# Comparing the Effectiveness of Diegetic vs Non-Diegetic Interface Designs for 3D Manipulation in Virtual Reality

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## Background

Virtual Reality is becoming more and more prevalent in many domains. With this, VR technology has become increasingly advanced. VR Interfaces, however, still require further research to determine how they impact user experience and presence in virtual environments.
In this study, we explore the time-efficiency and overall "presence" of two UI patterns, Diegetic and Non-Diegetic, for completing 3D manipulation tasks to determine which is a more effective form of UI.

## Participants

For this study, eighteen volunteer participants were recruited by email and through events among students at Winona State University. The participants included in the study were aged between 18-24 years. The study does not include people who are prone to motion sickness; struggle to balance, have a visual impairment, or hearing disability.

| | |
|---|---|
| Gender | Male = 13, Female = 5 |
| Height (cm) | *M* = 175.97, *SD* = 12.77 |
| Prior Experience in VR | 2 had no prior experience in VR<br>11 had minimum experience in VR<br>5 had a lot of experience in VR |
| Video Game Experience In the Last Three Years | 3 played 1-2 times a year<br>2 played 1-2 times a month<br>1 played weekly<br>12 played daily |

**Table 1.** Participant Demographics

## Experimental Design

Participants were put into one of two groups with Diegetic or Non-Diegetic interfaces. They then took a brief self survey. Once they completed it, they put on the VR headset and began the experiment. Inside of the VR environment, the participants were instructed to complete four tasks one by one. For the diegetic interface, controls were integrated onto the table and a part of the environment, while for the non-diegetic interface, controls were displayed on a rectangular canvas in front of the camera.


**Figure 1.** Diegetic(left) and Non-Diegetic(right) interfaces used

## Results

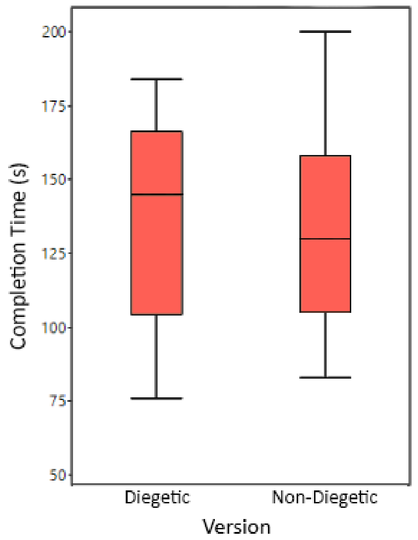


**Figure 2.** Plot of completion times

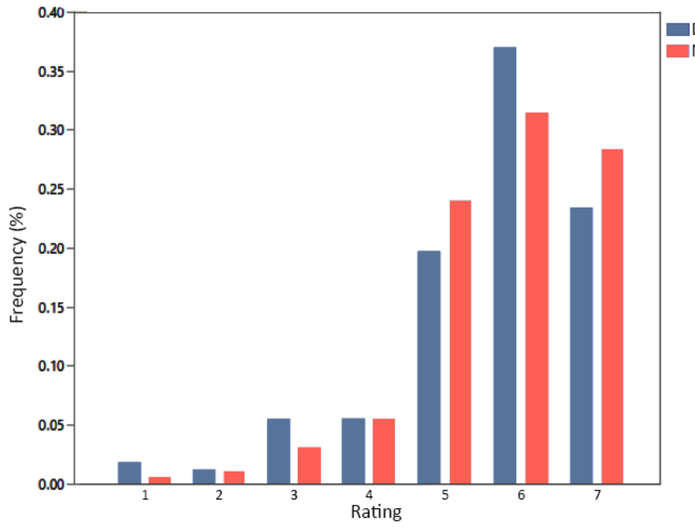


**Figure 3.** Frequency of ratings from the presence questionnaire

Results fail to show a significant difference between the two interface designs on the dependent variables. In fact, the average completion time between the two conditions had no difference at all, with an average of 138.89 seconds for both conditions. Average presence scores only had a marginal difference with an average score of 95.11 for Diegetic UI and 97.67 for Non-Diegetic UI. Neither completion time nor environmental presence were significantly impacted by the interface design.

## Measures

*Completion Time –*

Measured in seconds and calculated from the moment the participant pressed the start button until the time they took to finish all 4 tasks. Individual times for each task were measured from when they started to when they pressed the finish button.

*Environmental Presence –*

Participants were given an 18-item post-test presence questionnaire composed of questions in 3 main categories: involved/control, natural, and interface quality.

## Discussion / Future Work

This study had several limitations, we will name a few here.
First, the study sample size was fairly small (N = 18). After separating the participants into groups, there were only 9 for each condition. Second, more research into the measures used is required. A more holistic assessment of the interface controls, and a way to measure presence/immersion in real time are required.
Third, the tasks given lacked nuance and complexity and the scenario created in the virtual environment was not very believable. Completion times were too short for a valuable result and creating a more realistic scenario would allow for a more valuable experiment.

## References

[1] Robin Schlünsen, Oscar Ariza, and Frank Steinicke. 2019. A VR Study on Freehand vs. Widgets for 3D Manipulation Tasks. In Proceedings of Mensch und Computer 2019 (MuC'19). Association for Computing Machinery, New York, NY, USA, 223–233. DOI:10.1145/3340764.3340791
[2] Sun Y, Kar G, Stevenson Won A, Hedge A. Postural Risks and User Experience of 3D Interface Designs for Virtual Reality-based Learning Environments. Proceedings of the Human Factors and Ergonomics Society Annual Meeting. 2019;63(1):2313-2317.
[3] Valentin Schwind, Pascal Knierim, Nico Haas, and Niels Henze. 2019. Using Presence Questionnaires in Virtual Reality. In Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems (CHI '19). Association for Computing Machinery, New York, NY, USA, Paper 360, 1–12. DOI:10.1145/3290605.3300590