A CASE STUDY OF OSH STUDENTS' EXPERIENCE WITH THE USE OF VIRTUAL REALITY AS A LEARNING MEDIA IN THE CONSTRUCTION SECTOR AT THE PUBLIC HEALTH PROGRAM, GADJAH MADA UNIVERSITY

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ABSTRACT

This study explores students' experiences using Virtual Reality (VR) as a learning medium for Occupational Safety and Health (OSH) in the construction sector at the Public Health Study Program, Gadjah Mada University. A qualitative research design with a case study approach was employed, involving 15 participants selected from 43 respondents. Data were collected through in-depth interviews after participants underwent VR OSH training. The analysis revealed that VR provided an engaging and enjoyable learning experience, enhancing students' understanding of safety protocols in hazardous situations. Participants found the VR content relevant and offered practical insights without physical risk. The effectiveness and efficiency of using VR for OSH training were widely recognized, with positive feedback regarding comfort and visual clarity. These findings indicate that VR has the potential to be an innovative tool in OSH education, bridging the gap between theory and practice. The study concludes that integrating VR into higher education curricula can significantly enhance learning experiences and deepen students' understanding of OSH concepts.

KEYWORDS	Virtual Reality, Occupational Safety and Health, learning, higher education, student experience.

INTRODUCTION

The International Labour Organization (ILO) estimates that annually, 2.3 million individuals lose their lives due to work-related accidents or diseases. Of this, over 350,000 deaths result from fatal accidents, and nearly 2 million are due to work-related fatal diseases (ILO, 2015). In Indonesia, workplace accidents have been on the rise since 2017, with a 5.65% increase in 2021 compared to the previous year (Mahdi, 2022). Occupational Safety and Health(OSH) is crucial, yet traditional training methods often fail to prepare workers for workplace risks. A European study (Lindholm et al., 2019) reveals diverse perspectives among students, emphasizing the need for improved OSH education at the university level.

The use of Virtual Reality (VR) in Occupational Health and Safety (OHS) education offers significant advantages over conventional methods, particularly in high-risk industries such as construction. Unlike traditional lectures or manuals, VR provides an immersive and interactive learning experience that allows students to simulate hazardous conditions in a safe, controlled environment. This approach enhances understanding and increases retention of safety procedures through experiential learning. Studies by Sacks et al. (2013) and Li et al. (2022) confirm that VR improves hazard recognition and decision-making capabilities, making it an effective tool in safety training. Furthermore, VR's visual and kinesthetic elements accommodate diverse learning styles and foster higher engagement among learners. In this study, students reported feeling more engaged and better able to understand OHS protocols after using VR, which supports the assertion that VR bridges the gap between theoretical knowledge and practical application. The ability to simulate real-life scenarios, such as working at heights or responding to equipment failure, without exposing students to actual risk is a significant strength of this method. Therefore, VR can serve as an innovative complement to traditional safety training, helping future public health professionals internalize safety principles more effectively and confidently.

Amid technological advancements, Virtual Reality (VR) emerges as an interactive tool for OSH learning. VR offers a simulated environment for training, particularly beneficial when real-life scenarios are impractical or dangerous (Au & Lee, 2017). Recent developments also indicate its efficacy for individuals with Autism Spectrum Condition (Kurniawati & al., 2020). Studies (Bernal & al., 2022) Li et al. (2022) underscore the effectiveness of VR in enhancing safety training, emphasizing its customization benefits. However, prior VR research lacks user experience and product usability assessments. Based on the background description above, the problem formulation in this research is "How is the experience of using virtual reality as an OSH learning medium for the construction sector in the Public Health Study Program at Gadjah Mada University?"

Motivated by VR's potential, this research aims to explore students' experiences with VR as an OSH learning medium in the construction sector at Gadjah Mada University. The research seeks to understand user perceptions, attractiveness, visual clarity, tool efficiency, content accuracy, and novelty. The ultimate goal is to assess VR's usability and user experience, contributing to its potential integration as a supplementary OSH learning tool.

