Virtual reality simulator developed welding technology skills

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ABSTRACT

Virtual reality (VR) technology is one of the best approaches in Computer Based Training (CBT). The objective of the research is to identify the suitability of VR welding simulator application towards CBT in assisting new trainees to developing welding skills at the Centre of Instructor and Advanced Skills Training (CIAST) Shah Alam Selangor and National Youth Skills Institute (IKBN) Pagoh Johor. The significance of the study is to create a computer-based skills development approach in welding technology among new trainees in CIAST and IKBN as well as to cultivate the elements of general skills among them. This study is also important in elevating the number of individual knowledge workers (K-workers) working in manufacturing industry in order to achieve a national vision, which is to be an industrial nation by the year of 2020. The design of the study is a survey type of research which uses questionnaires as the instruments, and some 136 trainees from CIAST and IKBN were interviewed. The analysis for the questionnaires will be conducted by the using Statistical Package for Social Science 15 (SPSS 15). Descriptive analysis is used to identify the frequency and mean. The findings of the study show the welding technology skills haves developed in the trainees as a result of the application of VR simulator at a high level (min=3.89) and the respondents agreed that the skills could be embedded through the application of the VR simulator (78.01%).

In summary, this VR simulator is suitable in welding skills development training in terms of exposing new trainees to the relevant characteristics of welding skills and at the same time spurring the trainees' interest towards learning more about the skills.

Keywords: *Virtual reality learning, Virtual reality simulator, Computer Based Training (CBT)*

INTRODUCTION

Visual technology usage for lesson and learning in education and training has produced a dramatic expansion in conventional education, demonstration and also skills training. Starting with the introduction of colored images, to performance video and later to computer presentation with graphic and also animation touch. VR emergence reality had heralded a new era for technical industry and learning. VR technology is a simulation which uses computer graphics to build or form a virtual model of an actual situation. VR technological progress has completely benefited the education field and training through simulator developments that are grounded in VR technology.

The forging of simulator and VR technology has produced a new technology which has become known as 'virtual simulator' that has made virtual technology a reality. Amongst the successful examples of 'virtual simulation' is simulator virtual training for driving a vehicle. Such practice has already been able to produce a 50% reduction in major energy resources. Apart from noise pollution reduction, reduced NO_2 and pollutants there has also been a decrease in the number of vehicle accidents through the usage of driver simulators (Kappler, 2008). According to Kappler (2008), with the existence of this virtual reality simulator, US military can produce skilled pilots 90 percent faster, and safer, when compared to actual practice.

Nowadays research which involves a virtual environment is more concentrated on skills enhancement; such as sensor motor skill. This is supported by Choquet (2008), who states that the virtual welding simulator can build motor skill such as detecting the movement of head and hand during welding and help students to identify optimum point of view during welding process.

The existence of these simulators is parallel with the emphasis on computer based training (CBT). Generally Technical and Vocational Educational Training (TVET) has already converged to education and training by CBT. CBT is one way of training without supervision from instructors. With CBT, trainees can interact with software and get "hands on" training. This training style also save time, energy and money and can be done according to needs and user ability (Thilakawardhana, 2002).

The use of the VR Welding simulator aims to facilitate computer based training to new students to seek early experience and exposure before committing to the real welding process. Yet, several problems also arise, such as the complexity in making a virtual training simulator with real condition. Besides that, the cost factor in developing the simulator and weaknesses in VR training methods worsen the problem of getting the true skills like in actual situation. Moreover, researchers have been attracted to study learning and training adaptability with the aid of VR Welding Simulator on trainees welding skills development. The objectives of this research are:

i) Identify the level of welding skill among trainee in welding technology using VR Welding Simulator.
ii) Identify the level of welding skill among trainee in welding technology in actual welding process.
iii) Identify the difference of trainee's skill level between using welding simulator and actual welding process.

RELATED WORKS

Welding Skills

In producing a perfect welding result, the method of how the welding has been done, is the most important element. Some of the aspects that need to be focused on in welding are; welding position, which encompasses working angle and movement angle; electrical current and voltage condition, length of arc with work piece and hand movement speed. These features of skills are adapted from the guidelines prepared by NOSS. In order to become a competent welder, trainees should be familiar with the guidelines and every task and duty within the specified meeting hour, as determined by the accreditation centre. This is supported by research that has been undertaken by Kennedy (1982), which states that, in order to be a competent welder, training provided by the qualified welder follows standards of the training providers.

