ENHANCING HAJJ LEARNING OUTCOMES USING DEEP LEARNING AND VIRTUAL REALITY TECHNOLOGY

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Abstract

This study aims to examine the effectiveness of Deep Learning-based Virtual Reality (VR) learning media on Hajj material in improving students' learning outcomes in accordance with the Independent Curriculum for phase D learners. The research continues the previous development stage, which demonstrated that the media was highly feasible and suitable for educational use, with validation scores of 82.5% from material experts, 85% from media experts, and student response scores of 88.6% and 84.6% in small- and large-scale trials respectively. The current phase focuses on evaluating the media's impact on students' cognitive achievement through experimental testing in three schools: SMP Negeri 1 Bojonegoro, SMP Negeri 1 Sumberrejo, and MTs Plus Miftahul Ulum Bulu Balen Bojonegoro. The results indicate a significant improvement in students' learning outcomes when using the VR-based media compared to conventional learning methods. The immersive environment provided by VR allows students to experience the Hajj rituals more interactively and meaningfully, fostering mindful, meaningful, and joyful learning. Therefore, the integration of Deep Learning and VR technologies proves to be an effective approach to enhancing comprehension and engagement in Hajj learning materials. This study contributes to the development of innovative Islamic education media that aligns with the principles of deep learning and the goals of the Independent Curriculum.
Keywords: *Deep Learning; Virtual Reality; Hajj.*

INTRODUCTION

Learning about Hajj rituals is an important part of Islamic education. However, teaching this material is often limited to verbal explanations or textbook illustrations, which make it difficult for students to understand the real atmosphere and sequence of Hajj activities. Many students struggle to imagine the process of performing Hajj in a meaningful and engaging way. Therefore, innovative learning media are needed (Handayani et al., 2023), to help students experience Hajj more realistically and understand its meaning more deeply. Understanding the correct procedure (kaifiat) of worship is a recurring concern in Indonesian Islamic guidance, as reflected in MUI fatwas on how worship should be performed under particular conditions (Oktalita & Rizki, 2021).

Virtual Reality (VR) technology provides a promising solution to this challenge (Shofiyuddin, Manshur, et al., 2025). Through immersive visual and interactive environments (Khoiriyah et al., 2025), students can experience the steps of Hajj as if they were physically present in Mecca. When combined with a deep learning

approach, VR can encourage students to learn meaningfully (Feriyanto & Anjariyah, 2024), mindfully (Cendana & Sari, 2025), and joyfully (Maknun & Niswar, 2025). Previous studies (Fitrianto & Saif, 2024) have shown that VR-based learning can improve students' engagement, motivation (Wijayama et al., 2024), and conceptual understanding (Marougkas et al., 2023). However, most existing research still focuses on product development or feasibility testing, without measuring how much such media can actually improve students' learning outcomes. The influence of digital media on Muslim audiences is also evident beyond the classroom, where social media has been shown to shape concrete behavior such as consumer boycotts (Rizki et al., 2025).

Based on this gap, this study aims to examine the effectiveness of Deep Learning-based Virtual Reality media in improving students' learning outcomes in *Hajj* material. This research continues the previous phase that focused on feasibility testing, which showed very good results. In this study, the concept of Deep Learning is not related to artificial intelligence but refers to a pedagogical approach that emphasizes *mindful*, *meaningful*, and *joyful* learning. *Mindful learning* encourages students to be fully aware and reflective during the learning process, *meaningful learning* helps them connect new knowledge with real-life experiences and prior understanding, and *joyful learning* creates a positive emotional environment that increases motivation and curiosity. The integration of these principles with Virtual Reality technology allows students to experience *Hajj* rituals more vividly and personally, fostering deeper understanding and engagement. Therefore, this study focuses on evaluating how the developed media influences students' comprehension and learning achievement. The findings are expected to contribute to the development of innovative Islamic learning media and provide new insights into how VR and Deep Learning can support the goals of the Independent Curriculum.

METHOD

Research Design

This study employed a Research and Development (Gustiani, 2019) approach using the ADDIE model (Jayani, 2024), which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. The current phase focused on the implementation and evaluation stages to test the effectiveness of the previously developed Deep Learning-based Virtual Reality media for *Hajj* material. The design of this study used a quasi-experimental method with a pretest-posttest non-equivalent control group design. This design aimed to measure the improvement in students' learning outcomes after using the VR-based media compared to conventional learning methods.

Participants

The participants of this study were students from three junior high schools in Bojonegoro Regency: SMP Negeri 1 Bojonegoro, SMP Negeri 1 Sumberrejo, and MTs Plus Miftahul Ulum Bulu Balen. These schools were selected based on their readiness to integrate technology into Islamic education and their prior participation in the product feasibility stage. The participants were students in phase D (grade VIII) under the Independent Curriculum. A total of 90 students participated in the study, divided into experimental and control groups for comparative analysis.

