BIS HUMANITIES AND SOCIAL SCIENCE

Volume 1 2024 | DOI: 10.31603/bishss.104
5th Borobudur International Symposium on Humanities and Social Science (BIS-HSS) 2023

UNIMMA PRESS
Universitas Muhammadiyah Magelang

Virtual reality development for learning media welding practice

T H Saputra[1*], M B Triyono[1] and B S Wijanarka[1]

[1] Program Studi Pendidikan Teknologi Kejuruan, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
*Corresponding author email: trihannanto.2022@student.uny.ac.id

Abstract

The purpose of this research and development project is to create virtual reality media that can be used as a tool for learning welding practices. Welding is a process of joining two or more materials to create a strong and stable connection. Welding training is essential for students in vocational schools and for welders in the industry. Conventional welding training has some challenges, such as requiring a lot of resources like money, materials, and labor, as well as a special room or workshop. Additionally, the training is often less engaging for students. To address these challenges, this research uses the ADDIE method, which includes Analysis, Design, Development, Implementation, and Evaluation. The virtual reality learning media includes a Personal Computer, Mouse, Keyboard, VR Glasses, and Touch Controller, and is used as an introduction to welding practice. To measure the perceived feasibility of the virtual reality media, we provide a questionnaire based on consumer perceived value. The results of the feasibility test conducted on welding instructors and students were overwhelmingly positive. This indicates that virtual reality media is a suitable tool for learning welding practices. The media makes it easier for students to understand and practice welding, and also increases their motivation to learn.

Keywords

Virtual reality, Learning media, Welding practice

Introduction

Published:
October 20, 2024

Selection and Peer-review under the responsibility of the 5th BIS-HSS 2023 Committee

Welding is a process that involves joining two or more materials by using high heat to melt and fuse them together. It is an important manufacturing process that requires specialized skills. The materials that are generally welded are metals or thermoplastics. To produce a joint, welders use filler material at the joint of materials to create a molten material, called a weld pool, which cools to form a joint. Welding is a physically demanding and challenging job that requires working in hot conditions. Despite its challenges, it is a necessary process to produce a variety of products and infrastructure.

Vocational education students and welders in industry need welding training. Currently the number of welders is decreasing alarmingly especially in the new generation [1][2].

This is partly due to several problems reported in conventional welding practical sessions involving real welding training. Problems in the economic field include training requires a large cost [3][4], training requires a lot of consumable materials and energy [5][6], training equipment must be frequently maintained [4][7]. Problems in the technical field include welding containing harmful gases and contamination [8][2], welding practices are prone to accidents [9][10], welding is not environmentally friendly [5][6], welding training requires a special room or workshop for training [6][4]. Problems in the social field include the welding profession experiencing social prejudice due to the harsh and high-risk work environment [2], Low motivation among students and prospective workers [10]. Training issues include training is difficult to learn and master [11][4], complexity in implementing educational processes and assessment in learning [11][9][10], welding training requires a lot of guidance from instructors [5][12][8], training requires a relatively long training time [9][6].

These problems must be solved so as not to discourage potential welders. So virtual simulation is a potential and timely solution to this problem. Examples of implementations of virtual simulation are virtual reality (VR) and augmented reality (AR). In VR applications, users immerse themselves in a virtual world and interact with virtual objects. This allows them to interact with virtual objects by using real objects [13]. Previous research states that VR and AR interventions in welding training can improve knowledge transfer, save a lot of consumable costs, and support new pedagogical approaches and learning experiences. Previous research shows that the integration of VR and AR technologies can bring various benefits to education and improve student performance [14][15][16][17]. With the advent of Industrial Revolution 4.0, there is a growing interest in exploring the potential of virtual reality (VR) and augmented reality (AR) technologies in vocational welding training. These technologies can provide useful guidelines for instructors and policy makers to design effective learning materials and enhance students' psychomotor skills. Therefore, the main objective of our study was to conduct a review of the latest developments in the use of VR techniques for welding training. Our research aims to investigate whether VR can effectively improve welding skills.

Methods

Based on the constructivist-oriented process of adult learning [18], Weld VR is designed to provide prospective workers with an interactive experience in conducting welding training. The development of Weld VR was conducted in 5 stages based on the ADDIE model [19]. ADDIE model consists of Analysis, Design, Development, Implementation and Evaluation. This paper reports on the Design, Development, Implementation and Evaluation show in Figure 1.

Figure 1. Using ADDIE Model to develop Weld VR

Analysis

During the analysis stage, a list of requirements is created, such as the necessary equipment, welding procedures, exercises, competencies, and safety measures. Once the list is finalized, the design process commences. To prepare the list, interviews with industry experts, lecturers, and trainers were conducted.

Design

This study involves the use of a computer and Unity Software to design a 3D virtual welding workshop environment. The environment will include workshops, welders, and workpieces. The computer used for the study will have Intel i7 GPU specifications and Nvidia RTX 3060. The researchers will also utilize an Oculus Rift S VR device.

