Creating Virtual Reality Immersive Games for Construction Safety Training

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Jobsite safety has always been a top priority in the construction industry. Although remarkable improvements have taken place in construction technologies and processes in recent years, the safety records in the construction industry continue to be one of the poorest. Unsafe jobsite conditions, inappropriate work planning, insufficient communication between workers and supervisors, and lack of safety training are some of the key contributing factors.

In recent years, several construction companies have tried to improve safety training in an attempt to reduce fatalities and injury rates. However, many companies found it challenging to provide effective safety training to construction workers due to language barriers, limited training time, and use of non-visual safety training methods. This research study was carried out to introduce a new construction safety training paradigm using the Virtual Reality (VR) technology, which is more realistic and independent of language barriers. The most significant advantage of VR technology is gaining real-life experience without exposing students to the danger of the jobsite.

In this research, three VR-based construction safety games were prepared to introduce students to possible hazards as well as safety measures while working in a confined space, at heights on a scaffold, or walking on a construction site cluttered with materials and debris (Figure 1). To begin with, a conceptual framework for design efficiency, execution, time-period, and method of delivery was laid out to improve pedagogical and participation experience about construction safety. Unity 3D® was selected as the developing platform and three VR-based safety games were created for Oculus Go™ VR headset.

The three VR games were introduced to a group of students who were taking the construction safety class at the McWhorter School of Building Science at Auburn University. The students played the three games and compared them with the traditional lectures they received earlier in the semester. Their feedback was collected via a questionnaire survey. The VR training showed significant improvements in correctly identifying hazards and most suitable mitigation plan at the jobsite. The survey results clearly indicate that the VR based safety games/training can play a positive role in improving students' understanding, knowledge, and interest in the construction safety education (Table 1). The following are excerpts from feedback collected from the students through a post-exercise survey:

"Very promising way to assess potential dangers without being put in the actual situation."

"It reminds me of a (video) game. It's very interactive and effective. I think it's an interactive idea for safety training and the immersive environment is definitely useful."

"I believe it will be a great training tool for new construction workers."

Statement of Research Advisor

The thrust of our research was to investigate how emerging visualization technologies such as VR can help construction students and industry workers to improve their learning and knowledge retention in the subject matter. We found that the VR technology was very effective in training students and workers for construction sites without exposing them to any dangers. The research results are valuable for both academic and industry professionals and will help them to revamp construction safety training methods currently in use.

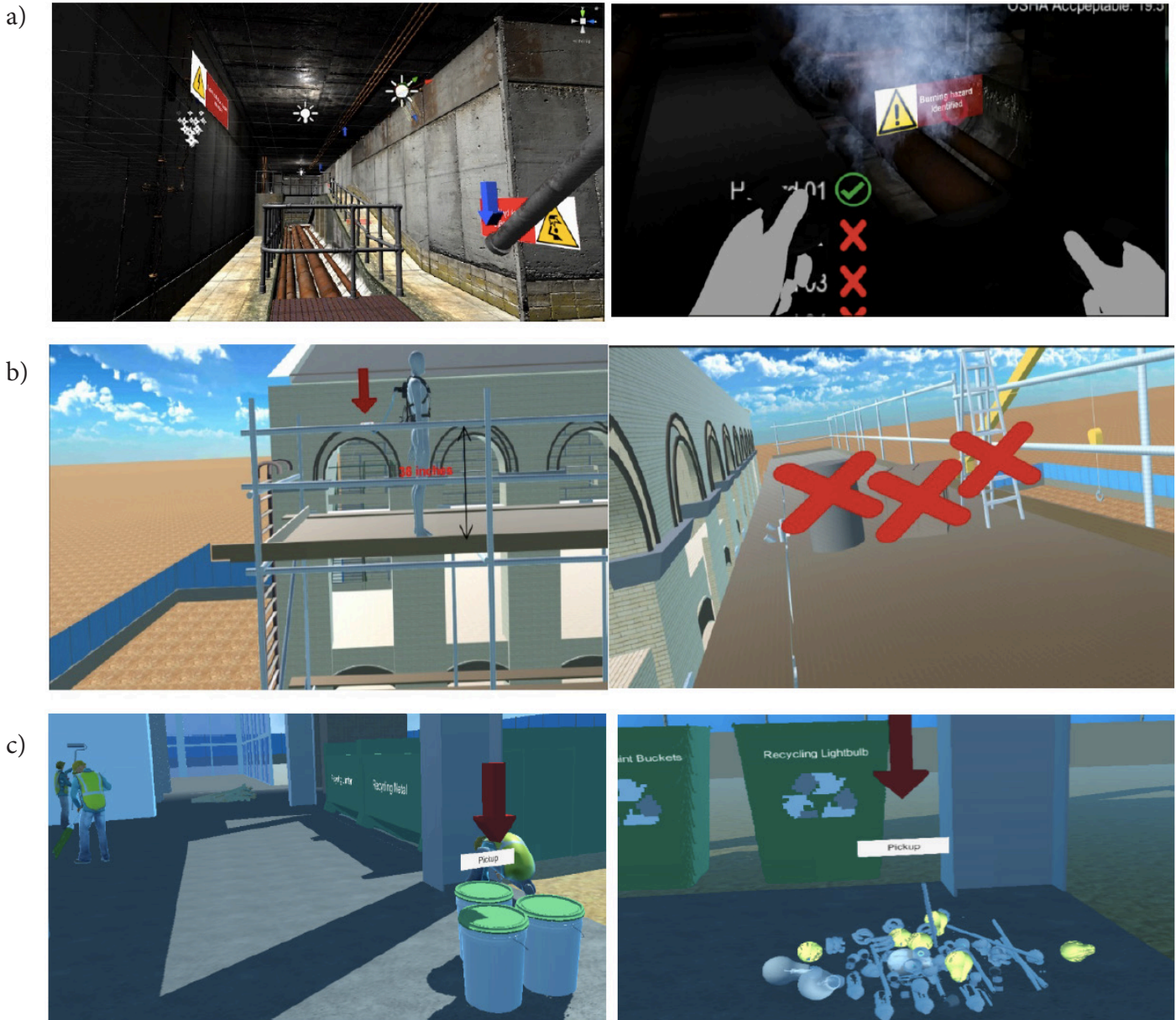*– Salman Azhar, McWhorter School of Building Science*

a)

b)

c)

Figure 1: VR-based safety training for (a) working in a confined space; (b) working at heights/on a scalfold; and (c) working on jobsites cluttered with materials and debris.

Table 1: VR Based Safety Training System Effectiveness Scores Based on Students' Responses (Sample Size: 25)

	Questions	Average Score (1: Lowest, 5: Highest)
1	Ease of use (Did you feel comfortable when interacting with the virtual screen of the VR system?)	4.48
2	How real is the virtual environment in the game?	4.12
3	Do you believe the VR system could improve the hazard recognition process for a real construction site?	4.32
4	Do you think the VR games enhanced your safety knowledge or understanding?	4.64
5	Do the VR games improve your long-term memory about hazard recognition	4.09
7	Does the information provide in the VR safety training games more understandable than traditional safety training?	4.36
8	Was the safety content of the VR safety training games helpful in safety cognition?	4.68
9	Do you think the VR safety training games can enhance construction safety education effectively?	4.76
10	Do you think the VR safety training games are more beneficial than the class-based educator's lectures?	4.36