Draft HCI Project Final Paper - PC Builder in VR

A detailed overview of our semester project

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***Abstract*—This article describes the group project in CS464: Introduction to Human-Computer Interaction at Colorado State University. This project focuses on a custom made virtual reality computer building simulator designed to teach individuals how to build a computer and the importance of each component. An experiment for testing the effectiveness of our program was designed, but not carried out due to certain circumstances.**

***Index Terms*—**

- **VR: Virtual Reality**
- **VRLE: Virtual Reality Learning Environment**
- **PC: Personal Computer**
- **HCI: Human Computer Interaction**

I. Introduction

A. Purpose

The goal of this experiment is to see if the VR computer-building tutorial helps people learn how to assemble a computer. If the participant who completed the VR tutorial can assemble the computer faster than the one who did not receive VR training, then the VR tutorial is deemed useful.

B. COVID-19 Circumstances

TODO - Include a description of how covid changed the criterea for the project

II. Previous Research

TODO - find 12 sources total

A. Context

This project uses peer reviewed articles in order to help support our research and to provide us with a basis for our experiment. So far we have collected three articles to reference. We will discuss these articles in this section and describe why they are important to this project.

B. Interactive multimodal learning environments [2]

The article "Interactive multimodal learning environments" is a great source for a basis to our research project. The article is about research trying to determine what are interactive multimodal learning environments and how they can be created to promote learning for students. Their research has shown that interaction with a concept can lead to a healthy relationship between working memory and long-term memory through the use of integrating tasks and information together in the working memory to further cement concepts and information. Our project will use this information to help determine if the VR interaction will help cement the working memory and the long-term memory in a similar fashion to the article.

C. Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach [1]

The article "Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach" studied what participants thought of learning in a VR learning environment(VRLE), based on participants' responses on a questionnaire after being exposed to a VRLE. This study defines what a VRLE is, in addition to what aspects should be incorporated in an effective, constructivist VRLE. Huang, Rauch, Liaw (2010) define "constructivism", the paradigm in which they are conducting this study as the idea that "learners take an active role in their learning, since they not only absorb information, but also connect it with previously assimilated knowledge" [1]. According to this paradigm, learners absorb the most meaningful information from actual experience. Using VRLEs as a constructivist approach involves incorporating five different learning aspects. First, *situated* learning should be implemented: the idea that students interact with simulated objects inside a simulated environment, treating it like they would the real world; thereby giving them experience that will transfer to real-world skills and knowledge. Next, VRLEs should incorporate *role playing*; the use of characters helps a learner express what he/she thinks, particularly with younger learners. *Collaborative learning* should also be incorporated: the idea that a VRLE is a shared space, with the ability for users to communicate with each other within the virtual reality environment. The final two important aspects are *problem-based learning*, in which a learner needs to complete tasks, and *creative learning*, in which learners must visualize new ideas to solve problems. The article defines VRLEs as incorporating these fundamental principles. Note the researchers do not define virtual reality as requiring a headset, or being able to directly manipulate objects with your hands, as many would picture VR; instead, the VR used in this study was a web-based system involving 3D models that can be interacted with through typical computer input devices.

The first part of this study was conducted by starting with exposing the participants to this web-based VR system. The VR system was a program developed for medical students to learn about human physiology, and specifically includes models of the body that can be manipulated and broken down. The researchers thought that this VR system embodied the three most important factors of VR: "intuitive interaction, the sense of physical imagination, and the feeling of immersion" [1]. The researchers hypothesized that "with the increased immersion, interaction, and imagination provided by a VR environment," [1] the motivation and problem-solving capability of the learners would increase in a VRLE. Despite the program in this study simply being a web-based, interactive 3D system, the researchers still considered it an effective VRLE. In comparison, our VRLE incorporating an Oculus Rift headset and hand controllers is much more immersive, and so should only increase the benefits that may be seen from a less immersive VRLE such as the one seen in this study.