Data Collection

Data were collected through pretests and posttests to measure students' cognitive learning outcomes related to *Hajj* material. The experimental group learned using the Deep Learning-based VR media, while the control group used conventional learning methods. The learning activities were conducted in three sessions over two

weeks. Observations and questionnaires were also used to gather data on students' engagement and responses to the learning experience. In addition, interviews with teachers were conducted to obtain qualitative insights regarding the practicality and impact of the media in classroom settings.

Data Analysis

The collected data were analyzed quantitatively and qualitatively. Quantitative data from the pretest and posttest were analyzed using descriptive statistics and paired sample t-tests to determine the significance of the improvement in learning outcomes. The gain score was calculated to identify the effectiveness level of the media. Meanwhile, qualitative data from observations and interviews were analyzed thematically to describe students' learning experiences, focusing on mindful, meaningful, and joyful aspects of learning. The results from both analyses were then interpreted to provide a comprehensive understanding of the media's impact on students' learning achievement.

FINDINGS

The findings of this research are divided into two main parts: (1) the feasibility results of the Deep Learning-based Virtual Reality (VR) media for *Hajj* material, and (2) the effectiveness of the media in improving students' learning outcomes. Both parts are presented to demonstrate the overall quality and impact of the developed learning innovation.

Product Feasibility Results

The feasibility testing phase aimed to evaluate the quality of the developed media before it was implemented in the classroom. Expert validation involved two categories: material validation and media validation. The material expert provided a score of 82.5%, indicating that the content accuracy, sequence, and alignment with the *Hajj* learning objectives were highly appropriate. Meanwhile, the media expert gave a score of 85%, suggesting that the VR-based media design was visually appealing, interactive, and user-friendly for students at the junior high school level.

Student trials were also conducted in two stages: a small-scale test and a large-scale test. The small-scale test, involving a limited number of students, achieved a response score of 88.6%, showing strong enthusiasm and positive perceptions toward the media. The large-scale trial, which included more students from three different schools, obtained an average response of 84.6%. When averaged across all validation and trial results, the overall feasibility score reached 85.2%, categorizing the product as *highly feasible* for use in Islamic learning contexts. These results confirm that the developed VR media meets both technical and pedagogical standards, making it suitable for the next stage of effectiveness testing.

Students' Learning Outcomes

After confirming its feasibility, the research continued to the effectiveness phase to measure how the developed VR media influenced students' learning outcomes. The study used a quasi-experimental design with two groups: the experimental group, which used the Deep Learning-based VR media, and the control group, which received instruction through conventional methods such as lectures and textbooks.

The pretest and posttest data revealed significant differences between the two groups, showing that the Deep Learning-based Virtual Reality media had a strong effect on students' learning outcomes. Before using the media, the average pretest score in the experimental group was 69.4, reflecting a moderate level of understanding of Hajj material. After the implementation of VR-based learning, the average posttest score increased remarkably to 86.8, indicating a substantial improvement in students'

comprehension, retention, and ability to recall procedural knowledge related to Hajj rituals. In contrast, the control group, which received instruction through conventional classroom methods such as lectures and textbook explanations, showed only a modest improvement, from an average pretest score of 74.2 to a posttest score of 82.1. This relatively small increase suggests that traditional approaches were less effective in promoting meaningful understanding of the material.

Students' Learning Experience

The quantitative findings were strongly supported by qualitative data gathered from classroom observations, student reflections, and teacher interviews. Students consistently reported that using VR helped them understand the *Hajj* rituals more clearly because they could see and experience the process as if they were physically present in Mecca. The immersive learning environment made them feel more focused and connected to the material. They described the learning experience as enjoyable and inspiring, noting that they were more curious and motivated to explore each stage of the *Hajj* journey, as shown in Figure, this was reflected in their active engagement and enthusiasm during the implementation process. This is relevant for a generation whose religious outlook has itself become a subject of study, as in research on the reception of public issues among Gen Z Muslims in Indonesia (Rizki et al., 2022).



Figure 1.

Teachers also observed a noticeable improvement in classroom dynamics. Students became more active in discussions, asked deeper questions, and demonstrated greater empathy toward the spiritual values of *Hajj*. These findings illustrate the realization of the Deep Learning principles: *mindful learning*, students learned with full awareness and reflection; *meaningful learning*, they connected new knowledge to real-life religious contexts; and *joyful learning*, they experienced satisfaction and enthusiasm throughout the process.

Comparison with Previous Studies

Compared with previous studies on AR and VR in Islamic education, which mainly focused on product development and usability (Shofiyuddin, Choiri, et al., 2025), this research contributes new empirical evidence regarding measurable improvements in learning outcomes. While earlier works demonstrated that VR increases engagement, this study shows that when combined with a Deep Learning approach, VR can also lead to deeper conceptual understanding and sustained

motivation. The combination of immersive technology and reflective pedagogy thus creates a more holistic learning experience, bridging cognitive, affective, and spiritual dimensions of Islamic learning.

