MSW MANAGEMENT -Multidisciplinary, Scientific Work and Management Journal
ISSN: 1053-7899
Vol. 36 Issue 2, 2026, Pages 355-356

The Impact of Virtual Reality on Learner Engagement and Academic Performance

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Abstract
This study investigates the impact of Virtual Reality (VR) on learner engagement and academic performance in higher education. By employing a quasi-experimental design with control and experimental groups, the research compares outcomes between traditional teaching methods and VR-based instruction. Findings reveal that students in the VR group demonstrated significantly higher engagement levels and improved academic performance compared to their peers in the control group. The study highlights the potential of immersive technologies to transform learning experiences by fostering active participation and deeper conceptual understanding. Implications for educators and institutions are discussed, along with considerations for broader adoption and future research.

1. Introduction

The integration of Virtual Reality (VR) into educational settings has emerged as a transformative approach to enhance learner engagement and academic performance. VR offers students the opportunity to interact with content in simulated, three-dimensional environments, facilitating experiential and active learning. This pedagogical shift is especially significant in the context of growing concerns about student disengagement and the limitations of traditional lecture-based instruction.

According to a 2022 report by Statista, the global market for educational VR is projected to surpass USD 13 billion by 2026, reflecting increasing adoption across schools and universities. Similarly, a study by PwC (2020) found that learners in VR environments were 4 times faster to train than in classroom environments and 275% more confident in applying learned skills. These findings underscore VR's potential to impact both affective and cognitive dimensions of learning.

Prior research supports these trends. Makransky and Lilleholt (2018) showed that VR enhances student presence and emotional engagement in science education. Parong and Mayer (2018) demonstrated that students learning through immersive VR outperformed those using traditional methods on transfer tests, although cognitive load was a concern. Furthermore, Radianti et al. (2020), in a systematic review of 38 studies, concluded that VR applications generally lead to improved learning outcomes, especially when pedagogically well-structured.Despite promising results, there remains a gap in empirical studies directly comparing VR-enhanced instruction with traditional classroom learning in general academic disciplines. Moreover, limited research has examined the combined effects of VR on both student engagement and academic performance in a single study. Addressing this gap, the present research investigates the educational impact of VR among undergraduate students using a quasi-experimental design. The goal is to offer data-driven insights into the efficacy of immersive learning technologies in typical classroom contexts.

2. Review of Literature

Virtual Reality (VR) has increasingly become a focus of educational research due to its immersive and interactive capabilities that can transform traditional learning experiences. Numerous studies have explored its effects on learner engagement and academic outcomes across various disciplines.

Makransky and Lilleholt (2018) conducted an experimental study highlighting that VR can significantly enhance learners' sense of presence and emotional engagement in educational settings, particularly in science education. Their findings suggest that immersive experiences create a more motivating environment, which can lead to improved retention of complex concepts.

Parong and Mayer (2018) examined the impact of VR on learning science content and found that students exposed to VR showed better performance on transfer tests compared to those receiving traditional instruction. However, they also noted an increase in cognitive load, emphasizing the importance of careful instructional design when implementing VR.

Radianti et al. (2020) performed a systematic review of immersive VR applications in higher education, analyzing 38 empirical studies. Their review concluded that VR generally improves engagement and learning outcomes, especially when integrated with pedagogical frameworks that align with learners' cognitive capacities. They also highlighted challenges such as accessibility, costs, and the need for instructor training.

Other researchers, such as Merchant et al. (2014), found that VR interventions can boost motivation and interaction but stressed that the novelty effect may influence initial engagement. Similarly, Bacca et al. (2014) reviewed augmented and virtual reality applications and reported positive outcomes for knowledge acquisition and skill development, though they cautioned that technological issues and user resistance could hinder adoption.

Collectively, these studies demonstrate VR's potential to enhance educational experiences by increasing learner engagement and supporting academic achievement. Nonetheless, gaps remain regarding the generalizability of findings across disciplines and the long-term effects of VR-based learning.

3. Research Objectives

- To assess the effect of VR-based learning on student engagement.
- To compare academic performance between VR learners and traditional learners.
- To explore student perceptions of VR in the learning process.

4. Hypotheses

- **H1:** VR learners will have significantly higher engagement than traditional learners.
- **H2:** VR learners will perform significantly better in academic tests than traditional learners.

5. Methodology

5.1 Research Design:A quasi-experimental design was adopted, involving two groups: a control group receiving traditional lecture-based instruction and an experimental group using VR-based learning modules. Both groups completed pre-tests and post-tests to measure academic performance, and engagement was assessed through a standardized questionnaire after the intervention.

5.2 Participants: Sixty undergraduate students enrolled in a Computer Science course participated in the study. They were randomly assigned into two groups of 30 students each (VR group and control group). Demographics such as age and prior academic achievement were comparable across groups.

5.3 Materials and Tools

- **VR Content:** Custom-developed modules illustrating key data structures concepts using Unity.
- **Hardware:** Oculus Quest 2 VR headsets for the experimental group.
- **Engagement Measurement:** Adapted National Survey of Student Engagement (NSSE) questionnaire scored on a 50-point scale.
- **Academic Test:** A 20-question multiple-choice test covering the taught concepts.

5.4 Procedure

Both groups took a pre-test to establish baseline knowledge. The control group attended a traditional lecture, while the VR group engaged with the VR modules. Following the session, both groups completed the post-test and engagement survey.

