



The Wrist Game

Gamification of Medical Student Learning of Carpal Anatomy Using VR

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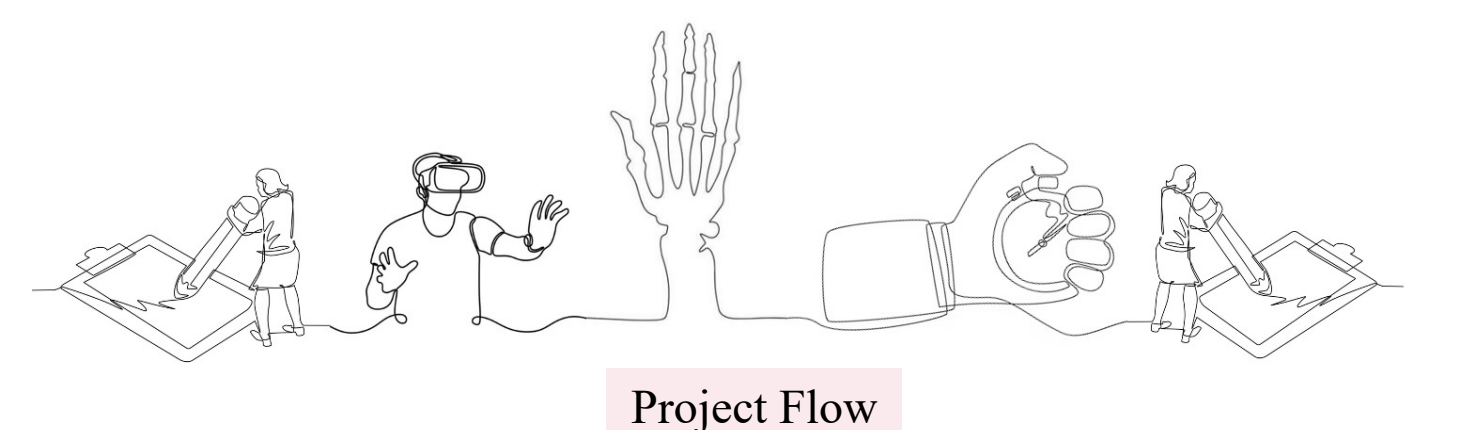


Introduction

Teaching anatomy an educational challenge due to rapid change in technology, decrease in anatomy-dedicated hours, and the evolution of students who require new learning channels. Traditional anatomy learning utilizes 2D media such as textbooks and video, which makes it difficult to conceptualize the 3D nature of the human body, whereas realistic, 3D learning in cadaver labs is often limited by feasibility, accessibility, and even ethical ambiguity.

Immersive VR is a 3D environment that generates realistic senses, which leads to gamification of medical education and allows for deliberate practice, which improves knowledge retention, skill acquisition, and learner satisfaction. Studies to validate VR use in medical education remain lacking.

Pre-clinical medical students at University of Illinois at Chicago learn the musculoskeletal anatomy utilizing traditional anatomical atlas images and cadaver labs, where one cadaver is shared by a group of students during the dedicated learning time. We designed a randomized controlled pilot that incorporates a carpal anatomy VR module, hypothesizing that this intervention will improve understanding of carpal bone spatial anatomy, gamify the learning experience, improve learner satisfaction, and potentially popularize VR as an adjunct to anatomy education.



Methods

Participants

All first-year medical students UIC COM were eligible

Questionnaires

Pre: Demographic backgrounds, prior anatomy exposure, learning styles & channels, and gaming and VR experience.

Post: Utility and effectiveness of our VR game as an educational tool, and general attitude towards VR in medical education.

