DEVELOPING A MANUAL ARC WELDING JOB SHEET FOR THE BASIC WELDING TECHNIQUE SUBJECT

Galih Adityawan and Riswan Dwi Djatmiko

Mechanical Engineering Education Study Program, Faculty of Engineering, Yogyakarta State University

Email: galihadityawan@gmail.com

Abstract. The study aims to describe (1) the development stages of the manual arc welding job sheet and (2) its validity. It is a Research and Development (R & D) of which the data were collected by means of non-test instruments, namely the closed-ended questionnaires with the 5-scale responses. The data were collected from the three research participants acting as the material and media experts, namely two lecturers in the Mechanical Engineering Education Study Program, Faculty of Engineering (FE), Yogyakarta State University (YSU), and a teacher of the Basic Welding Technique subject. The job sheet development stages were adapted from Thiagarajan’s model, namely the Four-D model covering the definition, design, development, and dissemination. Data were analyzed quantitatively by means of the descriptive statistics. The results of the material evaluation by the material expert I prove that the job sheet is categorized as Appropriate (with the total score of 145 or 82.9%) and Very Appropriate based on the material expert II with the total score of 153 (87.4%). Besides, in terms of the media, the job sheet is Appropriate based on the media expert I (with the total score of 207 or 82.8%) and Very Appropriate based on the media expert II (with the total score of 215 or 84.4%).

Keywords: job sheet, research and development, shield metal arc welding

1. INTRODUCTION

Education may be defined as the learning of knowledge, skills, and habits of a group of people who were passed from one generation to the next generations through teaching, training, or research. Besides, education can be considered as a way to educate a nation. In accordance with the functions of education stated in the Law No. 20 Year 2003, the Indonesian national education serves to develop the people’s competences and shape the national character and civilization with the aim of developing the potentials of students to become quality human beings with the characteristics of faith and devotion to the Almighty God, being healthy, faithful, competent, creative, independent, democratic, and responsible citizens.
Concerning this, education cannot be separated from the learning process. According to Wagiran (2007: 48), learning is the essence of education. Therefore solutions to education problems must center on the quality of learning, as the quality learning requires all components of learning to be good and integrated in a system.

While learning is defined similarly as teaching, both are different. In the education context, a teacher works hard in order that the students can learn and master the contents of a school subject so that they can achieve a predetermined objective (cognitive aspect), experience changes in attitude (affective aspect), as well as acquire skills (psychomotor aspect). However, this definition of teaching assumes that the process involves only a one-party job, namely teaching. Meanwhile, learning refers to the interaction between the teacher and students.

Concerning this, one place known to carry out learning is Vocational High Schools (VHSs). According to the Government Regulation No. 19 Year 2005 on the national education standards (Article 26, Paragraph 3), VHSs have the aim of cultivating the students’ intelligence, knowledge, personality, noble character, and the skills to live independently and attend further education. In line with this, VHSs are those prioritizing areas of expertise. They enable the students to learn everything in their preferred fields of expertise, while given directions and complemented by workshops and laboratory practicums aimed to prepare them to be ready to deal with the world of work. Thus, later VHSs may be usually known as generators of ready-to-work and competent workforces who can work directly without continuing their education to the higher degree. Nevertheless, it was found that in 2017 the biggest contributor to the unemployment rate in Indonesia come from the VHS graduates, namely 11.41% (Indonesia Central Bureau of Statistics, 2017). In addition to the factors of the availability of job suitable with the competencies of the graduates, the quality factor of the graduates has been accused of being a cause of the inappropriate work placement. These data and assumption lead the authors to capture the current learning process in a sample VHS.

Based on the results of the observation, interviews, and field industrial practice conducted at state vocational school SMKN 1 Magelang, especially in the Basic Welding Technique class conducted by the Mechanical Engineering Department, several problems were found in the teaching and learning process. They include some students did not know about the learning objectives of the subject, many students did not understand the welding techniques, the facilities and infrastructure used in the theoretical learning were less supportive so that students lack of focus in learning, and the media for the learning process were limited, e.g. there were only five manual arc welding machines used. In addition, other factors were the number of the Personal Protective Equipment (PPE) which were limited, the number of the work pieces were limited, the Student Worksheet has limited material coverage, the Occupational Health and Safety (OHS) procedures in the workshop were not applied by students, practicum instruments were insufficient so that the practice sessions could not be held. Later, this causes the monotonous lecturing method dominated the learning activities. Faced these various problems, students became less competent in welding using the manual arc welding machine.

The most imperative problem to be resolved in order to improve the learning process is one on the learning media because students were required to be able to practice the skills of welding properly. In carrying out the practicum activities, each student should refer to a guideline, so that the activities run efficiently. One of the guidelines used in the mechanical practices is a job sheet. Job sheet is a guideline for practicum that is arranged systematically and contains the learning objective, sequences of instructions, pictures of components/tools needed, their size specifications, measurement results, and conclusions about the practicum carried out.

