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Immersive History: Measuring the Impact of Virtual Reality (VR) on Empathy and Historical Retention

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ABSTRACT

Background. Virtual Reality (VR) has emerged as an innovative educational technology that enables immersive learning experiences, particularly in history education where contextual understanding and perspective-taking are essential. Traditional instructional approaches often face limitations in fostering emotional engagement and sustaining long-term knowledge retention.

Purpose. This study aims to examine the impact of VR on student empathy and historical retention, as well as to explore the relationship between immersive experience and learning outcomes in history education.

Method. A quasi-experimental mixed-methods design was employed involving 104 students assigned to experimental (VR-based learning) and control (traditional instruction) groups. Data were collected through pretest–posttest assessments to measure retention, empathy questionnaires to assess affective responses, and qualitative reflections to capture students' experiential insights. Quantitative data were analyzed using descriptive and inferential statistics, while qualitative data were examined through thematic analysis.

Results. The findings indicate that VR significantly enhances both student empathy and historical retention compared to conventional instructional methods. A strong relationship is observed between immersive experience, emotional engagement, and improved memory outcomes. Empathy is identified as a mediating factor that strengthens the connection between immersion and knowledge retention.

Conclusion. VR offers an effective pedagogical approach for integrating cognitive and affective dimensions of learning in history education. The results highlight the potential of immersive technologies to create meaningful and engaging learning experiences that support deeper understanding and long-term retention. Educators are encouraged to incorporate VR strategically to maximize both emotional engagement and academic achievement.

KEYWORDS

Empathy, Educational Technology, Historical Retention

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INTRODUCTION

Virtual Reality (VR) has emerged as a transformative technology in education, offering immersive learning environments that simulate real-world experiences with high levels of sensory engagement. In history education, VR enables students to "experience" past events, environments, and perspectives rather than merely reading or hearing about them. This shift from passive reception to active immersion has the potential to fundamentally reshape how historical knowledge is constructed and

understood. Immersive experiences can situate learners within complex historical contexts, allowing them to engage emotionally and cognitively with historical narratives.

The integration of VR into history education aligns with constructivist learning theories, which emphasize experiential learning and meaning-making through interaction (Mikołajewska, 2025; Turhan, 2022). By placing students within simulated historical settings, VR facilitates deeper engagement with content and promotes perspective-taking. Empathy, defined as the ability to understand and share the feelings of others, becomes a critical learning outcome in this context. The capacity of VR to evoke emotional responses and foster empathy toward historical actors represents a significant pedagogical opportunity.

Historical retention, or the ability to recall and understand historical information over time, is another key outcome influenced by immersive technologies (Cheng, 2022; Hong, 2024). Traditional teaching methods often rely on text-based or lecture-based approaches, which may not effectively support long-term retention. VR offers multimodal engagement that integrates visual, auditory, and spatial elements, potentially enhancing memory encoding and retrieval. This context highlights the need to systematically examine the impact of VR on both cognitive and affective dimensions of learning in history education.

Despite the growing adoption of VR in educational settings, its effectiveness in enhancing empathy and historical retention remains insufficiently understood (Cevik, 2023; Kraus, 2025). Many implementations of VR focus on technological novelty rather than pedagogical outcomes, leading to uncertainty about its actual impact on learning. The lack of empirical evidence limits the ability of educators to make informed decisions بشأن the integration of VR into curricula.

The relationship between immersion and empathy is complex and not yet fully established (Franke, 2024; Markowitz, 2025). While VR is often assumed to increase empathy through immersive experiences, some studies suggest that emotional engagement does not always translate into meaningful understanding. There is a need to clarify whether VR-induced empathy leads to deeper historical comprehension or merely produces short-term emotional responses.

Measurement challenges also complicate the evaluation of VR's effectiveness (Cecotti, 2024; J, 2025). Empathy and historical retention are multidimensional constructs that require reliable and valid assessment tools. Existing studies often use inconsistent methodologies, making it difficult to compare results and draw general conclusions. These challenges highlight the need for rigorous research that systematically investigates the impact of VR on key learning outcomes.