Development

The research was cantered around the stages of design, development, implementation, and evaluation. The simulation design utilized three learning components: a learning guide, a VR simulation, and security learning. Each participant underwent VR welding training, starting with the learning guide, followed by the simulation, and concluding with security learning. Learning media welding show in Figure 2 and Design welding process with welding learning media show in Figure 3.

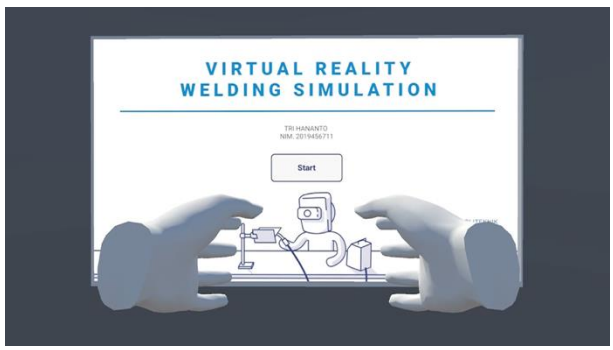

Figure 2. Learning media welding practice

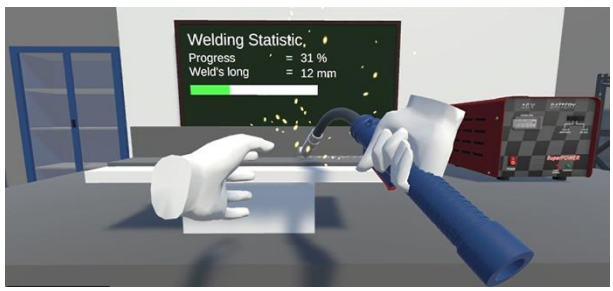

Figure 3. Design welding process with welding learning media welding practice

Implementation

In October 2023, a feasibility test was conducted to evaluate the effectiveness of the learning Media Welding simulation. The test recruited 10 participants who had a

background in industry practices, lecturing, and training. All the participants successfully completed the simulation after undergoing several processes. Firstly, they watched a pre-simulation video briefing, followed by a VR tutorial while wearing the Oculus Rift S. After that, they practiced controller manipulation for about 10 minutes. Finally, they removed the Oculus Rift S and wrote responses to 10 reflective questions. Implementation learning show in Figure 4.

Figure 4. Implementation learning media welding practice

Evaluation

We conducted a qualitative study to examine the possibility of learning Media Welding. We interviewed 10 participants by sending recruitment letters through social networking services and text messaging. We provided a questionnaire containing a questionnaire instrument for the application of perceptions. The instrument is based on Consumer perceived value [20]. In order to participate in the study, individuals had to be users of the learning program known as Media Welding, agree to take part in the trial, and give their written consent. The study was conducted in a classroom on a day when classes were not regularly scheduled, and involved the use of a simulation for the Media Welding program.

Results and Discussion

Participant characteristics

The average age of the 10 male participants was 39.12 years. 71.65% had basic welding experience and 28.35% had advanced welding experience.

Qualitative results

According to the feedback received from participants, the Media Welding learning program has been found to be effective in enhancing the learning experience. This is due to the immersive environment facilitated by the Oculus Rift S and learning guides. After practicing with the Media Welding program, participants reported an improvement in their welding competency. They found the program to be of an appropriate difficulty level, which encouraged learning and was useful for repetitive learning. Participants also found the program easy to operate. However, they suggested that the program could be further improved by adding a pre-briefing video and providing feedback during the learning process. Interviews and questionnaires given to

participants showed that all participants (100%) agreed that VR Welding is feasible to use to help develop welding skills.

Conclusion

Students who are pursuing vocational education and welders who work in the industrial sector require proper welding training. However, traditional welding training can be expensive, time-consuming, and requires a specialized workshop or room. Moreover, students often find the training process less engaging. To address these challenges, experts have developed a simulator using virtual reality (VR) called Learning Media Welding Practice. This simulator provides a more realistic and immersive experience to trainees. The main goal of this simulator is to offer comprehensive training to welding trainees. According to the results of a study based on consumer perceived value, VR Welding training is worth using to help develop welding skills.

Acknowledgments

This research was conducted at Universitas Negeri Yogyakarta and Politeknik ATMI Surakarta.

References

[1] G. Franklin Bickerstaff, "The Use Of Welding Simulators Improves Proficiency In Entry-Level Welding Students," 2015.

[2] J. Yao, S. I. Peleshenko, V. N. Korzhik, V. Y. Khaskin, and V. V Kvasnitsky, "Concept of creation of an improved artifical intelligence system and computerized trainer for virtual welding," Pat. Weld. J., vol. 2017, no. 6, pp. 19–26, 2017, doi: 10.15407/tpwj2017.06.04.

[3] D. Dalto, F. Benus, and O. Balet, "The use and benefits of Virtual Reality tools for the welding training," 63rd Annual Assembly & International Conference of the International Institute of Welding, vol. 63. pp. 587-592 PP-Istanbul, Turkey, 2010.