However, the existing job sheet has no descriptions on the practicum objectives, tools, materials, and procedures. The existing job sheet contained only the pictures of the working process and the assessment criteria. Thus, this study aimed at developing the job sheet that includes the learning
objectives, required tools and materials, work safety standards, practice procedures, results, and conclusions. The job sheet that had been developed was prepared to facilitate students during the welding practicum. The development of this job sheet is based on the fact that many students in Grade XI of Mechanical Engineering at state vocational school SMKN I Magelang had many difficulties in acquiring the welding competencies. It is expected that the developed job sheet can serve as an appropriate guideline for teachers and students in carrying out the welding practice.

Related to the job sheet development, Prasetyo (2015) and Anggarta (2016) employed the Four-D model to develop a job sheet through the four concise stages, namely definition, design, development, and dissemination. Further, Fathurochman (2012) indicates that there is a significant effect of using job sheet on the students’ learning achievement. Thus, it can be concluded that the Four-D model can be used to develop the learning media in the form of job sheets.

This research is expected to produce a valid job sheet for the students to assist them in acquiring the welding skills and provide students with experience to learn through both the tasks and welding practice. Thus, later the job sheet can contribute significantly to the learning outcomes as it encourages the students to activate various senses while learning, especially the sense of sight (visual) with the frequent use of job sheet, and strengthen their memory and understanding on the subject.

2. RESEARCH METHOD
This is a Research and Development (R&D) with material and media evaluators employed in the expert judgment. The study was carried out in the 2017/2018 academic year at Yogyakarta State University and state vocational school SMKN I Magelang.

The research participants were two lecturers in the Mechanical Engineering Education Study Program of FE YSU as the media experts, and a teacher of the Basic Welding Technique subject as the material and media expert at the same time.

The job sheet development procedures were of Thiagarajan’s et al. as stated in Mulyatiningsih (2012: 195-199), namely the Four-D model. Its stages include the definition, design, development, and dissemination. The design stage covers the front-end-analysis, learner analysis, task analysis, concept analysis, and specifying instructional objectives. In the design stage, the procedures are constructing criterion-referenced test, media selection, format selection, and initial design, while the last stage represents the product dissemination.

The study was preceded by class observation and interviews with the teacher of the Basic Welding Technique subject and the Head of the Engineering Department at state vocational school SMKN 1 Magelang. The identified problems were then formulated as the research problems. Then, the related research studies were collected and reviewed as the theoretical bases. After that, the research question was determined to be the basis of this research.

The research instruments were later developed based on the theories, and had been used to collect the data. Before the data collection stage, the developed job sheet was evaluated by material experts and media experts. This was done to find out whether the product is worthy using or not. The material evaluation phase was carried out by three experts, namely two lecturers of the Mechanical Engineering Education Study Program of FE YSU and a teacher of the Basic Welding Technique subject at state vocational school SMKN 1 Magelang. The next step was to carry out the product dissemination in the limited context, namely by giving the product from the researchers to the school.

2.1 Data, Data Collection Technique, and Its Instruments
The product was validated by the material experts and media experts both by responding to the questionnaire consisting of statements or criteria that should be rated from 1 to 5 and by giving comments, criticisms, and/or suggestions to the developed job sheet. The categories of the Likert scale responses are presented in Table 1.

### Table 1. The Likert Scale

| Response               | Score |
|------------------------|-------|
| SS (Strongly Agree)    | 5     |
| S (Agree)              | 4     |
| CS (Somewhat Agree)    | 3     |
| TS (Disagree)          | 2     |
| STS (Strongly Disagree)| 1     |

Based on this table, the questionnaire data with the above Likert scale have the maximum score of 5 and the minimum score of 1.

#### 2.2 Data Analysis Technique

Data obtained through the questionnaires were in the form of qualitative and quantitative data. The qualitative ones were in the form of comments, criticisms, and suggestions from the respondents. These data were summarized and used to revise the job sheet. The other type of data, the quantitative ones, were obtained through the same questionnaires and analyzed with the descriptive statistics to analyze the product quality. The results of the quantitative data analysis obtained were converted into the categories in Table 2. (Widoyoko, 2009: 238).

