International Journal of Advanced Science and Technology
Vol. 29, No. 8, (2020), pp. 1581-1588

Practicality Of Participatory Ergonomics And Teaching Factory Models In Metal Welding Training (Case Study At Batam Training School)

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Abstract

This study aims to measure the practicality of the participatory ergonomic and teaching factory model in metal welding training in order to improve the abilities and skills of welding training participants at Batam Training School. This research is based on findings at the research location where the welding training target has not been achieved ie 400 hours of welder can be proficient in 5 welding positions. This research uses research and development (R&D) methods and ADDIE development procedures. Data analysis techniques used quantitative descriptive analysis techniques and qualitative validity. The results of the study were the practicality of the model meeting the practical criteria based on the instructor's response was 84% and based on the training participants 86%. The application of the Participatory Ergonomics and Teaching Factory model in metal welding training can impacts the training participants, namely: 1) the ability to plan work, 2) the ability to analyze work, 3) the ability to perform work, 4) the ability to determine alternatives and how to complete the work well, 5) the ability to perform work on time, 6) the ability to evaluate work results, and 7) the ability to communicate.
Keywords*: Model Practicality, Metal Welding Training*

Introduction

The growth of the manufacturing and non oil and gas industries certainly requires welding products. Welding is an important process in the industrial world and is an inseparable part of industrial growth, because it plays a major role in the engineering and repair of metal production. Welding is the process of local connection between two or more metal parts by utilizing thermal energy (Wijayanto, 2012). The growth of the welding industry in the country is expected to accelerate in the coming years. According to Manara Lodewijk Hutapea President of the Indonesian Association of Welding Techniques currently requires a workforce of experts in the field of welding as many as 5,000,000 to 7,000,000 people but only about 2,000,000 to 3,000,000 people are available (Bisnis.com, 2017).

The rapid demand for welding power is not only caused by industrial growth factors but also because the government is making efforts to accelerate projects that are considered strategic and have a high urgency to be realized in a short period of time. Based on Presidential Regulation No. 58 of 2017 concerning amendments to Presidential Regulation No. 3 of 2016 concerning the Acceleration of the Implementation of the National Strategic Project, it was decided as many as 245 National Strategic Projects plus the electricity program and the aircraft industry program. This strategic project is implemented throughout Indonesia including the city of Batam.

Batam is an industrial city that has many companies engaged in manufacturing and production. In its implementation, many of these companies are related to the connection of metals so that they require skilled personnel in the field of welding (welding skills). Welder is required to have basic skills before plunging directly into the field. Welder with low skills and inexperience can have a negative impact on companies where welding quality will be low so that the overall quality of construction will be low and can have an impact on the swelling of operational costs.

Based on these problems the instructor must be able to innovate in developing learning that provides convenience in learning Metal Welding Training. The importance of the teacher creating an effective

ISSN: 2005-4238 IJAST

learning to achieve the learning objectives. (Verawardina, et al, 2020; Asnur, et al, 2019; Bandri, et al 2020; Feladi et al, 2020). Therefore to produce effective learning, it is necessary to develop a learning model. This study aims to measure the practicality of the ergonomic participatory model and teaching factory in metal welding training in order to improve the abilities and skills of welding training participants at Batam Training School.

Literature Review

Training Needs

According to Wognum (2001, 408), training and development needs can occur at three organizational levels namely; (1) strategic level, where needs are determined by top management while considering organizational goals, missions, strategies and problems, which need to be resolved or corrected (2) tactical level, where needs are determined with middle management while considering the development of coordination and cooperation between organizational units and (3) operational levels, where needs are determined by lower executive management and other employees while considering operational-related issues such as individual employee and departmental performance issues.

According to Wognum (2001) and Torrington et al. (2005), there are three categories to identify training and development needs. These needs include: solving problems, focusing on employee performance, improving certain work practices. It is important to remember that during identification of training needs, there is a need to create, develop, maintain and improve relevant systems. In addition, training programs must be designed to meet different needs. Furthermore, the training program, content and training participants selected depend on the objectives of the training program (Milkovic & Bordereau 2003).

