3D CHESS SET IN VR

FOR SPATIAL AND GEOMETRIC REASONING

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IMRE LAB

INTRODUCTION

Virtual Reality (VR) can replicate real world lessons, classrooms, or field trip sites as a tool for learning. Moreover, VR spaces offer teachers and researchers the opportunity to move beyond ‘what is physically possible’ in the real world to create learning environments based on ‘what can be imagined’ in order to test conceptual understanding and strengthen reasoning skills.

The goal of this project is to investigate the differences in spatial reasoning and performance strategies of novices and experts on objects based on scale, orientation, and dimensionality. The experimental tasks will be conducted within two virtual environments:

- Three standard chessboards at different scales.
- A 3-dimensional 9x9x9 chessboard with a variable orientation.

These virtual environments will be used for a replication of an earlier study that explored similar questions employing current VR hardware and software functionality and resolution.

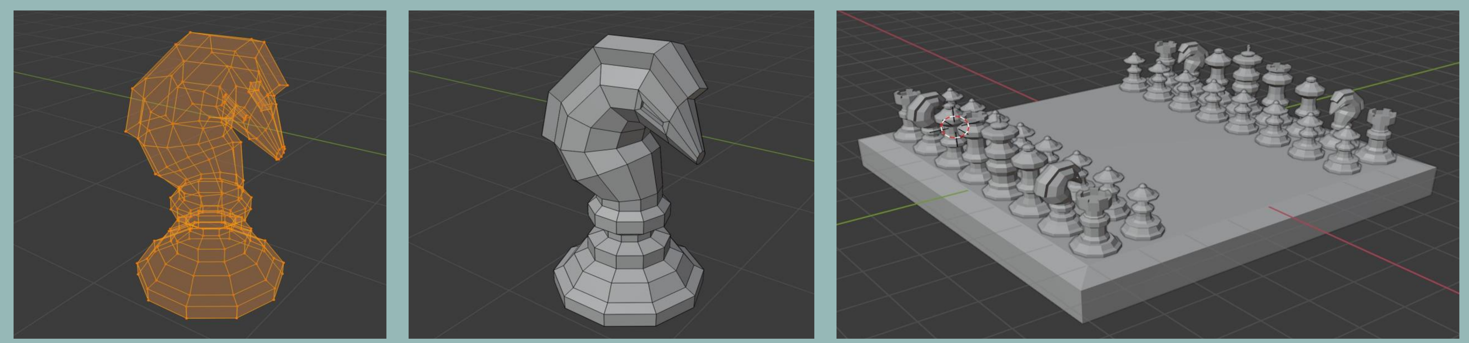

Figure 1: Chess pieces and the whole chess board created in Blender 3D modeling software

STUDY MOTIVATION

We are interested in how participants reason on and interact with objects within immersive virtual environments. By using VR, we will collect data such as participant movement in the tracking space, the manipulation of the objects in the space, as well as participant visual attention using eye tracking sensors in the VR headset.

By collecting these data, we hope to gain a better understanding about how learners explore virtual environments that are unlike the real world. This research will help to develop more creative and effective virtual classrooms of the future that push the boundaries of our current curricula. This work is a collaboration between researchers at Colby College's INSITE lab and the University of Maine's IMRE lab working to form a network of emerging technologies research labs across Maine’s colleges and universities.

ENVIRONMENT DEVELOPMENT

Environment 1: Spatial Reasoning with Objects with Varying Scales

- The board anchor was molded from a cube & cylinders in Blender then imported into Unity.
- Other game objects were imported from Unity’s Asset Store/created afresh inside the environment.
- Scale classes (Figural, Vista, Environmental) are based on Montello (1993).
- Both the vista and environmental spaces have stairs to access allocentric views.
- Player Prefab was imported from SteamVR to connect the environment to the headset & controllers, which also imports other specialized Prefabs for VR.
- Scripts to move chess pieces were written in C# in Visual Studio.
- Pieces are manipulated with hand controllers or haptic finger controllers.