### Table 2. The Estimated Score Categories

| Score                                      | Criteria               |
|--------------------------------------------|------------------------|
| $\overline{X}_1 + 1.80 SB_1 < X$          | Very Appropriate       |
| $\overline{X}_1 + 0.60 SB_1 < X \leq \overline{X}_1 + 1.80 SB_1$ | Appropriate            |
| $\overline{X}_1 - 0.60 SB_1 < X \leq \overline{X}_1 - 1.80 SB_1$ | Somewhat Appropriate   |
| $\overline{X}_1 - 1.80 SB_1 < X \leq \overline{X}_1 - 0.60 SB_1$ | Inappropriate           |
| $X \leq \overline{X}_1 - 1.80 SB_1$       | Very Inappropriate     |

#### 3. RESULTS AND DISCUSSION

##### 3.1 The Evaluation Results from the Material Experts

As mentioned, the material and media evaluation were carried out by the lecturers of the Mechanical Engineering Education Study Program of FE YSU and the teacher of the Basic Welding Technique subject at vocational school SMKN 1 Magelang. The material evaluation criteria cover three categories, namely the aspect of content, presentation, and utility. The content evaluation criteria included 21 items, the respective aspect covers 9, and the last, the aspect of utility, was evaluated through 5 items. Thus, they were 35 items in total. Besides, the evaluation questionnaire also allowed the validator to give their comments and suggestions to the betterment of the job sheet.

To determine the category of the evaluation results, the Likert scale with intervals of 1 to 5 for the 35 questions was used as seen in Table 3.

### Table 3. The Category of the Material Evaluation Results
Table 3 presents the score interval for the material evaluation of the manual arc welding job sheet. Based on the Likert scale, the lowest score (Xmin) is 35, while the highest score (Xmax) is 175. Thus, the estimated average value or $\bar{X}$ is 105 and the estimated standard deviation (SBx) is 23.33. The results of the data analysis were then categorized based on the score category in Table 2 for each evaluation aspect, so that the category of the material evaluation scores was obtained.

However, there have been some suggestions for the job sheet revision as given by the material expert I. They include checking whether the E6013 electrode needs to be heated and asking whether the vocational students are able to carry out all the tasks in the job sheet. After getting the input from material expert I, the immediate product improvement was made to produce the appropriate job sheet in accordance with the suggestions. The evaluation results from the material expert I are presented in the Table 4.

### Table 4. The Material Evaluation Results from the Material Expert I

| No. | Evaluation Aspect | Score | Percentage  |
|-----|------------------|-------|-------------|
| 1.  | Content          | 86    | 81.9 %      |
| 2.  | Presentation     | 38    | 84.4 %      |
| 3.  | Utility          | 21    | 84 %        |
|     | Total            | 145   | 82.9 %      |

Based on Table 4, it can be seen that as evaluated by the material expert I the aspect of content gains a score of 86, the presentation is on the score of 38, and the utility gets a score of 21. Thus, the total score given by the material expert I is 145, which implies that the job sheet is in the Appropriate category.

Considering the evaluation results from the second expert, the suggestion given by the material expert II covers adding a sign that shows the rotating work piece. After this input from the material expert II was received, the product was revised accordingly. The material evaluation results from the material expert II are presented in Table 5.

### Table 5. The Material Evaluation Results from the Material Expert II

| No. | Evaluation Aspect | Score | Percentage  |
|-----|------------------|-------|-------------|
| 1.  | Content          | 91    | 86.7 %      |
| 2.  | Presentation     | 40    | 88.9 %      |
| 3.  | Utility          | 22    | 88 %        |
|     | Total            | 153   | 87.4 %      |

Based on Table 5, the material expert II gives a score of 91 for the content, 40 for the presentation, and 22 for the utility, so that they are all accounted as 153 in total. In this table, the content aspect gains the highest score whilst the utility gets the least score.

### 3.2 The Evaluation Results from the Media Experts
The media evaluation was carried out by the Mechanical Engineering Education lecturer of FE YSU and the teacher of the Basic Welding Technique subject at vocational school SMKN 1 Magelang. It included five aspects, namely the presentation, ease of use, consistency, format, and graphics. Each aspect is composed of 6 to 16 items, and in total they make up 50 items altogether. In addition, the evaluation was managed to come by comments and suggestions regarding the job sheet.

The category of the media evaluation results for the total 50 items, then, was determined by the Likert scale with the five intervals as seen in Table 6.

Table 6. The Category for the Media Evaluation Results

| Score Interval | Category          |
|----------------|-------------------|
| 210 < X        | Very Appropriate  |
| 170 < X ≤ 210  | Appropriate       |
| 130 < X ≤ 170  | Somewhat Appropriate |
| 90 < X ≤ 130   | Inappropriate     |
| X ≤ 90         | Very Inappropriate|

Table 6 shows the score intervals that classifies the category of the media evaluation of the manual arc welding job sheet. Such Likert scale with a range of 1 to 5 for the 50 items has the lowest score (Xmin) 50 and the highest score (Xmax) 250. Besides, the estimated average value of X is 150 and the estimated standard deviation (SBx) is 33.33. The results of the data analysis were consecutively classified for each evaluation aspect based on the score category as stated in Table 2, so that the category for the whole media evaluation results is obtained.