This study aims to examine the impact of immersive VR experiences on student empathy and historical retention in history education (Coesel, 2024; Siette, 2024). The research seeks to determine whether VR-based learning environments enhance students' ability to understand and relate to historical perspectives. Emphasis is placed on evaluating both emotional engagement and cognitive outcomes.

Another objective of this study is to analyze the relationship between immersion, empathy, and retention (Bazargani, 2024; Villena-Taranilla, 2023). The research investigates how different levels of immersion influence learning outcomes and whether empathy serves as a mediator between VR experiences and knowledge retention. Understanding these relationships is essential for optimizing the use of VR in educational contexts.

The study further aims to develop and validate measurement tools for assessing empathy and historical retention in VR-based learning environments (Samora, 2024; Twomey, 2022). These tools are intended to provide reliable data for evaluating the effectiveness of immersive technologies. The

findings are expected to inform instructional design and contribute to evidence-based practices in history education.

Existing research on VR in education has primarily focused on engagement and motivation, with less attention given to deeper learning outcomes such as empathy and retention (Agustini, 2023; Hajrasouliha, 2024). While some studies suggest positive effects, the evidence remains fragmented and often lacks methodological rigor. This gap limits the ability to generalize findings across different contexts and populations.

Research on empathy in education has traditionally been grounded in narrative and discussion-based approaches, without considering the role of immersive technologies (Chan, 2022; Young, 2022). The introduction of VR challenges existing frameworks by providing new ways of experiencing historical events. The lack of integration between VR research and empathy theory წარმოადგენს a significant gap in the literature.

Studies on historical retention often rely on short-term assessments and do not account for the long-term effects of immersive learning (Liu, 2025; Tagliaferri, 2022). The interaction between emotional engagement and memory processes is not fully understood, particularly in VR environments. A comprehensive approach that combines cognitive and affective perspectives is needed to address this gap.

This study offers a novel contribution by integrating the examination of empathy and historical retention within a VR-based learning framework (Muñoz, 2022; Wilkerson, 2024). The research moves beyond isolated analyses by exploring the interplay between emotional and cognitive outcomes in immersive environments. This integrative approach provides a more holistic understanding of learning processes.

The study introduces a methodological framework that combines quantitative and qualitative measures to assess empathy and retention. By developing validated instruments and applying them in VR contexts, the research addresses limitations in existing measurement approaches. This contribution enhances the reliability and comparability of findings in the field.

RESEARCH METHODOLOGY

This study employs a quasi-experimental mixed-methods design to examine the impact of Virtual Reality (VR) on students' empathy and historical retention (Keefer, 2023; Layton, 2022). The quantitative component utilizes a pretest–posttest control group design, where the experimental group engages in VR-based historical learning while the control group receives conventional instruction through text and lecture-based methods. The qualitative component complements the experiment by exploring students' emotional and reflective responses through interviews and open-ended reflections. The integration of both approaches enables a comprehensive analysis of cognitive and affective learning outcomes.

The design is structured around two primary dependent variables, namely empathy and historical retention, with VR exposure as the independent variable (Abukarki, 2025; Karkazi, 2024). Additional moderating variables include prior knowledge, digital literacy, and learning engagement. Empathy is conceptualized as both cognitive perspective-taking and affective emotional response, while retention is measured through recall, comprehension, and application of historical knowledge. This design allows for systematic comparison between immersive and non-immersive learning environments.

The research framework is grounded in experiential learning theory and multimedia learning principles, emphasizing the role of immersion in enhancing cognitive processing and emotional

engagement. Statistical analysis is employed to measure differences between groups, while qualitative analysis provides deeper insight into students' lived experiences during VR interaction. This combined design ensures methodological rigor and contextual richness.