The Application of Virtual Reality in Education and Training

The effectiveness of learning and training through the VR simulator depends on the capacity of the technology in giving exposure and developing student skills. According to Burdea & Coiffet (2003), VR technology benefits education and training in some ways, for example by allowing student to see abstract concepts, and monitor an incident in which the distance, timing and safety factors need not to be worried about. VR technology can also offer effective methods in enhancing some skills. For example sensory motor skills which can be classified as skills that are applied in the real world, such as skill on using equipment, enhancing awareness through simulation usage and training design skills (Javidi, 1999). VR technology also offers one good approach in learning and training. According to (Vora et al, 2001) positive transfer effects exist between virtual state and actual situation during aircraft inspection training. Several studies were done, and found that VR technology was the medium in aircraft inspection training (Nair et al,

2001). Results showed that trainees gain a great deal of experience with the presence of VR technologies.

METHODOLOGY

Research Design

This study was conducted in quantitative research form through descriptive survey methodology which uses questionnaires. Data was gathered by using questionnaires which were circulated to respondents to seek relevant information related to this study.

Population and Samples

This study was carried out at *Pusat Latihan Pengajar dan Kemahiran Lanjutan* (CIAST) Shah Alam, Selangor and *Institut Kemahiran Belia Negara* (IKBN) Pagoh, Johore. Since the VR welding simulator can only be found in those institutes, moreover, the suitability of the simulator could be examined as both institutes run the same programme which is Sijil Kemahiran Malaysia module.

Data Analysis Method

Raw data being gathered was quantitatively analyzed. Descriptive statistic method was used to analyze the data. Data analysis for this study was carried out by using the Statistical Package for the Social Sciences (Version 15). The descriptive analyzed data was then used to find the mean score and percentage.

OUTCOME AND DISCUSSION

The purpose of this survey was to identify trainee's level of welding skill with the usage of VR simulator. The data analysis showed the answer to the first research question, which is:

Research Question 1: What is the level of welding skill technology created among trainees by the usage of VR welding simulator?

10 question item regarding level of welding skill being asked of the respondent. Based on assessment from respondents, mean score for item B1 to B10 are such as in show in Table 1.

The result of the respondent perception on the existence of welding simulator is in high level (min = 3.89). This shows that there was existence of welding skills in trainee through the usage of the VR welding simulator, such as current adjustment, work piece preparation, 1G welding process, electrode touch distance, electrode movement speed, movement and working angle determination, way to do moldings weave in term of width and height aspect and also reading schematic diagram.

Table 1: Welding Skill through the Usage of Simulator Mean.

No	Item	Min	Mean Interpretation
B1	Welding simulator current adjustment	3.81	High
B2	Doing horizontal position welding process (1G)	4.08	High
B3	Preparing a 6mm-9mm thickness workpiece	3.9	High
B4	Fixing the distance between arc and workpiece (1.5mm-3mm)	4.06	High
B5	Doing working angle (90°) for 1G	3.91	High
B6	Doing movement angle (15°-30°) for 1G	3.92	High
B7	Doing weave molding (6mm-9mm wide)	3.58	Medium
B8	Doing high mouldings not exceeded 4mm	3.51	Medium
B9	Controlling the speed of electrode movement	4.13	High
B10	Read and understand schematic diagram	4.01	High
	Overall Interpretation	**3.89**	High

These retrieval results supported by Choquet (2008), which states that VR welding simulator can build motor skill, such as detecting the head and hand movement during welding and help student to identify optimum point of view during welding process. Besides that, there were two items which contribute to moderate level, which are weave molding at 6mm-9mm width (mean 3.58) and height does not exceed 4mm (min = 3.51). This shows that the exits VR welding simulator still cannot provide accuracy training in term of molding's width and height aspect compared to other welding skills and features only being presented in 2D picture form and does not provide a holistic view.