The “Wrist Game”

A virtual hand in a virtual environment. 3 play modes: Tutorial, Practice and Test modes. Only performance in the test mode was recorded for the study

The Physical Model

Participants were provided with a wrist model with disassembled carpal bones. They arranged the bones using rubber putty

Procedure

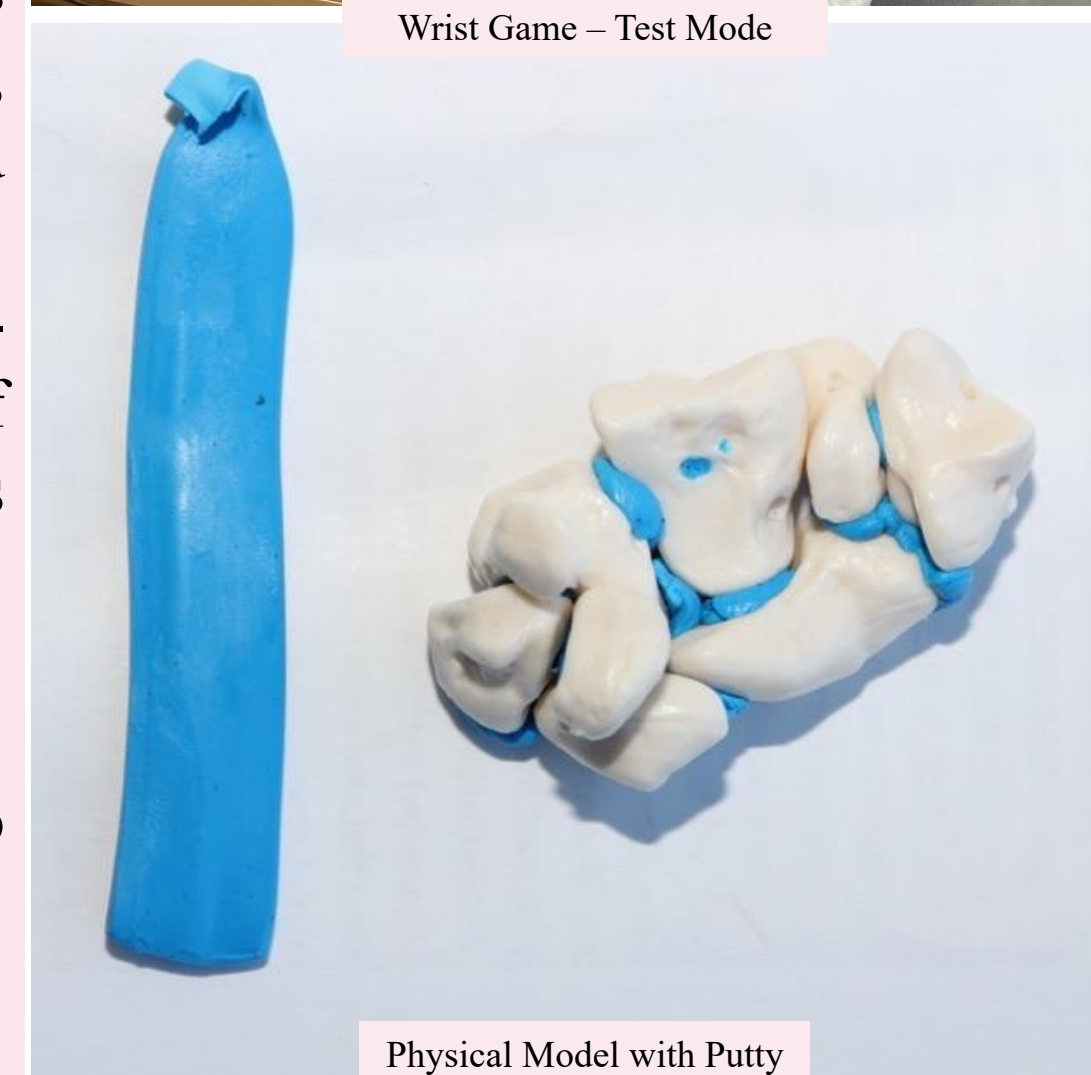
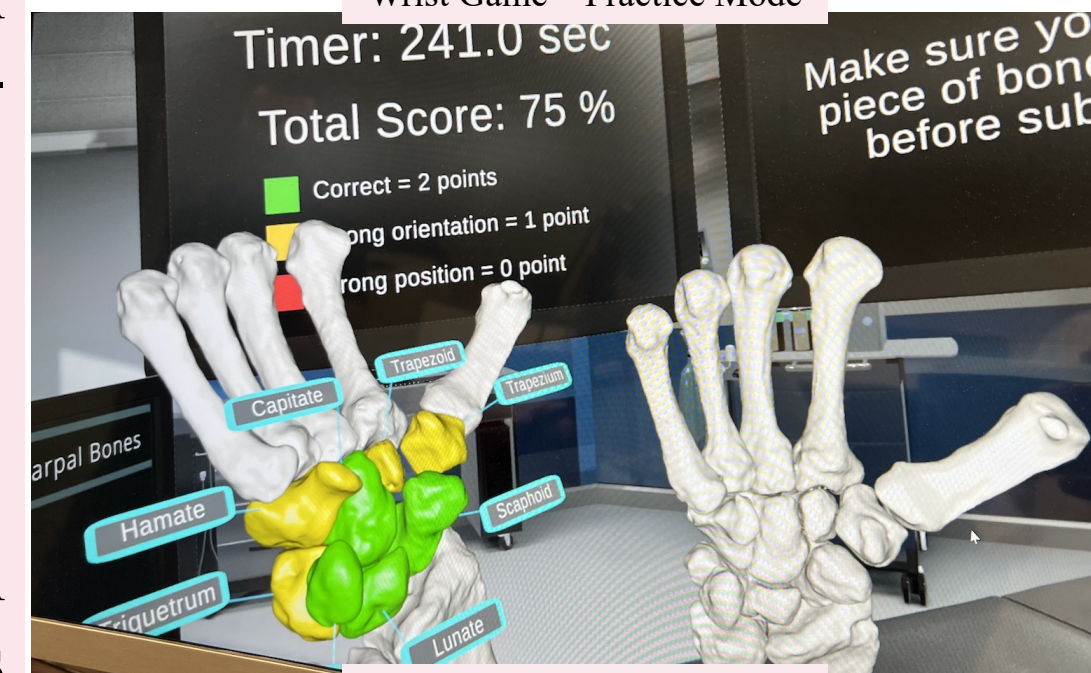
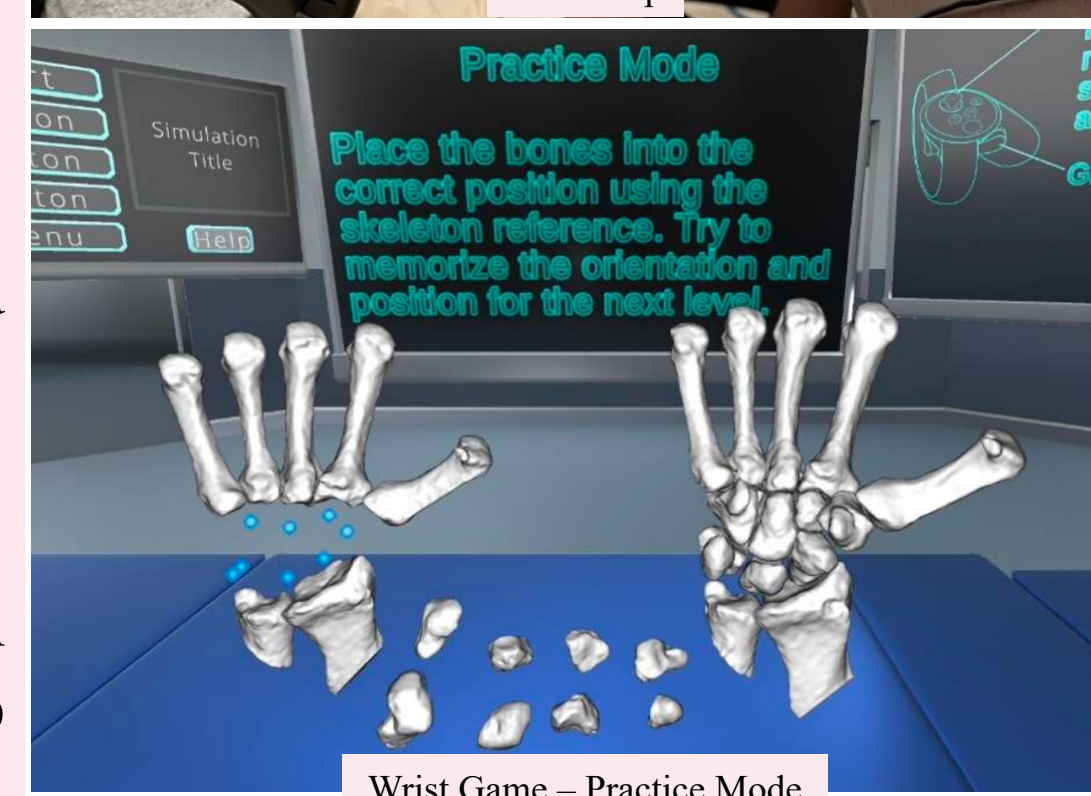
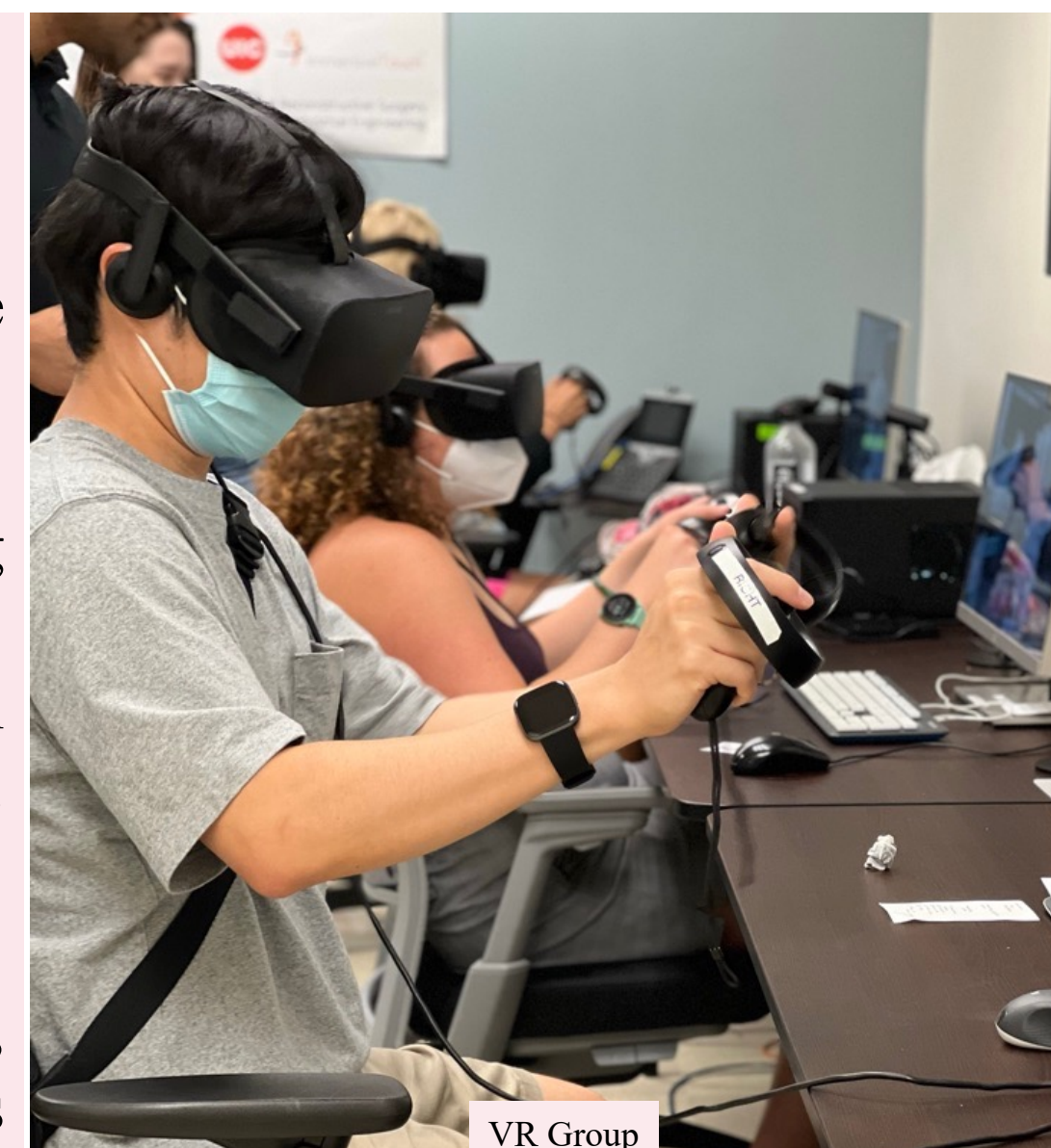
All students completed the pre-questionnaire and were provided with reading materials to study carpal bone anatomy. The VR group completed the VR Wrist Game. Both groups completed an in-person physical model test a week later. All participants completed a post-intervention questionnaire.