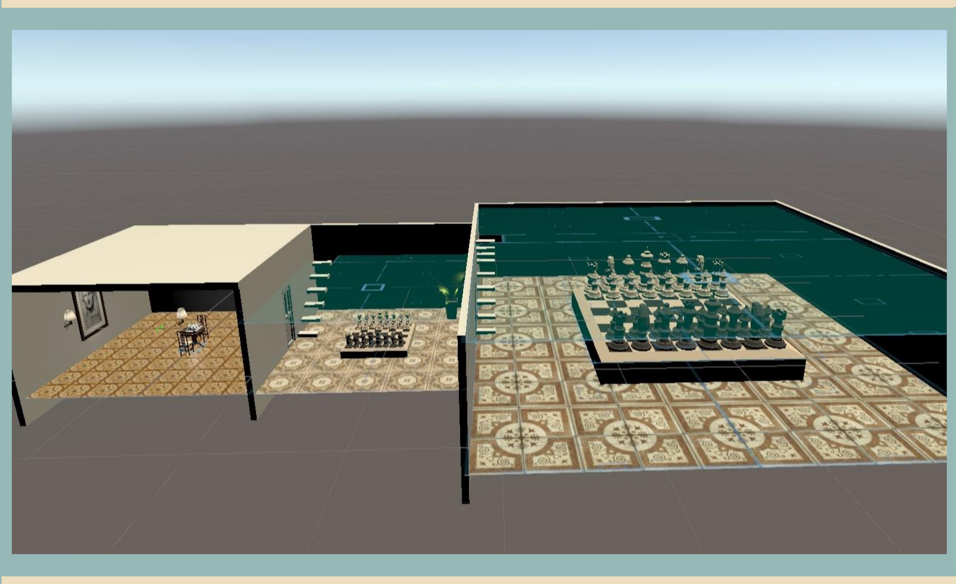

Figure 2: Chessboard environments at three scales (left - right): Figural Space, Vista Space, Environmental Space (Montello, 1993)

Figure 3: Participant view of Figural Scale environment

Environment 2: Geometric Reasoning with 3D Space Chess

- The 3D board is created from via a custom script. The script can adjust the dimensions of the board as well as the spacings between each tile. The script also optionally places the pieces on the board.
- There are no defined rules implemented in the environment. This means pieces can be grabbed and dropped anywhere on the board. It is not possible to stack your own pieces on a single tile and captured pieces get discarded from the board like regular chess.
- The highlighting system of SteamVR lets the player see which piece is being grabbed.
- The highlighting functionality shows where the piece will be dropped, avoiding unintentional moves.
- The participant can navigate into and around the game cube.
- Currently working on adding the ability for the participant to rotate the game cube to gain additional viewpoints.