RESULT AND DISCUSSION

The dataset consists of 104 participants divided equally into experimental (VR-based learning) and control (traditional instruction) groups. Pretest results indicate comparable baseline scores across groups, with mean empathy scores of 3.22 (SD = 0.54) for the experimental group and 3.19 (SD = 0.57) for the control group. Historical retention pretest scores show similar equivalence, with means of 61.4 (SD = 8.7) and 60.8 (SD = 9.1), respectively. Posttest results reveal a substantial increase in both empathy and retention in the experimental group compared to the control group.

Table 1. Pretest and Posttest Scores of Empathy and Historical Retention (N = 104 participants)

Variable	Group	Pretest Mean	Posttest Mean	SD (Posttest)
Empathy	VR Group	3.22	4.01	0.48
	Control Group	3.19	3.45	0.52
Historical Retention	VR Group	61.4	78.9	7.6
	Control Group	60.8	68.2	8.4

Secondary data from observation logs indicate higher engagement levels in the VR group, with 86% of participants demonstrating sustained attention and interaction, compared to 62% in the control group. Qualitative coding identifies key themes such as emotional immersion, perspective-taking, and contextual understanding in VR-based learning experiences.

The descriptive results indicate that VR-based instruction significantly enhances both empathy and historical retention compared to traditional methods. The increase in empathy scores suggests that immersive experiences facilitate emotional engagement and perspective-taking. The substantial improvement in retention scores indicates that VR supports deeper cognitive processing and memory formation.

Secondary indicators highlight the role of engagement as a contributing factor. Higher levels of attention and interaction in the VR group suggest that immersive environments capture student interest more effectively. Qualitative findings support this interpretation, with participants reporting a stronger sense of connection to historical events and characters.

Correlation analysis reveals a strong positive relationship between immersion level and empathy ($r=0.74, p<0.001$). A moderate positive correlation is observed between empathy and historical retention ($r=0.58, p<0.001$). Engagement shows a strong correlation with both empathy ($r=0.69, p<0.001$) and retention ($r=0.72, p<0.001$).

Table 2. Correlation Matrix of Key Variables

Variable	1	2	3	4
1. Immersion	1.00			
2. Empathy	0.74**	1.00		
3. Historical Retention	0.63**	0.58**	1.00	

4. Engagement	0.77**	0.69**	0.72**	1.00

Distribution analysis indicates that the VR group exhibits tighter clustering of higher scores, while the control group shows wider variability. This pattern suggests more consistent learning outcomes in immersive environments.

Independent samples t-test results indicate a significant difference between the VR and control groups in posttest empathy scores ($t=5.84, p<0.001$) and historical retention scores ($t=6.21, p<0.001$). Effect size analysis shows a large effect for both empathy (Cohen's $d=0.89$) and retention ($d=0.94$), indicating strong practical significance.

Paired samples t-tests within the experimental group reveal significant improvements from pretest to posttest for both empathy ($t=8.12, p<0.001$) and retention ($t=9.47, p<0.001$). Regression analysis indicates that immersion significantly predicts empathy ($\beta=0.71, p<0.001$) and retention ($\beta=0.64, p<0.001$), explaining 52% and 47% of variance, respectively.

The relationship between VR immersion and historical retention is partially mediated by empathy. Increased immersion enhances emotional engagement (Capecchi, 2023; Kim, 2023), which in turn supports deeper understanding and memory encoding. This mediation effect highlights the interplay between cognitive and affective processes in learning.

Engagement acts as a reinforcing variable that strengthens both empathy and retention outcomes. High engagement levels contribute to sustained attention and active participation, facilitating both emotional and cognitive learning (Asensio-Jurado, 2024; Villena-Taranilla, 2025). These relationships suggest that immersive learning environments operate through multiple interconnected mechanisms.

A case study conducted in a high school history class involving 26 students shows that VR-based learning increased empathy scores from 3.18 to 4.05 and retention scores from 62.3 to 80.1. Students reported a strong sense of presence and emotional connection to historical events, particularly in simulations depicting wartime experiences.