Scoring

Both VR and physical model were scored based on correct position and orientation of carpal bones, and time to complete. Two points were awarded for each of the correctly positioned and oriented bones, one point correctly positioned but incorrectly oriented bones, and zero for incorrectly positioned bone, for a maximum of 16 points. Additional 3 more points were awarded for identifying the three pre-selected bones during the physical model test, toward a maximum of 19 points. Time-to-complete the VR test and physical model was recorded in seconds.

Standardization

Participants were assigned randomly to groups. The author who scored the physical model tests was blinded to group assignments. All data was deidentified.



Results

Sample

11 first year medical students completed all the requirements of the project

VR Wrist Game Results

Median completion time: 1,303 seconds (range 476 - 1,719 seconds).

Higher initial carpal bone anatomy confidence did not correlate with higher scores in VR Wrist Game

Prior anatomy exposure beyond high school level had no effect on Wrist Game scores.

Prior video game experience and prior VR experience had no effect on Wrist Game scores

Physical Model Test Results

VR group:

Performed significantly better in **3D orientation of the bones** (p = 0.039).

x8 more likely to complete the test **faster** than all-participant median of 1558 seconds (p=0.140).

x3 more likely to **score higher** than all-participant test score median of 5 points (p=0.389)

x20 more likely to correctly **position and orient** more than all-participant median (p=0.055)

x7.5 more likely to correctly **name** more than all-participant median of 1 bone (p=0.158).

Group	VR							Control							MWU; p-value
Gender	M	F	F	M	M	F	-	M	F	M	F	M	-	-	-
Correct 2D and 3D	0	1	2	6	1	1	1	0	1	0	0	0	0	0	4.5; 0.039
Correctly 2D only	3	1	4	2	7	2	2.5	4	0	4	0	8	4	4	15.0; 1.0
Incorrect 2D and 3D	5	6	2	0	0	5	3.5	4	7	4	8	0	4	4	11.0; 0.459
Correct identification	1	0	2	3	3	1	1.5	1	0	0	0	3	0	0	8.5; 0.216
Total Score	6	3	10	17	12	4	7.5	5	2	4	0	11	4	4	8.0; 0.199
Completion time (s)	1026	1236	3180	1558	885	1381	1308	720	1911	2394	2720	2550	1911	1911	10.0; 0.361

Higher Wrist Game score correlated with higher physical model test score (p=0.019).

Realism of the VR Environment and Satisfaction with the Learning Tool

High quality, realistic, 3D graphics of carpal bone – 100%

Realistic virtual handling of bones – 66%

Easy to use, would recommend it to colleagues – 100%

Headset discomfort – 34%

Would purchase VR to learn anatomy – 36%

Utility in Learning Spatial Anatomy

Effective in understanding basic carpal bone anatomy – 83% (p=0.306).

