MOTIVATING LEARNING PERFORMANCE IN COLLABORATIVE VIRTUAL REALITY ENVIRONMENTS

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Abstract - Motivation has been identified as a key factor in promoting students' higher-order thinking skills. Students who are highly motivated excel at absorbing and applying new materials and concepts. Students with low levels of motivation learn very little even with compelling and well designed classroom exercises. How then to motivate students beyond the traditional application of grade pressure? Collaborative Virtual Reality Environments, in which the students' avatars interact with each other and the objects in the environment, offers new possibilities for raising student motivation levels. This paper discusses the use of "Coexistence Competition" in which students share the same virtual workspace and can see and examine each others' ongoing progress. This new technique not only increases student motivation but also allows students to learn from each other more readily. This paper provides a template for the setup of Coexistence Competition learning environment in OS-BEST, the open source Collaborative Virtual Reality Environment under development at The University of Southern Mississippi.

Keywords: Virtual Reality, Multimedia, Learning, Share, Technology

INTRODUCTION

One emerging technology for distance education and classroom education is Collaborative Virtual Reality Environments. Collaborative Virtual Reality Environments (CVRE) is a technology that allows a user to interact with a computer-simulated environment, be it a real or imagined one and collaborate with possibly many participants that may be spread over large distances. The need to understand the motivational impact of Collaborative Virtual Environments is increasing both in the academic and in the professional worlds. A study done by Gartner Inc. in 2007 suggested that by 2012, 80% of internet users will have a presence in a 3-D virtual environment [1]. As the use of Virtual Environments increased the common problem faced by professors to better understand it motivational impact also increases. This paper presents the results of assessing motivation for learning in students using a collaborative Virtual Reality Environments developed in OS-BEST, the open source Collaborative Virtual Reality Environment under development at The University of Southern Mississippi

OPEN SOURCE BUILDING ENVIRONMENT FOR SIMULATION AND TRAINING (OS-BEST)

OS-BEST is a free open source on-line virtual environment platform that can be use to create and share simulating and training experiences in Architecture, Construction, Engineering and Computing. A sample environment created using OS-BEST is shown in Figure 1.

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Figure 1. Sample Environment Created using OS-BEST

OS-BEST is released under a BSD License, making it both open source, and commercially friendly to embed in products. OSBEST has been developed on top of two other open source virtual reality systems: RealXtend and OpenSimulator. RealXtend speeds up the development of the global standardized 3D internet of virtual worlds by making the best technology available to everyone. RealXtend's value is the ability to interconnect 3D worlds applications [2] OpenSimulator is a 3D Application Server that can be used to create a virtual environment (or world) which can be accessed through a variety of clients, on multiple protocols. OpenSimulator allows the development of environment using the technologies that the user considers work best. OpenSimulator is designed to be easily extendable through loadable modules to build completely custom configurations [3].

OS-BEST emulates the features of Second Life - a free 3D virtual world where users can socialize, connect and create using free voice and text chat [4]. OS-BEST provides superior rendering and scripting capabilities in Python. The backend database uses MySQL for authentication and inventory. OS-BEST provides security through SSH tunneling, local backups of the entire server, administrative server side features through a web- portal, and enhanced server-side functionality through Python scripting. The software architecture showing the interrelationship between the software and the users in Figure 2.

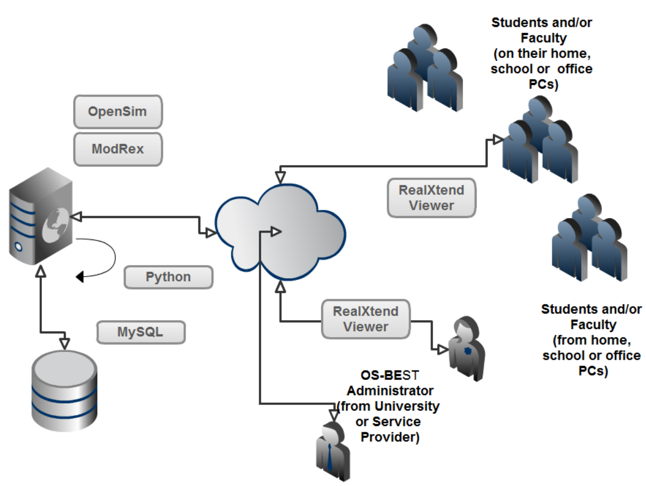

Figure 2. The OS-BEST Architecture

Faculty and students interested in using OSBEST, can create a free account on the OSBEST-Grid, download the OSBEST-Viewer and install the viewer on their desktop computers to connect to the OSBEST-Grid. The complete process should take no longer than 10 minutes, and will give the faculty and students a flavor for what OSBEST is capable of doing for teaching and research activities.