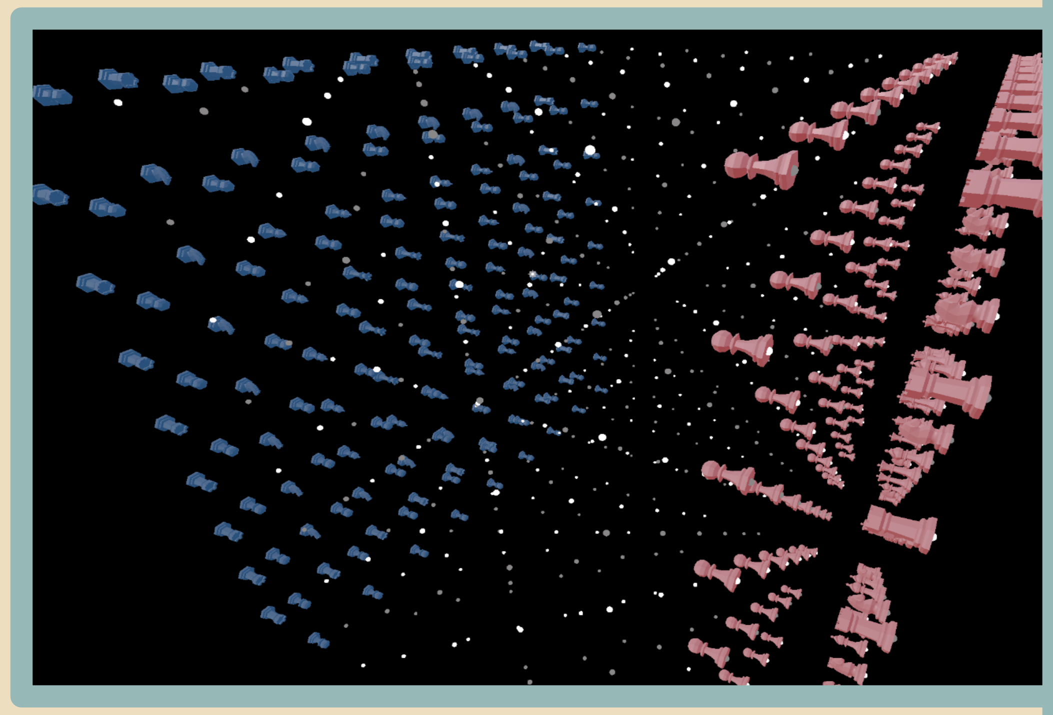

Figure 4: Participant view of 3D 9x9x9 chess environment.

ANTICIPATED EXPERIMENTS

Our environments are suitable for variety of spatial memory and reasoning experiments. Slater et al. (1999) found that participants who reported they experienced greater levels of immersion in the virtual environment had increased levels of spatial task performance.

Our first experiment will be replicating Slater's memorization experiment where novice and expert chess players will be asked to remember a sequence of moves in either and immersive VR or desktop VR environment to test the hypothesis that the immersive environment condition will lead to increased spatial task performance. Subsequent studies will explore questions raised in more recent work in this area (Al-Amri, Osman, and Al Musawi, 2020; Citrasukmawati, Julianingsih, and Trisnawaty, 2020).

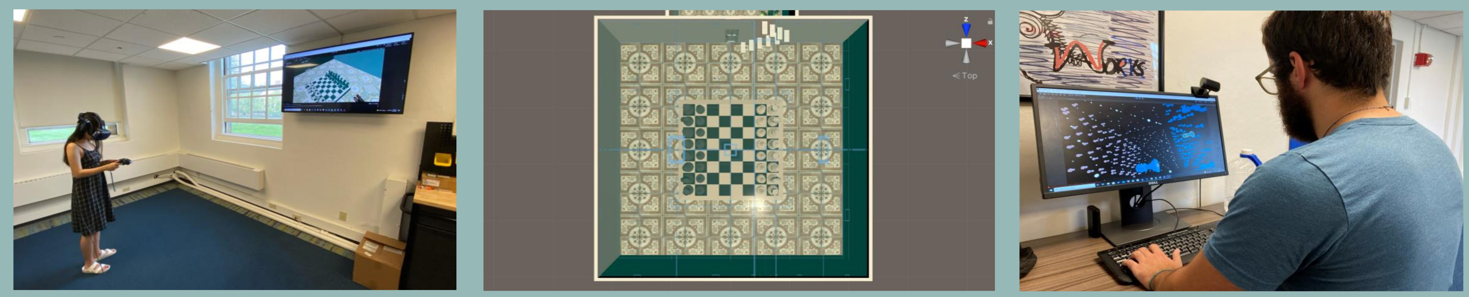

Figure 5-7 (left-right): Participant in Immersive VR environment, Allocentric view of Environmental scale space, Participant in 3D 9x9x9 Desktop VR environment

FUTURE WORK

We hope our environments will contribute to new opportunities for teachers and learners to break free from traditional teaching 2D curricular materials. Immersive learning experiences may allow new types of assessments of student comprehension and concepts.

Additional equipment and a larger tracking space will enhance our ability to conduct experiments with more sensitive sensors that can track movement and attention more precisely with body sensors and eye tracking headsets.

Works Cited

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