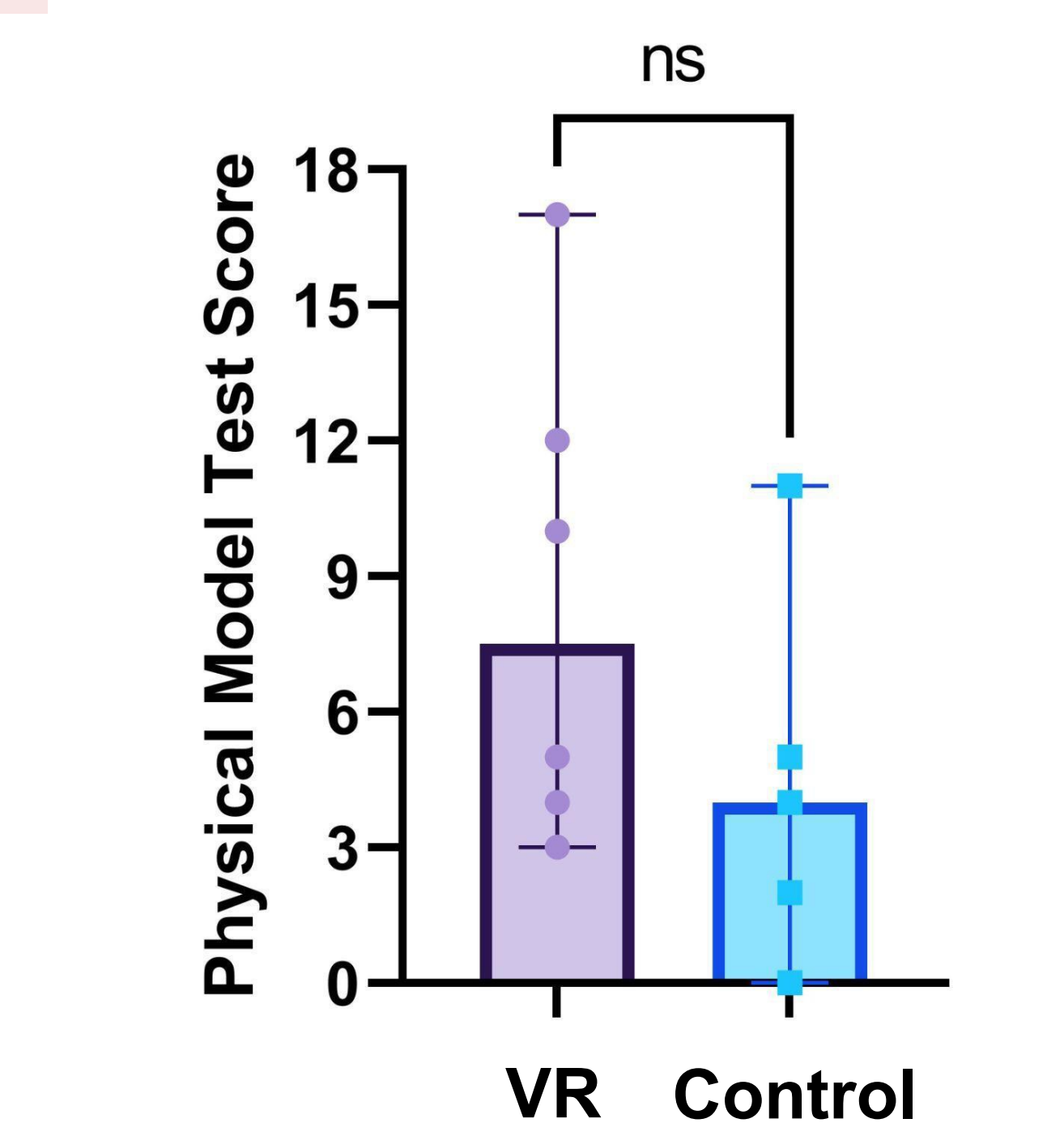
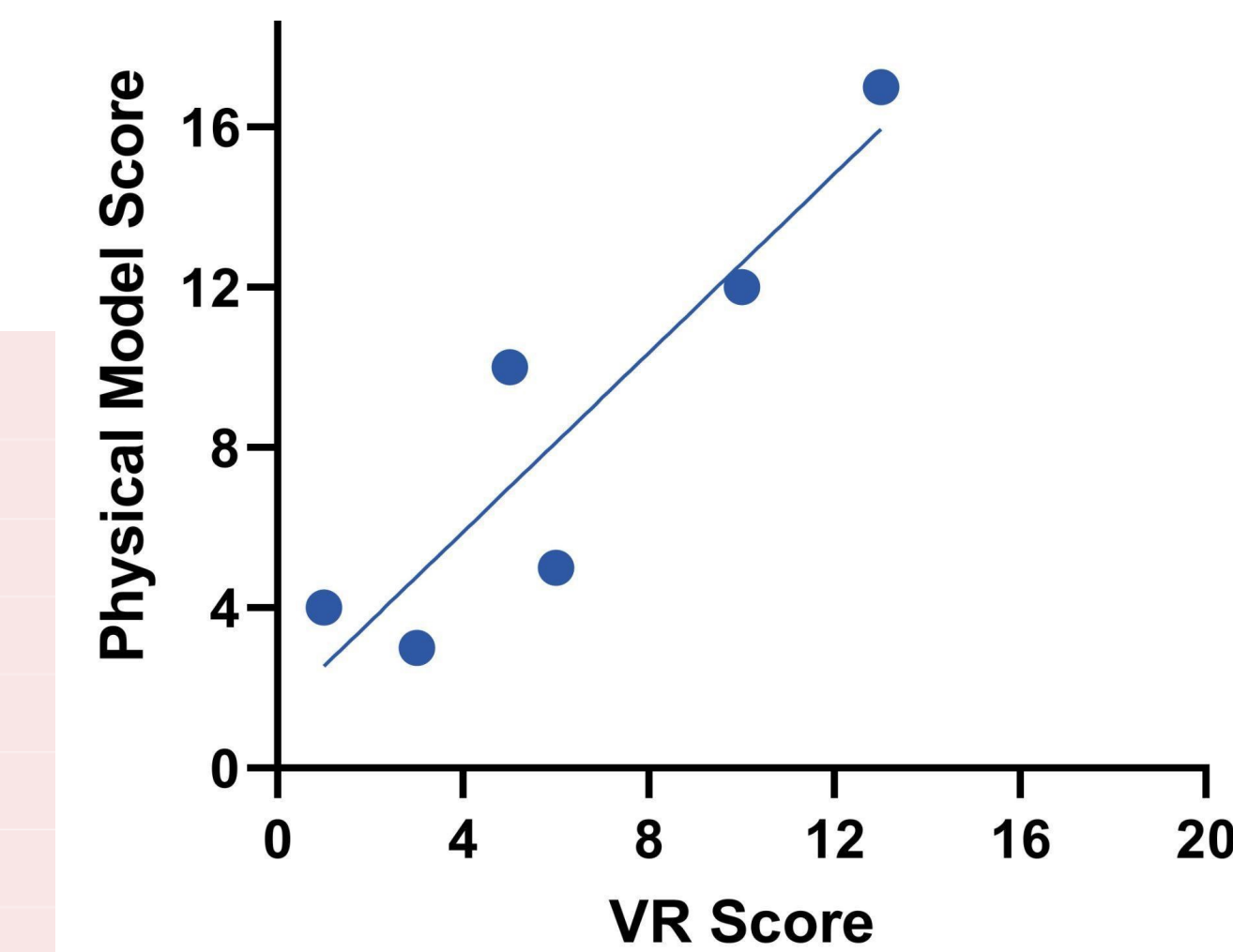
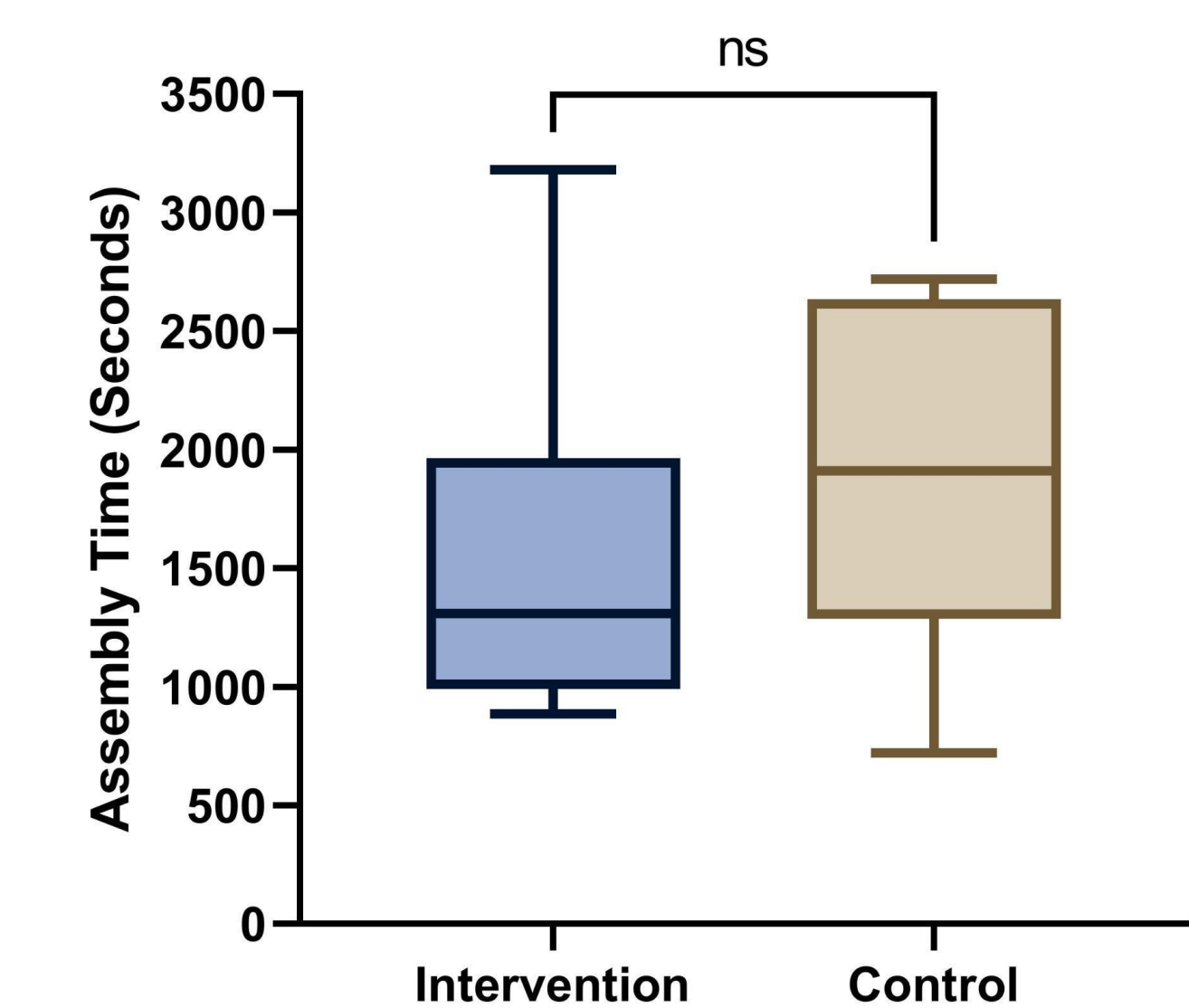
Better understanding of the spatial anatomy of carpal anatomy – 100%

Improved knowledge retention – 67% (p=0.285).

General Opinions on VR in Anatomy Education

Would like to use VR to learn other anatomy topics – 100% (p=0.388).

VR applications can potentially replace anatomy labs and cadaver use – 37% (p=0.153).



Affiliations
University of Illinois at Chicago (UIC)
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No Disclosures

Keywords

#Gamification
#MedicalEducation
#Anatomy
#VirtualReality
#DeliberatePractice

Video Links