RESEARCH SETTING

The research setting was based on an experimental methodology. As indicated by Melville, the experimental research identifies the variables of interest and seeks to determine if changes in one variable (called the independent variable) results in changes in another (called the dependent variable) [5]. In the portion of the research presented in this paper, the independent variable was the instructional media used (traditional vs. Virtual Reality), and the dependent variable was the student motivation to learn.

The experiment consisted of a Virtual Reality Environment accessible through the Internet where the students could schedule a construction project after studying the corresponding building design drawings. Samples of the web presentation of building design drawings are presented in Figures 3.

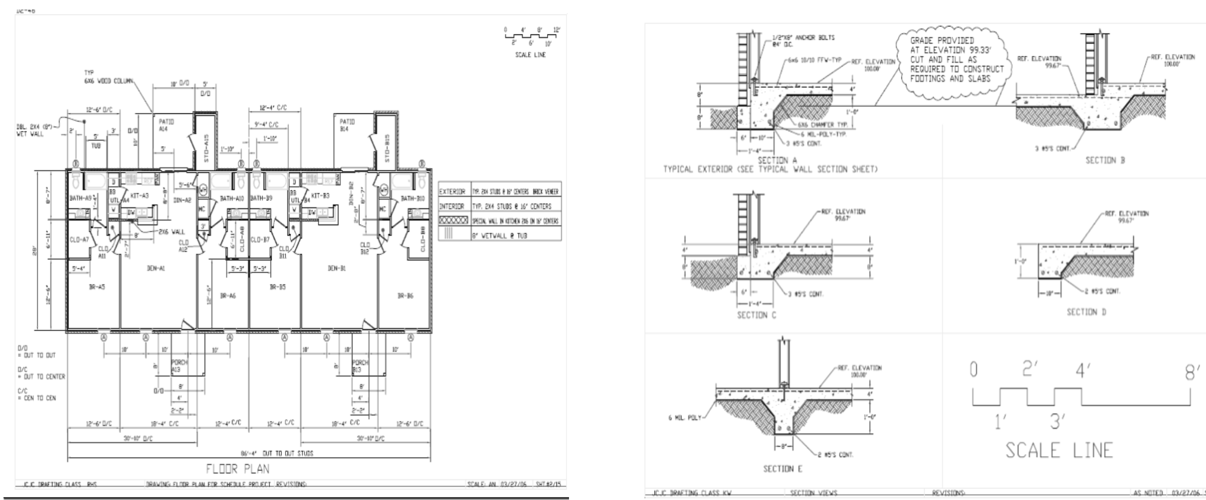

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Figure 3: Sample Project Drawings Presented to the Construction Students

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The students were enrolled in a scheduling course and were asked to complete the schedule of the project based on the information provided in the project documents. After the students completed the project schedule, the Virtual Reality environment proceeded to build the project using the student's schedule. If the student made a scheduling mistake the Virtual Reality environment would stop, color the error red and add additional cost and time to the construction project. This penalty corresponds with the real life cost of construction scheduling errors. Students then needed to identify the scheduling mistake and re-schedule again until the construction project was completed. The student objective within the Virtual Environment was to complete the construction schedule with the minimum number of mistakes.

The Virtual Reality Schedule Simulation (VRSS) was designed to provide students with hands on experience in scheduling a construction project and to experience the consequences both visually and productively in terms of cost and time. The VRSS was developed for use in the classroom. However, it is accessible from anywhere via the Internet by a typical multimedia computer. Therefore, it can be used as an online learning tool as well. Since the tool is new, it needed to be tested for usability, pedagogical merit and student motivation. During the evaluation process, a usability, motivation and learning assessment instrument was administered to the students to quantify the impact of the VRSS. This paper focuses primarily on presentation and analysis of the cognitive development results of the two year VRSS experiment.

ASSESSMENT

The assessment was implemented by dividing the sample group into two groups (Control and Intervention with Virtual Reality). The control group was assigned a scheduling activity using traditional classroom pedagogy while the intervention group was assigned a scheduling activity to be performed in the Virtual Reality Environment as described above. It is important to highlight that the only difference between the control group and the intervention group was the instructional media (traditional vs. Virtual Reality Environment). Upon completing the assignment a motivational survey was administered.

The motivational survey was based on the Intrinsic Motivation Inventory (IMI) developed by Deci and Ryan [6]. The IMI is a multidimensional measurement device intended to assess participants' subjective experience related to a target activity in laboratory experiments. It has been used in several experiments related to intrinsic motivation and self-regulation (e.g., Ryan, 1982; Ryan, Mims & Koestner, 1983; Plant & Ryan, 1985; Ryan, Connell, & Plant, 1990; Ryan, Koestner & Deci, 1991; Deci, Eghrari, Patrick, & Leone, 1994). The instrument assesses participants' interest/enjoyment, perceived competence, effort, value/usefulness, felt pressure and tension, and perceived choice while performing a given activity, thus yielding six subscale scores [6].

