The development of tungsten inert gas welding practical manual for vocational high school

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Abstract. This study aims to develop a product in the form of a tungsten inert gas (TIG) welding practice manual for Class XII students and find out the level of the eligibility. This research is a type of Research and Development (R&D) research. The stages of this research include problem identification, data collection, product design, design validation, design revision, limited trial, product revision I, large group trial, product revision 2, product ready to use. Data collection techniques are done using a questionnaire. The data obtained were analyzed using quantitative descriptive analysis techniques. The results of this study are in the form of a TIG welding practice manual for class XII students. The feasibility level of the TIG welding practice manual is known through the validation process carried out by 4 expert validators. The feasibility test was conducted on 30 students. The average feasibility value obtained from experts as well as the feasibility test on students was 84.81% and included in the very feasible category.

1. Introduction
In education there are learning activities and learning processes. Learning is a whole series of activities or activities carried out consciously by someone and cause changes in him in the form of additional knowledge or skills based on sensory devices and experience [1]. Teaching materials are materials, information, tools/ media that used by lecturers to carry out learning including creating an atmosphere that encourages students to learn [2]. The process of teaching and learning is something that needs to be considered in the administration of a school institution starting from elementary school to university. One of the providers of education is at the Vocational High School. Learning is a system that aims to help the learning process of students, which contains a series of events that are designed, arranged in such a way as to influence and support the occurrence of students’ learning processes that are internal [3]. To organize the learning process as expected, appropriate instructional materials are needed. Martono & Wagiran's state the use of learning modules can create effective learning processes and have an impact on improving learning outcomes [4]. Media learning is everything that becomes a means of delivering information from the sender to the recipient so that what is delivered can be well received [5].

Tungsten Inert Gas (TIG) welding practice subjects are one of the supports for producing competent graduates so they can compete in the workforce. The results of observations made at Vocational High School 1 Pundong showed that students still had difficulty understanding the material being taught. One reason is the unavailability of material books for students and teachers. In the learning process students are not actively involved. At the time of the practice in the workshop some
students seemed to be having difficulty doing the given task. Students are still confused about completing the steps in working on TIG welding practical assignments. This confusion may be due to the absence of printed TIG welding jobsheets that can be learned by students.

Instructional materials refer to those alternative channels of communication, which a classroom teacher can use to concretize a concept during teaching and learning process. [6]. The selection of instructional material must be appropriate and in accordance with the needs of students so students can be actively involved in the learning process. TIG welding practice subjects consist of theoretical lessons conducted in the classroom or theoretical room and practical lessons are carried out in the workshop. Based on these considerations, the instructional materials that is very likely to be applied in the Department of Welding Engineering at Vocational High School 1 Pundong is printed media in the form of books. The selection of instructional materials in the form of books is based on the characteristics of books that can contain a broad and flexible study of theory because it can be used in theoretical lessons in the classroom or when practicing in a welding workshop.

2. Method
This research uses the Research & Development (R&D) method. This study uses a quantitative descriptive approach to the percentage and is more focused on the feasibility of the products produced.

2.1. Time and Location of Research
This research was conducted in February 2019. The research was carried out in the Department of Welding Engineering at Vocational High School 1 Pundong, Bantul, Special Region of Yogyakarta.

2.2. Target/Subject of Research
Data collection in this study used a questionnaire given to the research subjects. The subjects of this research include TIG welding experts, media experts, and 30 XII grade students of Welding Engineering at Vocational High School 1 Pundong.

2.3. Procedure
The steps used in developing the TIG welding manual adopt the 4D (four-D) development model. The 4D model consists of 4 stages, namely; define, design, develop, and disseminate [7]. Adopting from the 4D model this research step was carried out until the third stage namely; problem identification, data collection, product design, design validation, design revision, limited trial, first product revision, large group trial, second product revision, product ready to use.