Meanwhile, according to Edmond & Noon (2001), Torrington et al. (2005). The identification of these needs is centered on the problem (performance gap) and the profile comparison (change and skills) approach. Likewise, a number of approaches for analyzing training needs depend on the needs of new employees. A problem-centered approach focuses on performance difficulties and the corporation analyzes whether the problem is caused by a lack of skills, so it needs to be developed if the problem is to be solved. The profile comparison approach on the other hand focuses on matching competencies with work, whether new positions or existing positions. Some changes in strategy and technology can also lead to the need for new or additional skills.

Teaching Factory Model

According to Hadlock et.al (2008: 14), the purpose of teaching factory is: *'The goal of learning factory is to change that and teach students more than what is in the book. Not only do students practice the "soft skill," in the Learning Factory, such as teamwork and interpersonal communication skills, but also get the crucial hands on experience and future job training. "Learning Factory participants learn how to define a problem, build a prototype, write a business proposal, and make a presentation about their solution. In the process, the students learn critical skill, such as how to meet deadlines and expectations, build and work on multidisciplinary teams, and use people's varied talent".*

According to the Directorate of PSMK (2008), the components of the teaching factory consist of: *Operational management, Human Resource, Financial and Investment, Entrepreneur, Partnership, Curriculum, Learning Process of product realization, Infrastructure, Facilities, and product/service.* The operational management in question is the management of teaching factory. The management includes planning, organizing, implementing, and evaluating. Planning is a systematic process in an organization to agree and building a commitment with policy makers to prioritize important things in accordance with organizational goals and responsibilities for the surrounding environment. Planning and goals are made with clear targets and strategies for achievement.

Participatory Ergonomics

Participatory ergonomics is a method of macro ergonomics that emphasizes the involvement of workers in the design and analysis of ergonomics (Brown, 2002). Whereas Wilson defines "participatory

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ergonomics is the involvement of people in planning and controlling a significant amount of their own work activities, with sufficient knowledge and power to influence both processes and outcomes in order to achieve desirable goals" (Haines & Wilson, 1998). This means that participatory ergonomics is the involvement of humans (workers) in planning and controlling work activities with sufficient knowledge and power in the process and results to achieve the desired goals.

Welding

Welding is a process in which materials of the same type are joined together to form connections through chemical bonds from the use of heat and pressure (Suratman, 2001). The function and purpose of welding is to connect two or more metals into one whole component. In the early stages of developing welding technology, welding is used in less important connections and repairs. But over time, the welding process and the use of welding construction are common in all countries of the world. Meanwhile, according to the American welding society (1981) Welding is the process of unifying metals or non-metals made by heating the material connected by using high temperatures and carried out using pressure, and without using filler metals. In addition, according to Harsono (1991), welding is a metallurgical bond in an alloy made in a liquid state.

The welding position is to adjust the position of the electrode direction during the welding process. According to Purwanto (2015), the position of welds consists of four types, namely: 1) the position under the hand, is a welding method that is carried out on a flat or flat surface and is carried out under the hand. The slope of the welding electrode is around 10º -20 ° to the vertical line and 70º-80 ° to the workpiece. 2) welding the upright position is when the direction of welding is done up or down. This welding is among the most difficult welding because liquid material flowing or accumulating in the lower direction is reduced by electrode slopes around 10º-15º to the vertical line and 70º-85º to the workpiece. 3) the flat position is also called a uniform weld where the position of the workpiece is made upright and the direction of the electrodes follows horizontally. When the welding electrode is tilted about 5º-10º to the vertical line and 70º-80º towards the workpiece. 4) The welding position is very difficult and dangerous because the liquid material falls a lot and about the welder. Therefore, complete equipment is needed, including welding clothes, gloves, and leather shoes. Welding with this position the workpiece is located at the top of the welder and the electrode position is around 5º-20º to the vertical line and 75º-85º to the workpiece.