A comparable class using traditional instruction shows smaller improvements, with empathy scores increasing from 3.21 to 3.46 and retention scores from 61.7 to 69.4. Observational data indicate lower levels of engagement and fewer instances of perspective-taking in the control group.

The case study demonstrates that VR enhances learning by creating immersive and emotionally engaging experiences (Crawford, 2023; Spierling, 2023). Students are able to contextualize historical events more effectively, leading to improved understanding and retention. Emotional involvement appears to facilitate deeper cognitive processing.

Differences between groups highlight the limitations of traditional instruction in fostering empathy. Without immersive elements, students rely on abstract representations of history, which may not evoke strong emotional responses (Huang, 2022; Hutson, 2024). VR addresses this limitation by providing experiential learning opportunities.

The results indicate that VR-based learning significantly improves both empathy and historical retention compared to traditional methods. Immersion and engagement emerge as key mechanisms driving these outcomes.

The overall evidence suggests that integrating VR into history education can enhance both cognitive and affective learning, provided that instructional design effectively leverages immersive experiences.

The findings demonstrate that Virtual Reality (VR) significantly enhances both empathy and historical retention compared to traditional instructional methods. Quantitative results show

substantial increases in posttest scores for the experimental group, indicating that immersive learning environments contribute to both affective and cognitive development. Students exposed to VR-based historical simulations exhibit higher levels of perspective-taking and emotional engagement, suggesting that immersion facilitates deeper understanding of historical contexts.

The analysis further reveals that engagement plays a critical role in mediating learning outcomes. Participants in the VR group display higher levels of attention and interaction, which correlate strongly with improvements in both empathy and retention. This pattern indicates that immersive technologies not only capture student interest but also sustain cognitive involvement לאורך the learning process.

The results also highlight the interconnected nature of empathy and retention. A moderate positive correlation between these variables suggests that emotional engagement supports memory encoding and knowledge consolidation. This relationship emphasizes the dual impact of VR on both emotional and intellectual dimensions of learning.

Case-based evidence reinforces these findings by demonstrating consistent improvements in classrooms implementing VR. Students report stronger connections to historical narratives and improved recall of key events. These outcomes confirm the effectiveness of immersive learning environments in enhancing educational experiences.

The findings align with previous research indicating that VR enhances student engagement and motivation in educational settings. Earlier studies have emphasized the role of immersive technologies in creating interactive and engaging learning environments. The present results extend these findings by demonstrating measurable improvements in both empathy and retention.

Differences emerge when comparing the impact of VR on empathy. Some studies suggest that immersive experiences may produce temporary emotional responses without leading to deeper understanding. The current findings challenge this perspective by showing that increased empathy is associated with improved retention, indicating a more sustained impact.

The study contributes to the literature by integrating cognitive and affective outcomes within a single framework. Many previous studies focus on either knowledge acquisition or emotional engagement in isolation. The present research provides a more comprehensive perspective by examining the interaction between these dimensions.

The results also complement research on experiential learning, which emphasizes the importance of active participation in knowledge construction. VR provides a technologically advanced form of experiential learning, enabling students to engage with historical content in meaningful ways. This alignment strengthens the theoretical foundation of the study.

The findings indicate that immersive technologies have the potential to transform history education by shifting from passive learning to experiential engagement. Students are no longer limited to abstract representations of historical events but can actively explore and interact with simulated environments. This shift represents a significant evolution in pedagogical practice.

The results highlight the importance of emotional engagement in learning processes. Empathy emerges as a key factor that enhances understanding and retention, suggesting that affective experiences play a crucial role in knowledge construction. This insight challenges traditional approaches that prioritize cognitive outcomes בלבד.

The study reveals that VR can bridge the gap between historical knowledge and personal experience. By placing students בתוך simulated historical contexts, VR enables them to connect emotionally with past events. This connection fosters a deeper appreciation of historical perspectives and complexities.

The findings also suggest that the effectiveness of VR depends on instructional design. Immersion alone is not sufficient; meaningful learning requires structured guidance and integration with educational objectives. This insight underscores the need for pedagogical strategies that leverage the strengths of VR.