2.4. Data, Instrument, and Technique of Collecting Data
The data obtained in this study are qualitative data and quantitative data. Quantitative data in the form of response scores about the quality of products from material experts, media experts, and students are then converted in the form of percentages. Qualitative data in the form of suggestions and input from material experts, media experts, and students for the improvement of books developed. The research instruments used in this study were the material expert validation test instrument, the media expert validation test instrument, and the eligibility instrument for students. Respondent's assessment questionnaire was prepared using Likert scale assessment criteria with 4 alternative answers such as table 1.

| Table 1. Validation Criteria Guidelines |
|----------------------------------------|
| Criteria     | Score |
|----------------|--------|
| Very good     | 4      |
| Good          | 3      |
| Bad           | 2      |
| Very bad      | 1      |
2.5. Technique of Analyzing Data
The data obtained were analyzed descriptively as a percentage. The percentage calculation process is done by scoring the results of the assessment divided by the expected score, then multiplied by one hundred percent. The data that has been calculated the percentage with the formula for the percentage of eligibility is converted into qualitative data with the provision of meaning and decision making [8]. The validation criteria guidelines can be seen in table 2.

| Table 2. Validation Criteria Guidelines |
|----------------------------------------|
| Percentage                             | Criteria     | Score scale |
| 76% - 100%                             | Very good    | 4           |
| 56% - 75%                              | Good         | 3           |
| 40% - 55%                              | Bad          | 2           |
| 0 – 39%                                | Very bad     | 1           |

3. Results and Discussion

3.1. Product design
The results of this study are the TIG welding practice manual book for Class XII students at Vocational High School 1 Pundong. This practice manual consists of three parts, namely an introduction, a content section in the form of a theory about TIG welding, and a Jobsheet section.

The introduction to this book consists of the title page, preface, table of contents, list of figures, list of tables, and introduction. The contents of the book contain chapters of TIG welding materials consisting of chapter 1 on Occupational Health and Safety (OHS), chapter 2 on TIG welding, chapter 3 on TIG welding equipment, chapter 4 on shielding gases, electrodes, and TIG welding filler materials, chapter 5 on TIG welding techniques, and chapter 6 on weld defects. At the end of each chapter there are formative questions that must be done by students to assess student learning outcomes.

Jobsheet section consists of 10 types of TIG welding jobs. Job 1 makes welding lines with added material in the flat position. Job 2 about butt joint square groove welding in the flat position (1G). Job 3 about butt joint square groove welding in the horizontal position (2G). Job 4 about butt joint square groove welding in the vertical position position (3G). Job 5 about butt joint square groove welding in the overhead position (4G). Job 6 about corner joint welding in the flat position (1F). Job 7 about corner joint welding in the horizontal position (2F). Job 8 about corner joint welding in the vertical position (3F). Job 9 about corner joint welding in the overhead position (4F). Job 10 contains about welding pipes with square butt joint in the flat position.

3.2. Product validation
Product designs that have been completed are then validated by material experts and media experts. The validators in this process were lecturers from the Department of Mechanical Engineering, FT UNY and teachers of the Department of Welding Engineering at Vocational High School 1 Pundong.

3.2.1. Material validation
Material validation is done to assess the book in terms of material. The assessment of the book is reviewed from the aspect of material suitability, material quality, usefulness of the book, and language. The assessment process was carried out using a questionnaire with a total of 25 statements. In addition, suggestions and criticisms from material experts are used as a guide in making revisions to the product written in the advice column. Overall, the book product that was made received a percentage of feasibility assessment from material expert 1 of 89.00% with the criteria very feasible to use. The following results of the validation assessment by the first material expert can be seen in table 3.
Table 3. Material validation results 1

| Assessment aspects                  | Percentage (%) |
|-------------------------------------|----------------|
| Materials suitability               | 93.75          |
| Material quality                    | 85.42          |
| Usefulness of the book language     | 92.86          |
| Language                            | 87.50          |

The results of the feasibility assessment from material expert 2 can be seen in table 4. Overall, the book product that was made received a percentage of eligibility assessment from material experts 2 of 80.00% with the criteria very feasible to use.