Research methodology

The research will be carried out using a Research and Development (R & D) approach development model. Definition of Research and Development (R&D) According to Seals and Richey (1994) is a systematic assessment process of the design, development and evaluation of programs, processes and learning products that meet the criteria of validity, reliability and effectiveness. The development procedure will be used in this study is the ADDIE research and development model (Analysis, Design, Development, Implementation, and Evaluation). The steps taken in research and development using the ADDIE approach can be seen in table 1 as follows:

Table 1 Development Phases with ADDIE Approach

No.	Fase	Sample Task	Sample Output
1.	**Analysis:** The proces of defining what is to be learned	• Need Assessment • Problem Indentification • Task Analysis	• Leaner profile • Description of constraints • Needs, problem statement • Task analysis

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No.	Fase	Sample Task	Sample Output
2.	**Design:** The proces of specifing how it is to be learned	• Write objective • Develop test items • Plan instruction • Identify resources	• Instructional strategy • Prototype specification
3.	**Development:** The proces of autoring and producing the materials	• Work with procedures • Develop program	• Script • Exercises
4.	**Implementation:** The proces of installing the project it the real word context	• Teacher training • Tryout	• Student comment data
5.	**Evaluation:** The proces of determining the adequacy of the instruction	• Interprest test results • Survey graduates • Revise activities	• Recommendations • Project report • Reviseed prototype

Source*: San Jose State University, Instructional Technology Program (in Molenda, 2003)*

Data collection instrument is a tool used by researchers to collect research data by measuring and compiling written guidelines in the form of a list of questions prepared to obtain information from respondents (Widoyoko, 2013). The instrument used for data collection in this research and development was using a questionnaire. The following is table 2 of the instrument practicality grid.

Table 2 Practicality Instrument Lattice

No.	Instrument Name	Assessed Musty	Number of Statements
1.	Practicality assessment (instructor respondent)	a. The practicality of the training model b. Practicality of teaching modules c. Practicality guide instructor d. The practicality of the welding demonstration tool	10 bullet 10 bullet 10 bullet 10 bullet
2.	Practicality assessment (participant respondents)	a. The practicality of the training model b. Practicality of teaching modules c. Practicality of participant guides d. The practicality of the welding demonstration tool	10 bullet 10 bullet 10 bullet 10 bullet

Data analysis technique used in this research is descriptive qualitative data analysis method. Descriptive qualitative data analysis methods in qualitative studies are useful for developing theories that have been built from data that has been obtained in the field. The data obtained was then carried out a practicality analysis. Data on the practicality of the model is determined from the results of the instructor's observations and responses of trainees using a Likert scale. Practicality in terms of product ease of use and understanding in learning. Stages Analysis of practical data from the development of learning models and welding training are as follows:

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a. Answer score criteria:
   1 = Strongly Disagree
   2 = Disagree
   3 = Hesitating/ Undecided
   4 = Agree
   5 = Strongly Agree
b. Practical determination is done by descriptive statistical analysis through the conversion of quantitative to qualitative data as shown in table 3 below:
c.

Table 3 Converting Quantitative Data to Qualitative Data

Scale	Quantitative Data	Qualitative Data
1	0% - 54%	Not Practical
2	55% - 64%	Less Practical
3	65% - 79%	Quiet Practical
4	80% - 89%	Practical
5	90% - 100%	Very Practical

(Source: Widoyoko, 2013)

Results and Discussion

To test the practicality of applying the teaching factory model, practicality assessment was carried out by instructors and trainees who apply research products consisting of model books, teaching modules, instructor manuals, participant manuals and welding demonstration props. Practicality test results are based on the level of response achievement of the product users. The results of practicality are stated as follows:

a) The practicality test results of the instructor are: 1) aspects of the training model have an average response rate of 81% with a practical category, 2) aspects of the teaching module have an average response rate of 86% with a practical category, 3) the instructor guide aspect has an average response rate of 81% with the practical category, 4) the aspect of the welding demonstration tool has an average response rate of 87% with the practical category. It can be concluded overall the instructor's practicality assessment of the Participatory Ergonomics and Teaching Factory model in welding training was declared practical because all aspects had an average response rate of 84%. For more details can be seen in the following figure 1:

