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Immersive Visualization Environments for Teaching/Learning

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Comparative Study of Brain Activities in Immersive Visualization Environments: An Innovative Pedagogical Technique

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Abstract
The primary objective of this work-in-progress is to investigate advanced and innovative pedagogical techniques in teaching and learning STEM concepts by utilizing Immersive Visualization Environments (IVE). Specifically, a comparative study of brain activities was performed to determine effectiveness of different Immersive Visualization Environments in pedagogy. Twelve randomly selected college students participated in this investigation using an electroencephalography (EEG) device for measuring brain waves of the subjects. The preliminary collected data supported the assertion that dome-shaped IVE elicited a more relaxed state than its counterpart, head-mounted IVE, yielding a higher performance.

Introduction and Brief Background/Literature Review
Immersive visualization environments and variations of virtual reality technologies hold great promise for creating and advancing innovative pedagogical techniques in STEM and other related disciplines [1]. Recently, major researchers have undertaken multiple projects regarding use of immersive visualization technology for effective pedagogical practices—in-class and online approaches. As a contemporary filed of application in immersive environment, Virtual Reality Technology/Therapy (VRT) is incorporated in experimental phase of this study. Briefly, VRT is a comprehensive concept encompassing an array of technologies to collect, share, and analyze information that ultimately treating varieties of psychological disorders. To this end, authors have focused on a comparative investigation of the brain activities in Head-Mounted and dome-shaped Immersive Visualization Environments (IVE) – See Figures 1 & 2. For clarity, these systems in this article are called Head-Mounted IVE and Immersive Visualization IVE.

Figure 1. Head-Mounted Immersive Visulaization Environment

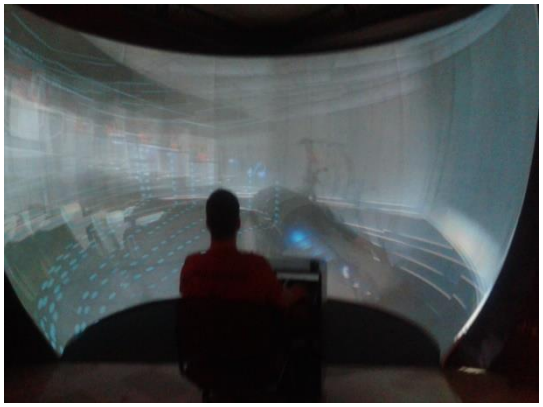

Figure 2. Dome-Shaped Immersive Visulaization Enviroment

For several decades, Virtual Reality Technology Therapy (VRT) has shown to be an effective treatment for phobias and other psychological disorders [1, 2, 3]. In fact, the primary author of this article has conducted pioneering research in VRT for a variety of psychological conditions [4, 5]. In addition to subjective measures that have been used in the past, electroencephalography (EEG) offers the ability to objectively measure success in treatment [6, 7, 8].

Research Question and Null Hypothesis

RQ-1: Does brain waves of participants in dome-shaped Immersive Visualization Environment elicit a higher level of relaxation/performance than a head-mounted Immersive Visualization Environment?

H0-1: There is no statistically significant difference in brain waves of participants in dome-shaped and head-mounted Immersive Visualization Environments pertaining to relaxation/performance. .

Methodology

Twelve college students were randomly selected to participate in this investigation. An electroencephalography (EEG) device was used to measure the brain waves of the subjects with no outside stimuli (Figures 3 & 4). The experiment was designed to measure the activities of the subjects' brainwaves in response to a virtual relaxation scene using EEG in two different IVE systems (Head-Mounted IVE and Immersive Visualization IVE systems). Initially, two experiments were conducted in four sessions of five minutes each for two distinctly configured IVE systems.

Figure 3. A subject is connected to an EEG system during experiment.

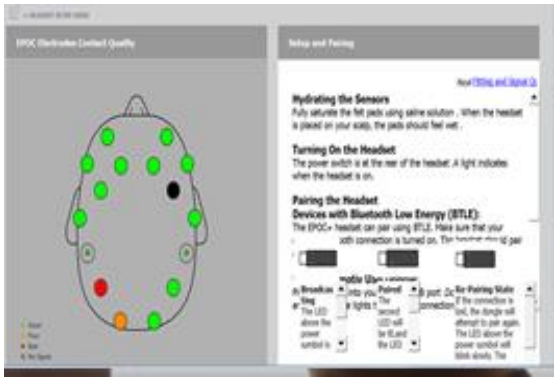

Figure 4. EEG software collaborating connections and collecting brainwaves

Preliminary Results

Just considering the preliminary data, it seems that the overall mean of all three brainwaves (Alpha, Beta and Theta) for participants within an Immersive Visualization IVE systems were lower than those measured during Head-Mounted IVE experiments, supporting the assertion that Immersive Visualizations IVE elicited a more relaxed state than its counterpart. Nevertheless, the statistical analysis of data using *t-test* showed statistically no significant difference between collected EEG data from all twelve participants from experiments with both IVE systems, thus null hypothesis *H0-1* is accepted.

Conclusions (Concise)

The preliminary analysis of collected data indicated that the Immersive Visualization IVE system yielded higher performance than the Head-Mounted IVE system. In many cases,

participants had a decline in activities of brain waves from baseline brain activities under the influence of an immersive relaxation scene. In rare instances, there were some participants that showed extreme increases in brain activity. The current study (work-in-progress) has collected an extremely small sample; future study is under way to experiment with a larger number of participants and to determine whether Immersive Visualization IVE (dome-shaped) continues to show higher performance over Head-Mounted IVE. The implication of this investigation can be directly extended to many fields, such as learning/training either in-class or online environment.

Acknowledgment

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