Table 4. Material validation results 2

| Assessment aspects                  | Percentage (%) |
|-------------------------------------|----------------|
| Materials suitability               | 93.75          |
| Material quality                    | 85.42          |
| Usefulness of the book language     | 92.86          |
| Language                            | 87.50          |

3.2.2. Media validation

Media validation is done to assess the book in terms of eligibility as a learning medium. Validation by media experts was carried out to assess the book from the aspect of appearance and linguistic aspects by filling in 22 items in the questionnaire provided.

Overall, the book product that was made received a percentage of the feasibility assessment from the first media expert at 84.09% with the criteria very feasible to use. The following results of the first media validation assessment can be seen in table 5.

Table 5. Media validation results 1

| Assessment aspects | Percentage (%) |
|--------------------|----------------|
| Skillfulness       | 86.76          |
| Linguistic         | 75.00          |
| Average rating     | 84.09          |

The results of the assessment of the second media expert obtained an average rating of 89.77% with the criteria very feasible to use. The results of the assessment of the validation of eligibility by the second media expert can be seen in table 6. After the book has been validated by material experts and media experts, it is obtained from the media and material aspects that the book is suitable for revision.

Table 6. Media validation results 2

| Assessment aspects | Percentage (%) |
|--------------------|----------------|
| Skillfulness       | 91.18          |
| Linguistic         | 85.00          |
| Average rating     | 89.77          |

3.2.3. Limited trial

Limited trials were conducted at Vocational High School 1 Pundong with 10 students as respondents. The aspects assessed in this limited trial include aspects of appearance, function and benefits, quality of material, presentation of material, language and readability. Overall, the book product made received a percentage of feasibility assessment of 82.50% with the criteria very feasible to use. The results of the evaluation from a limited trial can be seen in table 7.
Table 7. Limited trial results

| Assessment aspects                      | Percentage (%) |
|-----------------------------------------|----------------|
| Display                                 | 82,50          |
| Function and Benefits                   | 80,36          |
| Quality of Material                     | 81,50          |
| Presentation of Material                | 84,58          |
| Language and Readability                | 86,25          |
| Average rating                          | 82,50          |

3.2.4. Large group trials

Large group trials are conducted in class XII Welding Techniques B. The aspects assessed in the feasibility trial of this book include aspects of appearance, aspects of the functions and benefits of the book, aspects of material quality, as well as aspects of language and legibility. The test was carried out using a questionnaire consisting of 23 questions. Overall, the book product made received a percentage of feasibility assessment of 81.50% with the criteria very feasible to use. The results of the large group trial can be seen in table 8.

Table 8. Large group trial results

| Assessment aspects                      | Percentage (%) |
|-----------------------------------------|----------------|
| Display                                 | 82,22          |
| Function and Benefits                   | 78,45          |
| Quality of Material                     | 80,50          |
| Presentation of Material                | 82,50          |
| Language and Readability                | 87,08          |
| Average rating                          | 81,20          |

4. Discussion

Based on the data obtained, it is known that the Tungsten Inert Gas (TIG) welding practice class XII of Vocational High School 1 Pundong has a percentage value of eligibility according to first material expert which is 89.00%, second material expert is 80.00%, first media expert is 84.09%, second media expert is 89.77%, and in the limited trial the score was 82.50% and the large group trial received a score of 81.20%. So that for the overall percentage obtained at 84.86% and included in the category is very feasible to use.

5. Conclusion

Based on the results of the validation of material experts, media experts, and trials on students as a whole gained a percentage of 84.86% so that it is included in the criteria very feasible to use in the learning process at Vocational High School 1 Pundong. Further research can be in the form of experimental research to find out the effectiveness of using this book.

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