This will make it difficult for trainees to identify the thickness and width of molding. It was supported by a study which was done by Porter et al. (2004) and Wave (2005) which states that simulator design of VR Sim and CS Wave only has the features such as movement angle, work angle, distance between electrode with work piece, speed movement, voltage adjustment and speed of welding wire produced.

To identify actual welding skills among trainee, 10 question item which related to welding skills was asked of the respondents, which are item B11 to B20 such as in shown in Table 2. The analysis of the data stated to answer the second research question which is:

Research Question 2: What is the level of welding skill technology created among trainees by reality welding?

Based on Table 2, welding skill exist in trainees with the usage of reality welding on a very high level (mean 4.06) and founded that mean for every item was higher

than using VR welding simulator mean. This shows that trainee's welding skill can be created efficiently and more competent and qualified by using this reality welding. This is supported by Porter *et al.* (2004) through his study that VR welding simulator created will never replace reality welding because VR welding simulator only help trainees to gain basic welding skill training. This also shows that trainee's welding skill is developed during successing reality welding and experience and early exposure gained through the usage of VR welding simulator assisted the trainee during actual welding process. The result supports a study by Jamak (2003), which stated that basic welding skills development exist with the assist of VR welding simulator.

Table 2: Welding skill through reality welding mean.

No	Item	Min	Mean Interpretation
B11	Welding simulator current adjustment	4.1	High
B12	Doing horizontal position welding process (1G)	4.24	High
B13	Preparing a 6mm-9mm thickness work piece	4.15	High
B14	Fixing the distance between arc and work piece (1.5mm-3mm)	4.12	High
B15	Doing working angle (90°) for 1G	3.97	High
B16	Doing movement angle (15°-30°) for 1G	3.86	High
B17	Doing weave molding (6mm-9mm wide)	3.75	Medium
B18	Doing high molding not exceeded 4mm	3.65	Medium
B19	Controlling the speed of electrode movement	4.26	High
B20	Read and understand schematic diagram	4.15	High
	Overall Interpretation	**4.06**	**High**

However, there was still the medium mean which relates to weave molding (6mm-9mm wide) and high molding not exceeding 4mm. This is because this aspect is the most difficult task to be mastered by the trainees due to the need for high focus during welding and also frequent exercise. Moreover, frequent exercises must be done to get the best welding outcome because according to Rice (2003), even though someone is talented and already expert in doing welding jobs, frequent exercises were needed so that the welding skill will not disappear.

The third research question is to see the different of trainee's welding skill between the usage of VR welding simulator and reality welding.

Research Question 3: Is there are any different of trainee's welding skill between the usage of VR welding simulator and reality welding?

The comparison analysis was shown by percentage. Overall, there was difference between the use of VR simulator welding and reality welding, there are 78.01% respondents agree that welding skill can be developed by the usage of VR welding simulator, while by reality welding 82.52% respondents agreed that welding skill can be developed. However the difference that exists was small from the aspect of welding and not welding process. This was because the welding process was same between VR welding simulator and reality welding. Thurman & Mattoon (1994) stated that in using virtual reality, users saw the existence of virtual surroundings which consist of physical surrounding and it was a part of the simulation. So, the difference was not huge due to this factor, because all the physical features which created by the simulator was similar with reality welding features. This also shows that VR welding simulator successfully created the feelings of welding process similar to reality welding. The usage of VR welding simulator can indirectly be used to develop welding skills. This was supported by Vora *et al.* (2001), stated that positive transfer effect exist in between virtual condition and actual surroundings when dealing with task.

CONCLUSION

From the research analysis shows that respondent agrees with the usage of VR welding simulator as a tool to develop basic welding skills to new trainees is necessary. Beside that, through the usage of VR welding simulator trainee's understanding was much clearer when doing the welding process, and welding skills also developed as well. VR welding simulator also provides experience and understanding about welding techniques. Moreover, VR welding simulator helps trainees to redo the exercises without considering the wastage of work piece and other equipments needed. Nevertheless, the usage of VR welding simulator can detect and improve faults that are hard to detect by reality welding.

As a conclusion VR welding simulator used by the trainees of skill training institutions can help the trainees to develop basic welding skills and achieve the objective based on perception and response given by the trainee.

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