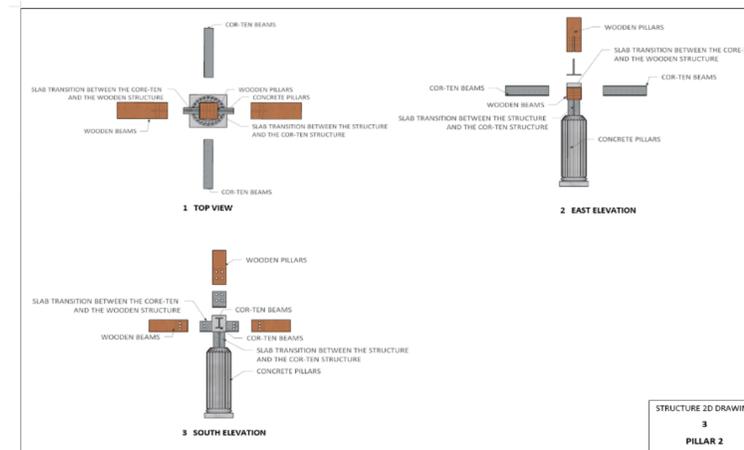# Experimental Investigation to Measure Improvements in Students' Comprehension in Building Structures using Augmented and Mixed Reality Applications

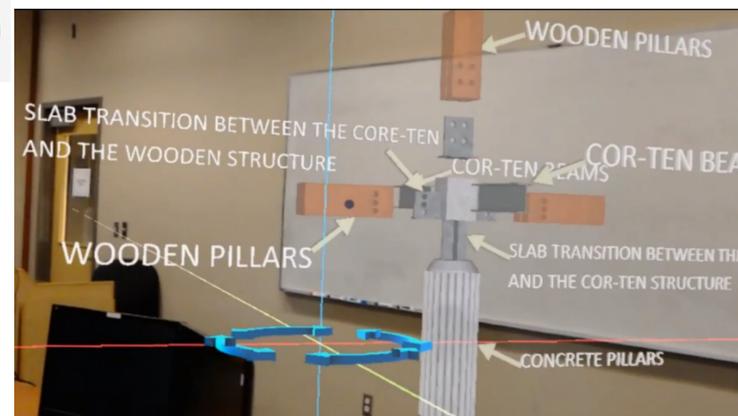**SALMAN AZHAR, GUANGYAN SHAO, AND AMNA SALMAN, January 11, 2021**
McWhorter School of Building Science, College of Architecture, Design, and Construction

Abstract

The use of technological gadgets is becoming an integral part of life for Generation Z students. Engaging these tech-savvy students in the learning process with their preferred learning style is a daunting task. The differences in teaching and learning styles result in problems such as disengagement of students, loss of learning aptitude, and loss of knowledge retention. Recent innovations in visualization technologies such as Augmented Reality (VR) and Mixed Reality (MR) provide avenues that allow these students to engage in a social, collaborative and active learning environment. In the Building Science program, 2D drawings, jobsite photos, and/or field trips are being used to teach students about the design and fabrication complexities of building structures. Experience shows that all students do not fully understand the subject matter through 2D drawings and photos. Field trips while valuable are many times hard to plan due to time, safety, cost (and now COVID) limitations. Creating and using 3D AR/MR models of different structural assemblies could be an engaging and meaningful experience to both building science and architecture students and it can vastly increase their interest in the subject matter. This project aims to experimentally measure improvements in students' comprehension in building structures using AR and MR applications.

Methodology

A mixed-methods research design is adopted as shown below:

Traditional 2D Drawing

3D Model viewable via AR/MR Apps

Results

Results of Timed Quiz Analysis

Group	Mean Score	Median Score	Standard Deviation	Mean Time for Quiz
Control	61%	55%	11.43	23:26
AR/MR	85%	71%	14.72	18:06

t-Test (Equal Variance)	
Mean diff.	-4.50%
SE	6.0%
t-value	-0.7474
df	25
two-tailed p value	0.4618
Result	Ha Accepted

Ease of learning and understanding through AR (Did you feel comfortable while learning and understanding the structural models)?

Do you think that AR based tools can significantly enhance the structure course education effectively?

Level of learning and understanding of structural model offered by AR technology as compared to 2D structural drawings/blue prints
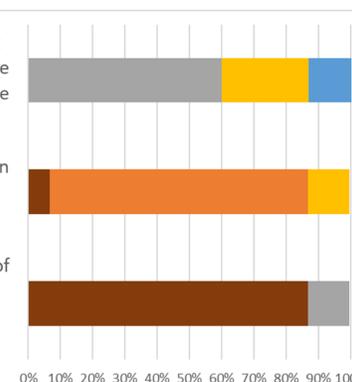
Extremely effective ■ Very effective ■ Moderately effective ■ Slightly effective ■ Not effective at all

SWOT Analysis

Strengths
- Accurate depiction of real scenarios
- Interactive
- Improve knowledge retention
- Improve students interest
- Reduce dependence on field visits
- Matches life style of Generation Z

Weaknesses
- Immature technology
- Substantial time commitment in the development stage
- Not suitable for all instructors
- Motion sickness
- High cost

SWOT Analysis of AR/MR Tech
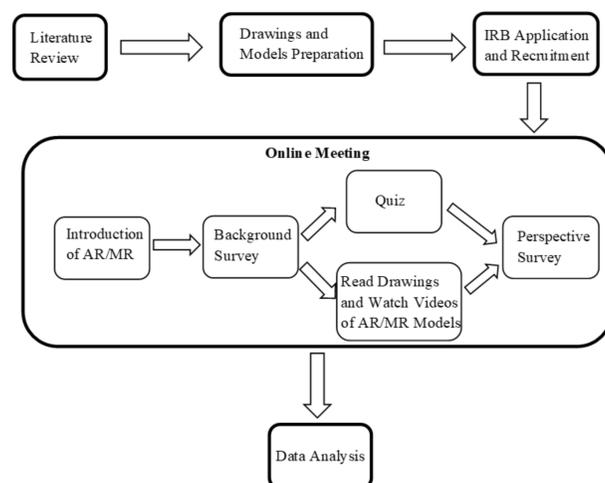
Opportunities
- Effective platform for the 21st century education
- Suitable in both education and training
- Technology is becoming cheaper and affordable
- Encourage Active Learning

Threats
- Less sustainable
- Not suitable in a traditional classroom
- Multiple support platforms "confuses" users

Conclusions

- A significant improvement in students' comprehension and knowledge retention is observed via use of AR/MR technologies. As a whole, the students' interest in the courses is immensely increased and their ability to interact and collaborate with the fellow students is significantly improved.

- There are numerous opportunities for blending these technologies into today's and future classrooms which closely match the life and education styles of Generation Z students. As the cost of technology is becoming cheaper day by day, it can be envisaged that the academic institutes may find it easier to procure and implement them in classes. They have equal applicability in traditional as well as online education and workers' training. Last but not least, these technologies support the active learning style which is becoming popular among the current academics in most disciplines.

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