Preliminary Evaluation of the Usability of a Virtual Reality Game for Mudslide Education for Children

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ABSTRACT

Mudslide education is important for children. In this study, a design-based research approach was used to develop an educational VR mudslide game for children. Eleven children participated in the usability evaluations. The results indicated the importance of intuitive, easy-to-learn controls. Six major refinements of the VR mudslide game were made to increase usabilities. Feedback from the participants will guide future game refinements to increase users' engagement and interaction.

CCS Concepts:

• Applied computing~Interactive learning environments

Aditional Keywords and Phrases:

Virtual reality, Usability, Mudslide education, Children

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1 Introduction

Vritual reality (VR) is the computerised simulation of a real environment, in which the user can interact actively [Naranjo et al. 2018]. It provides highly engaging experiences, which in the educational context can lead to a greater focus on learning [Bricken and Byrne 1993]. VR has been shown to be effective for learning, as it enables students to interact with spatial representations and educational environments [Markowitz et al. 2018]. Based on situated learning, immersive VR interfaces can foster educational experiences that provide authentic contexts, activities and assessment [Dede 2009]. Immersive interfaces can draw on the power of situated learning by VR simulation, which is a valuable learning resource, especially for children.

A mudslide is defined as the movement of a mixture of surface materials down a slope. Many areas of Taiwan have experienced major effects of mudslides. Mudslide records show that serious disasters can occur after a typhoon or downpour of rain because of failures in soil retention or damage to the natural environment caused by the mismanagement and overdevelopment of mountainous areas [Taiwan Ministry of the Interior, 2015]. To enhance children's safety awareness, mudslide education is important. The purposes of this preliminary study were to evaluate the usability of a commercial VR mudslide game, and to design and evaluate a modified VR game for children's mudslide education.

2 Methods

A design-based research methodology was used to develop a VR mudslide game. In the first phase, the usability of a commercial VR mudslide game was evaluated with a group of students. After playing the game, the students were interviewed by the researchers. In the second phase, the usability of the two VR mudslide games was evaluated comparatively with another group of students. The students played the two versions of the game. After playing the games, the students evaluated their usability by semi-structured interviews.

2.1 Participants

Five seven-grade students (4 boys, 1 girl) in a junior high school in Taipei participated in the first phase. Six six-grade students (5 boys, 1 girl) in an elementary school in Taipei participated in the second phase.

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2.2 The VR mudslide game

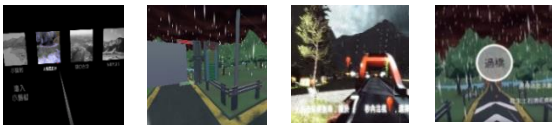
In the first phase, VR Mudslide Game Version A used with the HTC Vive headset, was evaluated. When playing this game, the user focuses his or her eyes on certain points to trigger events. When the mudslide event starts, the user is immersed in a valley environment. He or she must walk to one of three roads in the valley within 15 seconds. The three roads pass along a hill, a bridge and a riverside, representing different scenarios. The user can escape disaster only by taking the hill road.

3 Results

3.1 First phase results

Several usability issues were identified in this phase. First, the headset required a PC connection and game play required a large room for tracking. In addition, the selection interface was confusing; most students did not know how to select focus points, and the focus points were not sufficiently obvious. Moreover, most students did not walk to the hill road to escape from the mudslide.

To enhance usability, the research group collaborated with the company to develop a version B of the game, with the following features (Fig. 1). First, we changed the headset to the HTC Vive Focus Plus device, which is not tethered to a PC or base station. Moreover, students can use the physical controller to make selections. Second, we redesigned the whole mudslide scene using three-dimensional low polygonal resolution to reduce render times without sacrificing the minimalist aesthetic. Third, we presented three different terrains in Taiwan for students to navigate for students to read about the geology information. Fourth, we designed a rainfall scale that students can drag and drop. According to the scale, the system simulates the rate of rainfall and the time interval for triggering of the mudside event. Fifth, the size of the three roads in the valley was increased and selection markers were added. Sixth, we enabled game replay when the user chooses the wrong road. Finally, we added a helicopter when the user walks to the hill, to represent escape from the mudside disaster.



(1) First page (B) (2) Rainfall scale (B) (3) Road selection (A) (4) Road selection (B)

Fig. 1: Differences between the two versions of the VR mudside game.

3.2 Second phase results

In the second phase, three feedback categories emerged: game usability, version preference, and headset preference.

3.2.1 Usability of the two VR game versions. Most students indicated that version B (M = 4.83, SD = 0.41) was more usable than version A (M = 2.50, SD = 0.55), especially regarding the ability to make selections using the controller and the ease of road selection. Typical student comments were:

"The red road selection sign is too small in version A. I prefered the big circle in version B."

3.2.2 Students' preferences for the VR game versions and VR devices. Students were interviewed to rate the version of VR game they prefer. The results showed students more favior the version B (M = 4.25, SD = 0.96) than for version A (M = 3.50, SD = 0.58). They indicated that they would recommend that other students use version B to learn about mudslides. *"Version B had some instruction." ; "I like the mudslide scene in version B, which is more realistic.".* The students commented that they felt more comfortable wearing the Vive Focus Plus headset. *"White one (HTC Vive focus plus) is the better one which is more easily to wear. It supported the belt in the back of the headset, I don't need to hold it with my hand."*

4 Conclusion and future work

The results of this preliminary study indicate the importance of intuitive, easy-to-learn controls for the VR mudslide game. Six major designs of the modified game were developed in an effort to increase acceptability. In future work, we will incorporate learning analytics into the VR mudslide game, with logging of students' learning.

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