Moving to the results of the first media experts, the suggestion given by the media expert I is to provide an illustration of the parts that needs tack weld. The job sheet was revised accordingly for the purpose of this enhancement. The results of the evaluation by the media expert I can be seen in Table 7 below.

Table 7. The Results of the Media Evaluation by the Media Expert I

| No. | Evaluation Aspect | Score | Percentage |
|-----|------------------|-------|------------|
| 1.  | Presentation     | 23    | 76.7 %     |
| 2.  | Ease of Use      | 68    | 85 %       |
| 3.  | Consistency      | 38    | 95 %       |
| 4.  | Format           | 36    | 80 %       |
| 5.  | Graphics         | 42    | 76.4 %     |
|     | Total            | 207   | 82.8 %     |

Based on Table 7, it has been understood that the job sheet's evaluation results respectively show the following: a score of 23 for the display, 68 for the ease of use, 38 for the consistency, 36 for the format, and 42 for the graphic aspect. The total score given by the media expert I equals to 207, which includes in the Appropriate category.

Regarding the evaluation results from the second media expert, the media expert II suggests that its targeted users can already use the developed job sheet without any revision. The evaluation results as proposed by the media expert II are described in Table 8.

Table 8. The Results of the Media Evaluation from the Media Expert II
In the table above, the scores for each evaluation aspect as suggested by the media expert II are 24 for the presentation, 69 for the ease of use, 37 for the consistency, 38 for the format, and 47 for the graphics. As seen on the total score, 86% or a score of 215 is categorized in the Very Appropriate category.

4. CONCLUSIONS AND SUGGESTIONS

4.1 Conclusions
To conclude, the development stages for the manual arc welding job sheet cover those appearing in the Four-D development model, including definition, design, development, and dissemination. Besides, the material and media evaluation were carried out to analyze the product’s validity from various aspects. The evaluation involved two material experts and two media experts which later results in the following findings. The results of the material evaluation with three evaluation aspects obtain a score of 145 (Appropriate category) as suggested by the material experts I and 153 (Very Appropriate category) as proposed by the material expert II. In addition, the results of the media evaluation with five evaluation aspects obtain a score 207 (Appropriate) as suggested by the media expert I and 215 (Very Appropriate) as proposed by the media expert II. Thus, based on both evaluation results proposed by the material and media experts, the manual arc welding job sheet developed is valid to as it is in the Very Appropriate category.

4.2 Suggestions
Based on the results of the study, the suggestions are for the respective teachers to use the job sheet that had been developed as one of the learning resources in the welding practice. However, there needs to be further research to capture the students’ responses after using the job sheet to find out the effectiveness of job sheet in assisting them acquiring the skills practiced in the Basic Welding Technique subject.

5. REFERENCES
[1] Anggarta, Y.R.. (2016). Pengembangan Job Sheet sebagai Sumber Belajar Praktik Teknik Pengukuran Kelas X Teknik Pemesinan di SMK Muhammadiyah 1 Salam. *Jurnal Pendidikan Vokasional Teknik Mesin*, 4 (2), 102.
[2] Depdiknas. (2003). *Undang-undang Republik Indonesia No. 20 Tahun 2003 entang Sistem Pendidikan Nasional*. Jakarta: Direktorat Jenderal Pendidikan Dasar dan Menengah.
[3] Fathurochman, E. (2012). Pengaruh Job sheet Terhadap Prestasi Belajar Siswa pada Mata Pelajaran Pembubutan di SMK Nasional Berbah. Unpublished thesis. Yogyakarta: Yogyakarta State University.
[4] Mulyatiningsih, E. (2012). *Metode Penelitian Terapan Bidang Pendidikan*. Bandung: Alfabeta.
[5] Prasetya, A. (2015). Pengembang Job sheet Teknik Kerja Bengkel Elektronika Sebagai Media Pembelajaran Praktik Siswa Kelas X di SMK Negeri 2 Wonosari, Gunung Kidul. Unpublished thesis. Yogyakarta: Yogyakarta State University.
[6] Ratnasari, E.D.. (2018). *BPS: Lulusan SMK Banyak Menganggur Sepanjang 2017*. Retrieved from https://www.cnnindonesia.com/gaya-hidup/20180223141505-282-278333/bps-lulusan-smk-banyak-menganggur-sepanjang-2017 on 17 July 2018.
[7] Undang – Undang Republik Indonesia Nomor 20 Tahun 2003 Tentang Sistem Pendidikan Nasional. Retrieved from https://kemenag.go.id/file/dokumen/ UU2003.pdf on 4 January 2018.

[8] Wagiran. (2007). Inovasi Pembelajaran dalam Penyiapan Tenaga Kerja Masa Depan. *Jurnal Pendidikan Teknologi dan Kejuruan*, 16 (1), 48.

[9] Widoyoko, S.E.P.. (2009). *Evaluasi Program Pembelajaran*. Yogyakarta: Diva Press.