RESEARCH METHOD

This study adopts a qualitative research design with a case study approach to thoroughly explore the experiences of students engaged in Construction Sector Occupational Safety and Health (OSH) learning through the use of Virtual Reality (VR). The primary focus is on OSH Students, enrolled in the Public Health Science Program at Gadjah Mada University. The preliminary research participants were selected by administering a Google Form survey to students enrolled in the Occupational Safety and Health class for the Master of Public Health Study Program from 2021 to 2023. Out of the 43 respondents who completed the survey, only 15 fulfilled the inclusion and exclusion criteria stipulated in the research design.

Conducted within the academic premises of the Faculty of Medicine, Public Health, and Nursing at Gadjah Mada University, the research received ethical approval (No: KE/FK/1327/EC/2023) and was conducted in September 2023. The methodological approach involved offline, in-depth interviews to collect comprehensive data. Every participant was allowed to partake in the VR OSH training, and subsequent in-depth interviews were conducted to delve into their perspectives and responses to this innovative learning medium.

To enhance the rigor of the qualitative analysis, the data obtained through in-depth interviews were transcribed verbatim and systematically analyzed using thematic analysis. Coding was carried out manually and assisted with the use of qualitative data analysis software, NVivo 12 Plus, which facilitated the organization, categorization, and visualization of data. Initial open coding identified emerging themes from participants' responses, which were then grouped into axial codes to establish patterns and relationships. Thematic mapping was used to develop core themes aligned with the research objectives, particularly regarding user experience, content accuracy, and engagement level with VR-based OSH learning. Triangulation with field notes and reflective journaling was also employed to increase the credibility of the analysis. This structured approach ensured that the insights derived were grounded in the participants' perspectives and coherent with the research framework, ultimately contributing to a more robust interpretation of VR's usability and effectiveness in the context of construction safety training.

RESULT AND DISCUSSION

Result

The qualitative analysis of user experience in employing Virtual Reality (VR) as a learning medium for Construction Sector Occupational Safety and Health (OSH) revealed diverse responses from students. The themes extracted covered aspects like tool usage, media appeal, content relevance, visual clarity, efficiency, effectiveness, and novelty.

Tool Usage: Users needed time to acclimate to VR devices, varying from minutes to hours. Comfort and ease of use were emphasized, with positive feedback on grip comfort and practicality. Safety concerns were raised, but overall, users found the devices user-friendly.

Media Appeal: Motivation to use VR was high, with students finding it an engaging and enjoyable learning method. The "fun learning" aspect was highlighted, suggesting that VR's visual nature made learning more interesting than traditional methods.

Content Relevance: The VR content was deemed relevant, providing practical insights into occupational safety. Users appreciated the connection between VR simulations and real-world scenarios, enhancing their understanding of safety protocols.

Visual Clarity: VR's resolution and visual quality were commended, offering a detailed and realistic experience. Despite some feedback on less realistic graphics, the overall visual clarity was considered beneficial, contributing to a more immersive learning environment.

Novelty of VR Media: The novelty of VR as an educational tool was acknowledged. Students perceived VR as an innovative approach, bridging the gap between theory and real-world application. Its potential to revolutionize safety education in universities was recognized.

In analyzing user perceptions of Virtual Reality (VR) in OSH learning,

Perception of product usability refers to users' views and evaluations on how effectively, efficiently, and satisfactorily a product can be utilized. Here are the perceptions of effectiveness and efficiency:

Efficiency of Tools: Most students found VR tools efficient for OSH training, emphasizing cost-effectiveness and the ability to facilitate training. However, a few expressed concerns about costs and the availability of units, highlighting the need for careful consideration.

Effectiveness of VR Media: VR was recognized as a transformative learning tool, providing deep and interactive experiences. Students felt more connected to the practical aspects of OSH, enabling a better understanding of risks and safety measures.

Participants expressed unanimous agreement on its educational utility. The consensus among users was that VR serves as an effective tool within academic institutions and holds practical value in corporate environments. Here are excerpts reflecting participants' views on the usability of VR:

"For someone like me, unfamiliar with OSH, VR provides a deeper understanding, especially regarding equipment usage and field scenarios. It's genuinely useful." (R1)

"Yes, it's useful for learning. When going to the field, it provides knowledge about safety measures that should be handled with care." (R3)

"Experiencing field conditions directly through VR is useful, particularly for ordinary people who are typically restricted from certain dangerous areas. It's quite interesting and attractive." (R7)

"VR significantly enhances understanding by allowing us to directly experience situations. It goes beyond reading theory, providing an amazing immersive experience." (R13)

The unanimous positive feedback suggested that VR effectively bridges the gap between theory and practical experience. Users recognized its value in educational contexts and envisioned its broader application in diverse industries.

