Using Virtual World Lego to Develop Fraction Understanding

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Abstract: this poster presentation aims to introduce the pilot study of using Virtual Word (VW) based Lego Game to help the 5th grade students understand the mathematical concept of fraction. In this design-based study, the prototype of VW-based Lego Game was tested with pre-service teachers and math students to investigate its usability, playability, and learning integration. The data were collected via qualitative video analysis, observation, and interviewing.

Recently, using Virtual World (VW) games to help K-12 students with content learning is a popular idea for both educational researcher and game designers. The content knowledge spans from history, to science, to language (Chen et al., 2007; Von der Emde, Schneider & Kotter 2001; Urban et al., 2007)**.** The advantages of using the VW for educational purposes are described as (a) 3D virtual world environment, where students can fully engaged in the environment; (b) affording immersive learning; (c) user can interact with the content or information via multisensory channels; and (d) fostering intuitive learning interaction within the environment (Mikropoulos & Natsis, 2011).

Many studies focused on the benefits of using Lego bricks to facilitate students' mathematic learning and problem solving skills. Hussain, Lindh, & Shukur (2006), stated that students who play Lego bricks performed better on their mathematics tests than students who do not play Lego. They also found that students do not show a significant positive attitude towards Lego. Study also indicated that Lego could promote students' learning of ratio from their construction and explanation on the concept (Norton, 2004).

In this exploratory study, we investigated the usability, playability, and learning integration of the OpenSim-based Lego game prototype for the math learning of 5th graders. Specifically, our research questions are: (1) how did users interact with the design features of the VW Lego game? And (2) how can the game be further improved to promote learning and engagement?

Methods

Participants
Six participants comprised of 3 undergraduates and 3 graduate students majoring in math education or mathematics, aged 20-25, including 3 males and 3 females, participated in the study to provide perspectives of teachers and content experts on the game prototype. They were given basic instructions on how to operate their avatars in the OpenSim world prior to the usability test.

Virtual Lego World
The game is designed by using OpenSimulator (OpenSim), the online open source server platform of virtual world. The OpenSim-based Lego World will be designed to simulate the game world of Mine Craft. The game goal is to escape from the Lego World and the evil Lego King by outwitting him. In particular, players (students) need to complete a series of Lego-based tasks, which aims to teach them the concept of fraction. Students will navigate the game world in their own avatars while one of the researchers takes the avatar of the Lego King. Each round of game-play takes around 60-75 minutes to complete.

There are two major areas for students to play: the Lego kingdom palace, and the Lego factory. The Lego kingdom palace and The Lego factory are the virtual learning places. Within the Lego kingdom palace, the king will introduce the major Lego bricks to student, the concept of Lego, and the basic concept of fraction by using Lego bricks. In the Lego factory, there are many different types of Lego bricks, and students will find the correct ones to build up one object, which are given by the king. Thus, from the pedagogy perspective, the king is the "teacher" who facilitates and scaffolds students' learning process via presenting individualized learning tasks and challenging inquiries.

Data Collection
User-testing data were collected from: (1) video recording, (2) in-field observation, and (3) semi-structured interview. The participants' game-play performance was observed and screen recorded. Participates also completed

the interview on their attitudes towards the VW interface, the game design, and the story design at the end of user-testing session. A qualitative thematic analysis was conducted from the interview transcripts as well as reviewing the video recordings.

Results

All participants stated that they believe that the OpenSim-based Lego game would help fifth-grade students to understand the concept of fractions. In particular, they reported that the different color and sizes of Lego bricks had facilitated the learning process. They also considered the story line, the game world design, and the five game-based learning tasks as engaging for fifth-grade students. In particular, all six participants reported that the lack of tactical, physical sensation in interacting with the OpenSim-based Lego game did not affect their understanding of the concept of fraction at all.

However, participants all reported that it was harder to maneuver the VW Lego bricks to construct artifacts than the actual Lego brick. When building with Lego bricks in the current OpenSim-based virtual game, players were faced with three challenges: (1) intricate x, y, and z control with a three-dimensional (3D) object; (2) intricate three-dimensional position tracking, by which a player had to constantly change their standing positions and viewing angles in the virtual world to gauge the position of a 3D object; and (3) lack of full collision detection when putting two VW Lego bricks together. Five participants said it was necessary to remind them on the backdrop storyline during game play, since it was easy for them to forget why they had to complete each task. Half of the participants reported the need for more free-play time to design and construct artifacts in the VW-based Lego land.

Implication

The exploratory study findings provide valuable information for the future development of the OpenSim-based Lego game. Specifically, our next steps are: (1) seeking a more effective and intuitive way to Lego-brick maneuvering, (2) providing a more consistent game story presentation that is aligned with the learning task presentation, and (3) embedding and offering more free-play activities in the virtual Lego game.

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