[4] F. Torres-Guerrero, L. Neira-Tovar, and L. M. Torres-Treviño, "An Introductive Training for Welding Workshop: A Biometric Evaluation Using Virtual Reality Scenes to Improve Practice," pp. 319–331, 2019, doi: 10.1007/978-3-030-18715-6_27.

[5] H. Liyang, "Application of welding simulation training system," IOP Conf. Ser. Mater. Sci. Eng., vol. 439, p. 32122, 2018, doi: 10.1088/1757-899x/439/3/032122.

[6] A. H. Price, M. Kuttolamadom, and S. M. Obeidat, "Using virtual reality welding to improve manufacturing process education." 2019. [Online]. Available: https://api.semanticscholar.org/CorpusID:213346900

[7] F. Torres, L. A. N. Tovar, and M. Sylvia del Rio, "A Learning Evaluation for an Immersive Virtual Laboratory for Technical Training applied into a Welding Workshop," EURASIA J. Math. Sci. Technol. Educ., vol. 13, no. 2, 2017, doi: 10.12973/eurasia.2017.00629a.

[8] B. Xie, Q. Zhou, and L. Yu, "A real-time welding training system base on virtual reality," 2015 IEEE virtual Real. Conf., pp. 309–310, 2015, doi: 10.1109/vr.2015.7223419.

[9] J.-H. Ko, T.-H. Kim, J.-S. Choi, A. Angani, and H. T. Chung, "Development of Haptic Virtual Welding Torch Control System Using 3D printing," 2019 IEEE Int. Conf. Archit. Constr. Environ. Hydraul., pp. 29–32, 2019, doi: 10.1109/icaceh48424.2019.9041844.

[10] H. J. Yap, Z. Taha, H. L. Choo, and C. K. Kok, "Virtual Reality-based Training System for Metal Active Gas Welding," 2014, doi: 10.5772/59279.

[11] L. Baglow and C. Lovegrove, "Student perspectives, virtual welders and their effectiveness in developing welding skills.," www.researchbank.ac.nz, 2017, [Online]. Available: https://hdl.handle.net/10652/4270

[12] S. A. White, M. Prachyabrued, T. L. Chambers, C. W. Borst, and D. Reiners, "Low-cost simulated MIG welding for advancement in technical training," Virtual Real., vol. 15, no. 1, pp. 69–81, 2010, doi: 10.1007/s10055-010-0162-x.
[13] D. Chae, J. Kim, K. Kim, J. Ryu, K. Asami, and A. Z. Doorenbos, "An Immersive Virtual Reality Simulation for Cross-Cultural Communication Skills: Development and Feasibility," Clin. Simul. Nurs., vol. 77, no. Chae, D., Kim, J., Kim, K., Ryu, J., Asami, K., Doorenbos, A. Z. (2023). An Immersive Virtual Reality Simulation for Cross-Cultural Communication Skills: Development and Feasibility. Clinical Simulation in Nursing, 77, 13–22. https://doi.org/10.1016/j.e, pp. 13–22, 2023, doi: 10.1016/j.ecns.2023.01.005.
[14] A. A. Ali, G. A. Dafoulas, and J. C. Augusto, "Collaborative Educational Environments Incorporating Mixed Reality Technologies: A Systematic Mapping Study," IEEE Trans. Learn. Technol., vol. 12, no. 3, pp. 321–332, 2019, doi: 10.1109/tlt.2019.2926727.
[15] D. F. Angel-Urdinola, C. Castillo-Castro, and A. Hoyos, "Meta-Analysis Assessing the Effects of Virtual Reality Training on Student Learning and Skills Development," openknowledge.worldbank.org, vol. 9587, no. 1, 2021, doi: 10.1596/1813-9450-9587.
[16] L. Cen, D. Ruta, L. Mahmoud Mohd Said Al Qassem, and J. Ng, "Augmented Immersive Reality (AIR) for Improved Learning Performance: A Quantitative Evaluation," IEEE Trans. Learn. Technol., p. 1, 2019, doi: 10.1109/tlt.2019.2937525.
[17] C. de Armas, R. Tori, and A. V. Netto, "Use of virtual reality simulators for training programs in the areas of security and defense: a systematic review," Multimed. Tools Appl., vol. 79, no. 5–6, pp. 3495–3515, 2019, doi: 10.1007/s11042-019-08141-8.
[18] S. J. Allen, D. M. Rosch, and R. E. Riggio, "Advancing Leadership Education and Development: Integrating Adult Learning Theory," J. Manag. Educ., vol. 46, no. 2, p. 105256292110086, 2021, doi: 10.1177/10525629211008645.
[19] M. Molenda, J. A. Pershing, and C. Reigeluth, "Designing instructional systems (83)," in The ASTD Training and Development Handbook, McGraw-Hill, 1996, pp. 266-293 PP-New York.
[20] J. C. Sweeney and G. N. Soutar, "Consumer perceived value: The development of a multiple item scale," J. Retail., vol. 77, pp. 203–220, 2001, doi: https://doi.org/10.1016/S0022-4359(01)00041-0.