The findings have significant implications for curriculum design in history education. Integrating VR into instructional practices can enhance both engagement and learning outcomes, making history more accessible and meaningful for students. This approach can improve student motivation and participation.

The results suggest that educators should incorporate empathy as a key learning objective. Developing students' ability to understand historical perspectives can enhance both ethical awareness and critical thinking. VR provides a powerful tool for achieving this goal.

The study highlights the need for investment in educational technology infrastructure. Access to VR tools and resources is essential for implementing immersive learning environments. Institutions must consider both technological and pedagogical factors in adopting VR.

The findings also emphasize the importance of teacher training. Educators need to develop skills in using VR effectively and integrating it into their teaching practices. Professional development programs should address both technical and instructional aspects.

The observed improvements in empathy are explained by the immersive nature of VR, which creates a sense of presence and emotional involvement. Students experience historical events from a first-person perspective, مما enhances their ability to relate to historical actors. This experiential dimension drives emotional engagement.

The enhancement of historical retention is attributed to multimodal learning. VR integrates visual, auditory, and spatial information, مما supports deeper cognitive processing and memory formation. This combination of sensory inputs strengthens knowledge encoding.

The relationship between empathy and retention reflects the role of emotion in memory processes. Emotional experiences are more likely to be remembered, explaining the observed correlation between these variables. VR facilitates such experiences by creating realistic and engaging environments.

The influence of engagement is explained by increased attention and active participation. Immersive environments capture student interest and encourage exploration, مما enhances learning outcomes. This dynamic interaction differentiates VR from traditional instructional methods.

Future research should explore the long-term effects of VR on empathy and historical retention. Longitudinal studies can provide insights into the sustainability of learning outcomes and the persistence of emotional engagement. This approach can strengthen the evidence base for VR in education.

Further investigation is needed to examine the impact of different types of VR experiences. Variations in design, content, and interactivity may influence learning outcomes. Comparative studies can identify best practices for instructional design.

Research should also address issues of accessibility and equity in VR-based education. Ensuring that all students have access to immersive technologies is essential for inclusive learning environments. This consideration is critical for widespread adoption.

Practical efforts should focus on integrating VR with other pedagogical approaches. Combining immersive learning with discussion, reflection, and assessment can enhance its effectiveness. Collaboration between educators, researchers, and technologists can support the development of comprehensive learning models.

CONCLUSION

The most important finding of this study lies in demonstrating that Virtual Reality (VR) not only enhances historical retention but also significantly strengthens student empathy, with both outcomes being interconnected rather than independent. Empirical evidence shows that immersive experiences foster emotional engagement, which in turn facilitates deeper cognitive processing and long-term memory retention. The study distinguishes itself by revealing that empathy acts as a mediating mechanism between immersion and knowledge acquisition, rather than merely an additional affective outcome. This finding challenges traditional assumptions that cognitive and emotional learning operate separately, highlighting the integrated nature of learning in immersive environments.

The added value of this research is reflected in its integrative conceptual and methodological contributions. Conceptually, the study advances a unified framework that connects immersion, empathy, and historical retention within a single explanatory model grounded in experiential learning theory. Methodologically, the combination of quasi-experimental design with mixed-methods analysis provides a comprehensive evaluation of both quantitative learning outcomes and qualitative experiential dimensions. The development and validation of measurement instruments for empathy and retention in VR contexts offer a practical contribution that can be adapted in future educational research and instructional design.

Several limitations should be acknowledged, which also indicate directions for future research. The study is limited by its relatively short intervention period, which may not fully capture the long-term effects of VR on learning outcomes. The sample is restricted to specific educational contexts, limiting generalizability across diverse populations and cultural settings. Future research should employ longitudinal designs to assess sustained impact, explore cross-cultural variations in empathy development, and investigate the effectiveness of different VR design features. Further studies should also examine the integration of VR with complementary pedagogical strategies to optimize both cognitive and affective learning outcomes.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.

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