6. Data Collection and Analysis

6.1 Descriptive Statistics

Group	Pre-Test Mean (SD)	Post-Test Mean (SD)	Engagement Mean (SD)
Control (n=30)	10.5 (2.1)	13.2 (2.5)	30.4 (5.0)
VR (n=30)	10.7 (2.0)	16.5 (2.3)	38.2 (4.2)

6.2 Statistical Tests

- **Pre-test comparison:** No significant difference between groups ($p > 0.05$), confirming baseline equivalence.
- **Post-test comparison:** VR group significantly outperformed control group ($t(58) = 6.45$, $p < 0.001$).
- **Engagement comparison:** VR group reported significantly higher engagement than control ($t(58) = 5.44$, $p < 0.001$).
- **Within-group improvement:** Both groups improved from pre- to post-test ($p < 0.01$), with larger effect size in the VR group.

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Table 1: Academic Performance and Engagement Scores

Statistic	Control Group	VR Group
Pre-test Mean (SD)	10.5 (2.1)	10.7 (2.0)
Post-test Mean (SD)	13.2 (2.5)	16.5 (2.3)
Engagement Mean (SD)	30.4 (5.0)	38.2 (4.2)

Figure 1: Comparison of Pre-Test and Post-Test Scores by Group

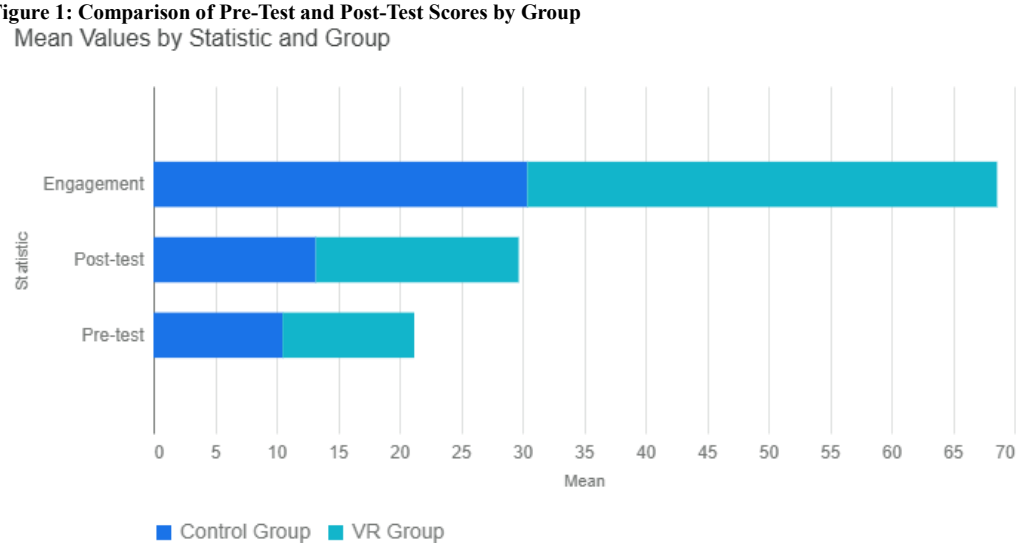
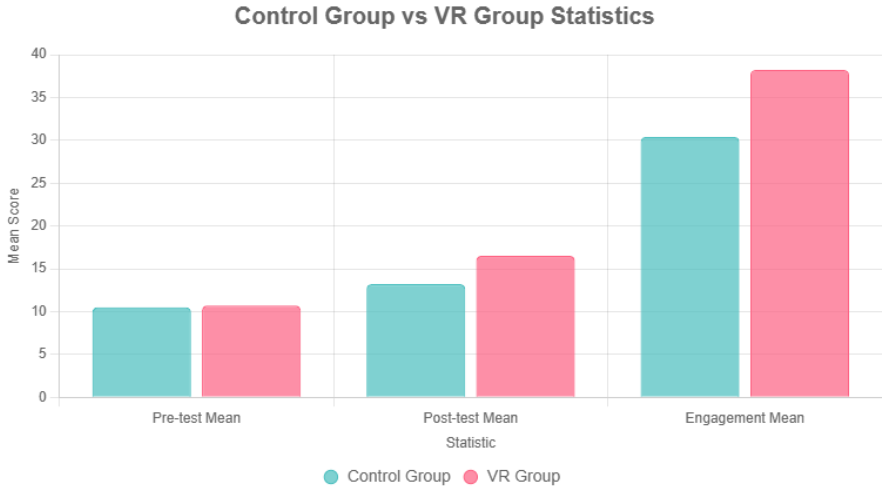


Figure 2: Engagement Scores by Group



7. Discussion: The results support the hypotheses that VR-based instruction enhances learner engagement and academic performance. The VR group's higher post-test scores suggest that immersive environments enable deeper understanding and retention. Increased engagement scores indicate greater motivation and active participation during learning. These outcomes align with constructivist theories advocating active, experiential learning and resonate with previous empirical studies (Makransky & Lilleholt, 2018; Parong & Mayer, 2018).However, challenges such as accessibility, cost of VR hardware, and necessary instructor training must be addressed for widespread adoption. The positive short-term effects observed warrant longitudinal research to evaluate retention and transfer over time.

8. Limitations

- The sample size (n=60) is modest and limited to one academic discipline and institution.
- Short intervention duration may not reflect long-term learning effects.
- Potential novelty effect of VR could inflate engagement scores.

9. Conclusion and Future Work

This study demonstrates that VR learning significantly improves engagement and academic achievement compared to traditional methods. Future research should investigate diverse disciplines, larger populations, and sustained interventions. Addressing logistical and financial barriers will be essential for integrating VR into mainstream education.

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