The 190 participants' attitudes towards the VRLE was then analyzed through a questionnaire using the 7-point Likert scale to measure agreement vs disagreement to certain statements. The results showed that the participants felt that the 3D VRLE was immersive, interactive, and imaginative, and tended to answer that in using this VRLE, they are more motivated to learn and have enhanced learning capability. These results show that first, a web-based, interactive 3D system is enough to feel immersive and beneficial to learners, and also that there is a correlation between a learning system being immersive, interactive, and imaginative and being effective in increasing motivation and learning capability. The second part of this study involved a 3D interactive program, this time with collaborative learning mode. In this mode different learners could interact and discuss with each other virtually. The purpose of this part of the study was to see the effect of virtual collaboration on a learner; the researchers predicted that there is a positive correlation between collaborative learning and the participants' intention in using the program to learn. The results showed that collaborative learning did indeed help the learners, because they felt that they could ask questions when problems arose, and could obtain help when needed. This approach in focusing collaborative learning shows another solution to how to best help learners in a VRLE. However, the results showed that the collaborative learning was slightly less impactful on learners' attitudes than the interaction and imagination aspects of the virtual reality learning environment. The participants' responses showed that they thought the interaction and imagination of the VR system increased their capability to learn.

The results from this study showing the importance of the aspects of interaction, imagination, and interactivity in a VRLE lead to the notion that a VRLE using an Oculus Rift will be effective in increasing learners' motivation and learning capability.

D. Virtual reality and mixed reality for virtual learning environments [3]

The article Virtual reality and mixed reality for virtual learning environments [3] lays out compelling reasons for why virtual and mixed reality can help increase the rate and effectiveness of one's learning. The implementation of using virtual reality for learning is called a virtual learning environment(VLE). The four fundamental components of such an environment outlined in this paper are the knowledge space, the communication community, active action, and facility toolkits. The knowledge space is the part of the environment that has the resources and data to be learned; the communication community includes email, group discussion, and other communications between learners in the VLE; the active action is the tools that allow VLE participants to actively interact with the environment; and the facility toolkit is what defines the curriculum as 'sections' that can be assessed to track how well a participant is learning. This paper also points to the statistic that the E-Learning market was estimated to be $5.2 billion in 2001, and would grow to $23.7 billion in 2006; the market for E-Learning, and therein VR learning, is huge. This, along with some psychology research producing positive reviews about peoples' attitudes towards E-Learning, gives a good reason for why people will likely be open to VLEs as they become more common.

Some of the advantages of VR learning pointed out in this paper include integration of learning with entertainment, storytelling and synthetic characters. By integrating learning and entertainment, children are more motivated to apply themselves and persist in learning in a VLE. Storytelling can also be an important factor in learning for children; it is a way to keep the child engaged. With AR, storytelling becomes more interactive and intuitive, and the user can participate in the story. Finally, synthetic characters, human-like entities that the user can interact with, can help increase learning by incorporating human-like common sense and the ability to answer certain questions, thereby acting as a virtual teacher.

This article seemed to have a focus on how VR learning would benefit children specifically, thereby narrowing the scope of VR's purpose. The article did a good job of outlining what VLEs would look like, and how they would work, but it didn't go into a lot of depth on why we should use them, or why they are better than traditional learning methods. The most relevant piece of the article to our project was a section about a virtual learning environment for building a Kyoto garden, a type of Japanese garden. This VLE involved picking up and dropping different virtual objects from a 'Menu board', moving virtual objects in the 'Sand Table'(the space where one builds the garden), and scaling the size of virtual ponds in the Sand Table. This VLE is an increase in similarity to real-world application when compared to working with 3-D models on a computer screen with a mouse. A VLE like this, that lets a user directly interact with virtual objects resembling real-world objects helps users learn through virtual hands-on experience. This directly applies to our computer building project, in which a user is handling virtual computer components, resulting in developing the user's long-term memory concerning the position of different components' placement in the computer.