DISCUSSION

The results of this study reveal that the integration of Deep Learning principles with Virtual Reality technology in learning *Hajj* material produces a significant positive impact on students' learning outcomes. The increase in posttest scores, from 69.4 to 86.8 in the experimental group, shows that students not only gained factual knowledge but also developed a deeper conceptual understanding of *Hajj* rituals. This improvement indicates that when learning is designed through immersive experiences (Shofiyuddin, Choiri, et al., 2025), students can engage in more reflective and meaningful learning processes. Such outcomes align with the goals of the Independent Curriculum, which emphasizes active, contextual, and student-centered learning experiences.

One of the main reasons for this improvement lies in the application of Deep Learning as a pedagogical framework. Deep Learning in this context does not refer merely to artificial intelligence, but rather to *mindful*, *meaningful*, and *joyful learning* (Feriyanto & Anjariyah, 2024). The VR-based *Hajj* simulation encouraged *mindful learning* by prompting students to focus their attention and awareness on the sequence of *Hajj* rituals, something that traditional lectures often fail to achieve. As students interacted with the virtual environment, they experienced *meaningful learning* through the connection of abstract religious concepts (such as *tawaf* or *wuquf*) with visual, concrete representations. Additionally, the immersive and game-like nature of VR promoted *joyful learning*, which fostered intrinsic motivation and emotional engagement, two critical factors for long-term knowledge retention.

These findings corroborate the works of (Iis Suryantini, et al., 2024), who found that VR-based Islamic learning environments increase students' engagement and moral reflection. Similarly, (Pitsikalis et al., 2024) emphasized that immersive experiences enhance both cognitive and affective learning outcomes, especially in topics related to ritual and practice. However, the present study advances these findings by combining the VR approach with a structured Deep Learning framework, emphasizing awareness, meaning construction, and emotional resonance. This integration offers a more holistic learning model that connects cognition, emotion, and spirituality, dimensions often treated separately in traditional Islamic education.

Further analysis shows that students in the experimental group demonstrated higher self-regulation and motivation during learning sessions. They asked more critical questions, engaged in peer discussions, and displayed stronger recall of procedural knowledge. These behavioral changes align with theories of experiential learning (Rahmi, 2024), which assert that learning becomes more effective when learners actively construct knowledge through concrete experiences and reflective observation. The VR environment provided these conditions by allowing learners to "experience" *Hajj* rather than merely memorize its steps. Consequently, their understanding became more internalized, and their attitudes toward the *Hajj* ritual became more appreciative and reflective.

However, the study also identified several challenges that should be addressed in future implementations. The first is related to infrastructure readiness. Some schools faced difficulties with device compatibility and internet bandwidth, which slightly affected user experience during large-scale trials. Secondly, although most students adapted quickly to VR navigation, a small portion required additional guidance, indicating a need for preliminary digital literacy orientation. These findings are consistent with prior research by (Akhyar et al., 2025), who noted that technology-driven religious learning environments demand careful consideration of learners' readiness and contextual limitations. Similar gaps in digital literacy and infrastructure have been documented elsewhere in Indonesia, for instance in rural Aceh, where practical training is needed to support digital transformation (Noviar et al., 2026).

Despite these challenges, the overall results suggest that VR-based *Hajj* learning can serve as an effective bridge between traditional Islamic education and modern pedagogical innovation. It encourages teachers to adopt roles as facilitators and guides, rather than sole knowledge providers. The deep learning-based design fosters collaboration, reflection, and exploration, creating a more humanistic and student-centered learning environment. This shift aligns with contemporary educational reform movements in Indonesia that seek to balance cognitive achievement with moral and spiritual development. Such innovation also supports the broader aims of Islamic education in Indonesia, including the cultivation of moderate religious understanding (Murad & Rizki, 2022).

CONCLUSION

This study concludes that the integration of Deep Learning principles, comprising mindful, meaningful, and joyful learning, with Virtual Reality technology significantly enhances students' understanding and engagement in Hajj material. The developed media not only proved feasible through expert validation but also demonstrated measurable improvements in students' learning outcomes compared to conventional methods. These results confirm that immersive, student-centered approaches can transform Islamic education into more interactive and reflective experiences. Beyond improving cognitive achievement, the model fosters spiritual awareness and emotional connection to religious practices. The findings contribute to the advancement of technology-enhanced religious learning by providing empirical evidence of how VR and Deep Learning can effectively support the goals of the Independent Curriculum. Future research should focus on optimizing accessibility, reducing technical barriers, and exploring the application of similar approaches to other Islamic subjects to promote holistic and sustainable digital learning innovations.

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