	Aspek kemanfaatan	27	30	90%	Sangat Layak
	Total	47	50	94%	Sangat Layak

Source: Data Analysis, 2022

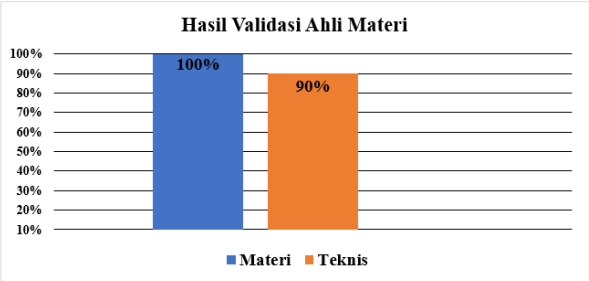

Figure 4. Diagram of Media Expert Validation Results Assessment Results

3.4 Product Trials

Product trials are stages carried out by researchers to obtain student responses and responses regarding the feasibility of developing roll welding table aids. At this stage, researchers used a sample of 30 respondents to provide feedback regarding feasibility. Based on the results of the calculation of student responses, the roll welding table as a learning aid for welding engineering practicum, received an achievement rating 87% based on the Likert scale, which is categorized as very feasible. The following is a diagram of the results of student responses to the aids.

3.5 Product Revision

The results of the product revision are the stages carried out by the researcher in order to perfect the results of the development of a roll welding table as a welding technique practicum tool. Also at this stage, the researcher perfected the tools according to the suggestions given by media experts, subject matter experts and student responses.

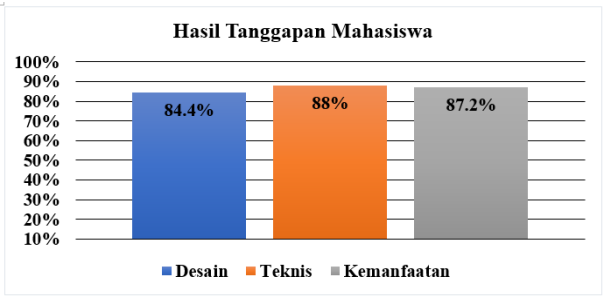

Figure 5. Student Response Results Diagram

3.6 The Final Product

The end product of this research is a roll welding table. This product has been validated and declared fit for use as a teaching aid for welding engineering practicum, especially in the Basic Welding Engineering course. The characteristics of this tool are that it has a length dimension of 100 cm, a width of 60 cm and a maximum table height of 80 cm. This is in line with [4], in his research explaining that the height of an ergonomic welding table is 80 cm. The following is a picture of the final product of this research.

Figure 6. Final Product (Roll welding table)

3.7 Tool Trial

Tool testing is carried out to find out whether the roll welding table tool can be used or not. In testing this tool was carried out using the SMAW (Shield Arc Welding) welding type, then the current strength used was 80 amperes and the electrode used was E6013. The workpiece used has a diameter of 2 inches and has a thickness of 2 mm. Then in this test, researchers used several variations of rotational speed, namely 5 mm/second, 10 mm/second and 15 mm/second. The results of welding using this tool are shown based on macroscopic results or visual testing withThe magnification x 1 is as follows.

Figure 9. Welding Results

From the welding trials using these tools, it can be seen that each heat input is shown in the following table.

Table 9. Heat Input

Sample	**Current (A)**	**Volt (V)**	**Welding Speed (mm/s)**	***Heat Input*(J/mm)**
Welding 1	80 A	60V	15mm/s	320 J/mm
Welding 2	80 A	60V	10mm/s	480 J/mm
Welding 3	80 A	60V	5mm/s	960 J/mm

4. CONCLUSION

Based on the results of the analysis and discussion, it can be concluded that in the development of a roll welding table as a learning aid for Basic Welding Engineering practicum, namely as follows:

In developing a roll welding table as a learning tool for Basic Welding Engineering practicum, the research and development of this tool does not apply all the steps of R&D (Research and Development), in this study it only applies a number of steps considering the purpose of this research is only up to the development and test the feasibility of the tool.

The development of a roll welding table as a teaching aid for this welding technique practicum, is categorized as very feasible to use. Judging from the average percentage value obtained from the media expert validator that is equal to 96.36%, the percentage value from material experts is equal to 94% and the percentage value of student responses is equal to 87%.

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