III. Program Description

A. Overall Prototype

The goal of this project is to design a VRLE that teaches players how to build a computer. This VRLE is split into two separate parts: a tutorial and a free-play section. *TODO - go in depth here. What are the in's and out's of the program. What does it do well, what does it not do well*

B. Tutorial

TODO - describe in depth info pertaining to this gamemode

C. Free-play

TODO - describe in depth info pertaining to this gamemode

D. Challenges

TODO - describe the challenges we faced when developing this program

E. Next Steps

TODO - how could this project be improved upon

IV. Project Evaluation

TODO - looking back, we learned blank from this project

A. Team Dynamic

TODO - discuss each individual's contribution to the project, what we learned about teamwork

B. HCI Experience

TODO - describe what we learned about human computer interaction from this project

C. Programming Experience

TODO - describe what we learned about programming from this project

V. Experiment Design

A. Note

It should be noted that this experiment was not performed. Due to the unforeseen circumstances of COVID-19, the experimental design had to be cancelled. The following is the complete design for the experiment, as we would execute if we were able to.

B. Experiment Overview

The purpose of our program is to teach computer desktop assembly to individuals who have no such experience. In order to observe if it effectively teaches this, we need to compare our learning method with a different learning method. We chose to compare our program's performance with what we perceived to be the best current method of learning how to build a desktop computer, which is through online tutorial videos. Our hypothesis is that our program will more effectively teach computer assembly than online tutorials. We believe our program will exhibit better performance because a user has more sensory input by actually building a virtual computer, rather than just watching steps on how to do the task.

C. Participants

The participants for this experiment will consist of 30 college students whose ages range from 20-25. Participants from this background will be used simply because the research pool for that population is very large. Participants will be screened beforehand to determine if they have little to no experience with computer hardware assembly. These will be the individuals that will be selected to continue in the study since the goal of this software is to teach computer hardware assembly effectively, at a beginner level.

D. Design

With 30 college students, there will be 15 individuals in each of the two treatment groups for a between subjects experimental design. The 2 treatment groups will be exposed to our tutorial VR program for building a computer desktop and exposure to a short video series on the same topic.

The experiment will include three phases: a pre-treatment survey, the treatment condition, and a post-treatment survey. The pre-treatment and post treatment surveys will be the same between individuals in both treatment groups, although the two surveys will have slight variations compared to each other. They will test the same information, but they will be worded slightly different so that they do not seem identical. These tests will assess the participants' knowledge of the functions of computer hardware components (like the GPU, RAM, etc.) and the order that one would have to assemble a desktop computer.

The two treatment groups will be using our proposed VR computer hardware assembly tutorial and watching a short video series on computer hardware assembly. The participants in the VR tutorial group will complete the ”Tutorial” feature of our proposed program, or until they have been using the feature for 15 minutes, whichever comes first. The other treatment group will watch 15 minutes of a beginner computer hardware assembly video series. Both treatment groups will complete the post treatment surveys immediately after they complete their treatment condition.

E. Data Collection

The data for this experiment will come from the pre-treatment and post-treatment surveys. We are interested in how each individual will improve based on which treatment group they were in. The pre-treatment and post-treatment test scores will be compared and analyzed for how much each participant progressed.

REFERENCES

[1] Hsiu-Mei Huang, Ulrich Rauch, and Shu-Sheng Liaw. Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. *Computers & Education*, 55(3):1171–1182, 2010.

[2] Roxana Moreno and Richard Mayer. Interactive multimodal learning environments. *Educational psychology review*, 19(3):309–326, 2007.

[3] Zhigeng Pan, Adrian David Cheok, Hongwei Yang, Jiejie Zhu, and Jiaoying Shi. Virtual reality and mixed reality for virtual learning environments. *Computers & graphics*, 30(1):20–28, 2006.