Virtual Reality (VR) presents substantial potential in Occupational Health and Safety (OSH) education, overcoming limitations of conventional methods. Traditional approaches relying on textbooks and lectures provide minimal direct experience, making workplace safety concepts seem theoretical and less practically understood. In contrast, VR excels in delivering immersive experiences. Interviews revealed significant potential:

a. Simulation of Hazardous Conditions: VR realistically exposes students to hazardous conditions without actual physical risk. Respondents emphasized the eye-opening nature of VR simulations.
   1) "Virtual reality truly opened my eyes to the risks at heights. Even though it's just a simulation, I felt like I was truly on the edge of a building." (R1)
   2) "VR allows us to experience hazardous conditions without real danger. It's comfortable." (R3)
   3) "The simulation experience in virtual reality provides direct insights into the dangers and preparations one might face in a construction environment." (R5)
b. Training on Personal Protective Equipment (PPE): In construction-related OSH training, VR engages students in simulating the use of Personal Protective Equipment (PPE). Participants expressed the effectiveness of this approach.
   1) "Learning to choose the right PPE before working in a construction environment is excellent." (R7)
   2) "I have never handled these PPE tools myself; through VR simulation, I now have an idea." (R9)

These findings underscore VR's transformative potential to enhance OSH education through realistic hazard simulations, PPE training, and exposure to intricate scenarios.

Discussion

The study delves into the transformative impact of Virtual Reality (VR) on Occupational Safety and Health (OSH) education within the Public Health Program, specifically focusing on the construction sector. Participants' experiences revealed a seamless integration of VR tools into the learning environment, highlighting their comfort and adaptability. This aligns with broader research asserting VR's capacity to provide immersive and interactive learning experiences without the constraints of traditional classroom settings (Marks et al., 2017).

The study also emphasized the emergence of a "fun learning" concept, with students motivated by curiosity and a desire for novel experiences, as supported by Loseva-Rimsha (2022). Furthermore, VR was recognized for its ability to deliver content tailored to students' needs, effectively bridging the gap between theoretical and practical learning. Study conducted by Adžgauskait (2020) stressed the significance of accurate content delivery to meet specific experiential needs, positioning VR as a valuable tool in facilitating personalized learning experiences.

The visual clarity of VR content, demonstrated through 3D depictions, emerged as a crucial factor influencing students' simulation experiences, consistent with the findings of (Zhao & al., 2019) and (Papagiannakis & al., 2018). Additionally, participants acknowledged the efficiency gains of VR in terms of cost

and its facilitation of OSH training, echoing the sentiments of (X. Li & Heidari, 2020).

Finally, the study underscored participants' recognition of VR as an innovative approach to OSH learning, aligning with research by Saniyah (2023) and Roy & al (2022), highlighting that VR-based learning technologies elevate interactive and immersive learning experiences, fostering real-world engagement. The study affirms VR's pivotal role in reshaping OSH education in the construction sector, offering a dynamic, engaging, and effective learning paradigm.

The perception of product usability refers to users' views and evaluations of how effectively, efficiently, and satisfactorily a product can be used. In the realm of tool efficiency, research participants found that the utilization of VR devices can offer various efficiencies, both in terms of cost and facilitating Occupational Health and Safety (OSH) training. A study by Li & Heidari (2020) proposed the use of VR technology in technical training programs at universities to provide intensive VR training for safety and economic efficiency. VR enhances training efficiency across various domains, including technical training programs, laboratory environments, construction equipment safety training, and flight training.

Moreover, this research focuses on the effectiveness of VR media in supporting the understanding of OSH concepts. Interviews revealed that VR effectively supports the comprehension of OSH concepts, especially for students with limited prior work experience, particularly in construction. According to employed participants, VR is effective in providing insights to non-compliant workers regarding OSH. This underscores VR's potential to enhance learning effectiveness, particularly in the realm of OSH.