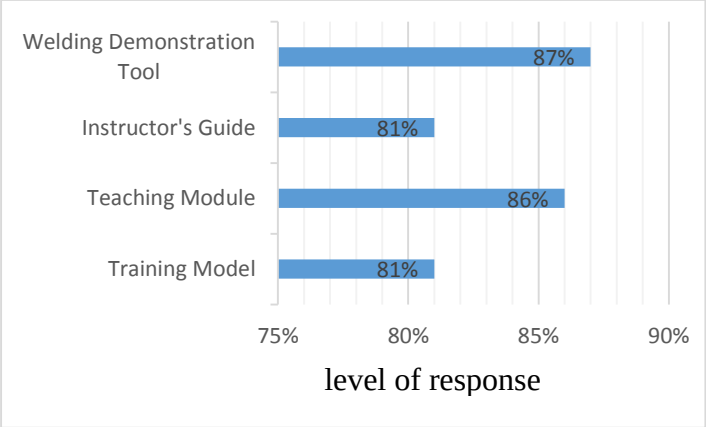

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Figure 1 Practicality Test Results from the Instructor

b) The practicality test results of the trainees are: 1) aspects of the training model have an average response rate of 89% with a practical category, 2) aspects of the teaching module have an average response rate of 83% with a practical category, 3) aspects of the guide participants have an average response rate of 82% with the Practical category, 4) aspects of welding demonstration tools have an average response rate of 90% with the Practical category. It can be concluded that overall the practicality assessment of the participants on the participatory ergonomics and teaching factory model in welding training was declared practical because all aspects had an average response rate of 86%. For more details can be seen in Figure 2 below:

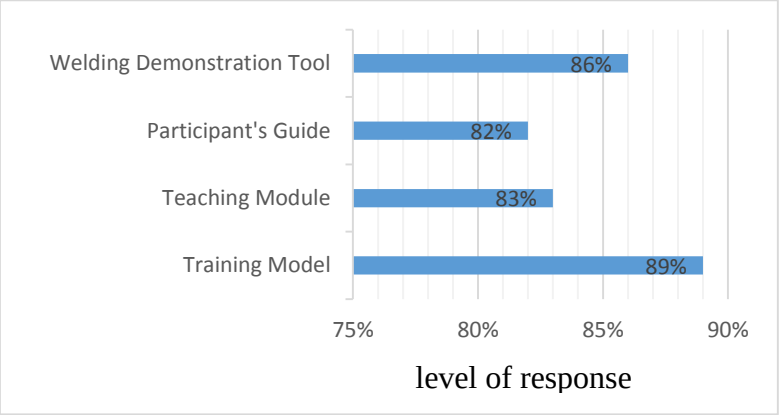

Figure 2 Practicality Test Results from Training Participants

The application of the participatory ergonomics and teaching factory model in metal welding training can result several impacts obtained by the training participants, namely: 1) the ability to plan work, 2) the ability to analyze work, 3) the ability to perform work, 4) the ability to determine alternatives and how to work both in completing work, 5) the ability to perform work on time, 6) the ability to evaluate work results, and 7) the ability to communicate. Judging from the abilities acquired by trainees are in line with some of the main capabilities that are most needed by workers in 2020 based on the results of research from the World Economic Forum (2018), which can solve complex problems, critical thinking, creative, the ability to manage humans, can coordinate with other people or team-work, have emotional intelligence, have the ability to judge and make decisions, service oriented or prioritizing service, have the ability to negotiate, and have cognitive flexibility.

Conclusion

All of the questionnaires have been carefully designed based on the related theories in order to guarantee that the assessments used in the research will be closely evaluated before it is actually used. In conclusion, all practicality assessment aspects of the Participatory Ergonomics and Teaching Factory model in welding training had an average response rate of 84% for the instructors and 86% for the participants. All aspects like the study a metal welding training tool, teaching modules, instructor guides, participant guides and practical welding demonstration tools were in practical category.

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