Research by Yossatorn & Nimnual (2019) developed a VR anatomy vocabulary learning program, testing its effectiveness and user satisfaction among medical experts, VR professionals, and thirty healthcare practitioners. The results demonstrated that the program's development was practical and applicable to future educational and research training. Additionally, a randomized control trial by Yu et al (2022) aimed to test VR's feasibility and initial effectiveness as an educational tool for cancer patients undergoing immunotherapy. The study indicated that using VR to convey medical information to patients could bridge communication gaps and result in more effective patient education. These findings collectively affirm VR's potential as a practical, applicable, and effective tool in the future development of education and training, especially in occupational health and safety.

Students' perceptions of the usability of VR in OSH learning reveal its potential for education in both academic institutions and corporate training. They perceive this technology as having practical applications in the real world, aiding companies in training their employees more interactively and effectively. This opens opportunities for educational institutions and training program development in industries focusing on OSH. Students view VR as a tool enabling them to conduct simulations and visualize workplace situations related to OSH, facilitating a better understanding of the practical impact of OSH principles, especially in the construction sector.

A study conducted by Renganayagalu (2021) illustrates the implementation of AI services in IBM Watson to facilitate user interactions in a virtual reality space

for training simulations. This project aims to enhance employee training efficiency by creating an immersive 3D VR environment tailored to specific professions. The study also emphasizes VR's versatility in simulating hazardous or uncommon situations, proving its utility across various fields.

VR is increasingly utilized in the construction industry for safety training, education, and project management. For instance, research by Getuli (2021) proposes safety training protocols based on VR simulations with BIM capabilities, addressing planning, management, and administrative issues to reduce accidents and enhance productivity on construction sites. Another study conducted by Chellappa (2022) A review of VR-based safety training in construction highlights the prevalence of immersive training methods and emphasizes VR's role in visualizing and managing construction projects.

Students express a desire for VR to be integrated into educational institutions, allowing them to bridge theoretical OSH learning with practical applications, fostering a more active learning process. This aligns with Li et al., (2022) findings, indicating that VR enhances online distance learning, offering an alternative to traditional face-to-face teaching, positively impacting teacher-student communication and student self-efficacy. VR facilitates more engaging and efficient learning processes, transforming students' perceptions of technology and classroom engagement. VR has the potential to transform theory into practical experience, aligning with theories of visual and kinesthetic learning. Dr. Eng. Herry Santosa (2021) emphasizes the importance of visualization and hands-on experience in learning, with VR allowing students to "see" and "feel" concepts or situations in a virtual setting close to reality (Santosa, 2021)Moreover, VR enables training participants to experience hazardous situations without physical risk, reducing dependence on physically challenging and costly environments. This reflects positive shifts in educational methodologies.

As students engage with VR, seamlessly transitioning between theory and hands-on experiences, they are more likely to comprehend and retain the material effectively, fostering a deeper understanding of the relationship between theory and practice. Thus, VR is expected to be a crucial tool supporting a more effective learning process in OSH education.

Virtual reality (VR) emerges as a revolutionary force in Occupational Health and Safety (OSH) education, surmounting limitations of traditional approaches. Students benefit from realistic exposure to hazardous scenarios in VR, sans physical risks, fostering insights into workplace risks. Informants highlight VR's role in comprehending height-related dangers, practicing PPE usage, and navigating diverse scaffolding scenarios. Notably, Hidetoshi and Kosei underscore VR's application in evaluating construction site layouts, contributing to hazard identification and bolstering overall construction safety.

CONCLUSION

To optimize Virtual Reality (VR) integration in Occupational Health and Safety (OHS) education, educational institutions are encouraged to adopt a phased implementation approach. Initially, institutions can introduce VR modules as

supplementary training tools alongside traditional teaching methods. This can be done through pilot projects targeting high-risk scenarios such as working at heights, fire evacuations, or using Personal Protective Equipment (PPE) correctly. Institutions should also invest in instructor training to ensure educators are proficient in operating VR systems and facilitating experiential learning effectively. Furthermore, collaboration with technology developers is essential to produce context-specific and culturally relevant content that aligns with national K3 standards. Regular evaluation and feedback mechanisms from students should be embedded into the VR learning process to refine content and usability continually. By integrating VR into the curriculum with appropriate pedagogical support, educational institutions can create a more immersive, safe, and impactful learning environment that prepares students with real-world K3 competencies.

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