After the students filled out the motivation survey, statistical analysis was performed to determine the motivational impact of the new pedagogy using virtual reality method versus the traditional method. The statistical analysis, as in most research projects, involved three major steps, done in roughly this order: cleaning and organizing the data for analysis (data preparation), describing the data (descriptive statistics), and testing hypotheses and models (inferential).

1- Data Preparation: involved checking or logging the data in; checking the data for accuracy; entering the data into the computer; transforming the data; and developing and documenting a database structure that integrates the various measures.

2-Descriptive Statistics: described the basic features of the data in this research project. They provided simple summaries about the sample and the measures. Descriptive statistics were used to present quantitative descriptions in a manageable form. They were used to simplify in a sensible way the large amounts of data collected. The descriptive statistics of this project involved the examination across cases of one variable at a time. The three major characteristics of use to describe a single variable were its distribution, central tendency and dispersion.

a. Distribution is a summary of the frequency on individual values for a variable. One of the most common ways to describe a single variable is with a frequency distribution. Graphical forms such as histograms or bar charts are effective tools for depicting frequency distributions. [7]

b. Central Tendency of a variable is the estimate of the "center" of a distribution of its values. The three major types of estimates of central tendency of a variable are its mean, median and mode. The mean is the variable's average value. The median is the score found at the exact middle of a set of variable values. The mode is the most frequently occurring value for the variable. [7]

c. Dispersion refers to the spread of the values of the variable around the central tendency. The two most common measures of dispersion of a variable are its range and standard deviation. The range is the highest value of the variable minus the lowest value. The standard deviation is more accurate reflection of dispersion by reducing the effect of outlier values of a variable. [7]

3- Inferential Statistics: focus on trying to reach conclusions that extend beyond the raw data. Inferential statistics were used to make inferences from the descriptive statistics to more general conditions. The inferential statistical method used for this paper was General Linear Model (GLM) Univariate. The GLM Univariate procedure was used because it provides regression analysis and analysis of variance for one dependent variable (motivation) by one or more factors and/or variables (traditional vs. Virtual Reality). This GLM Univariate procedure also allowed the research team to investigate interactions between factors (motivation versus traditional/Virtual Reality) as well as the effects of individual factors, some of which may be random.

RESULTS

As previously indicated, the three major statistical steps done in this research project were: cleaning and organizing the data for analysis (data preparation), describing the data (descriptive statistics), and testing hypotheses and models (inferential statistics).

1- Data Preparation: Students' responses were collected from four sets of students over the two year experiment and collated into an EXCEL spreadsheet. This data collection was scanned for basic correctness, for example questions where the student made no response were marked as missing. From this data three sets were developed: the control group which had done paper and pencil exercises, the Virtual Reality group which had done the exercise using Virtual Reality and the group of all students which included both control and Virtual Reality students students. These data sets were then imported into SPSS for further analysis.

2-Descriptive Statistics: Basic descriptive statistical analysis of the VRSS dataset was run in SPSS. SPSS is a statistical and data management package for analysts and researchers. SPSS Inc. have been in business for more than 40 years, and have more than 250,000 customers (academic institutions, healthcare providers, market research companies and government agencies) [8].

The research dataset included 113 students motivation survey of 57 students in the control group and 56 in the intervention (Virtual Reality) as shown in the Table 1.

Table 1. Distribution of Motivation Survey

Group	Frequency	Percentage
Control	57	50.4
VR	56	49.6
Total	113	100

Table 2 shows a summary of the data analyzed of the motivation survey for both control and intervention group. The analysis of the data indicated that there was an overall mean score of 0.27 based on a scale from -2 (Strong Disagreement/disinterest) to 2 (Strong Agreement/Interest) with a standard deviation of 0.87. The mean score for the control group was 0.06 and the mean score for the intervention (VR) group were 0.49.

Table 1. Interest and Enjoyment

Group	N	Mean	Median	Minimum	Maximum	Range	Std. Dev
Control (Paper)	57	0.06	0.14	-2.00	2.00	4.00	0.90
Intervention (VRSS)	56	0.49	0.43	-1.14	2.00	3.14	0.78
Total	113	0.27	0.43	-2.00	2.00	4.00	0.87

3- Inferential Statistics: The results of the GLM in Table 3 below, shows a difference significance level of .007 (0.7%) between Control and VR which it is significantly below 5%. As stated by Glenberg, values of test statistics that occur with a relative frequency (Sig.) of less than 5% are in the rejection region [9]. The rejection region means that the null hypothesis (no difference between groups/conditions) can be rejected, thus there is a difference between groups/conditions. This 0.007 means that only in less than 7/1000 cases in which the true means (motivation scores) were the same; the sample will show results as extreme as the one observed here. Therefore, with a significance level of .007 which is less than 0.1, the null hypothesis (which is that there is no difference between the groups/conditions) is rejected. Thus, it was concluded that there is statistically significant difference in the Interest Level of the students in the control group versus the Interest Level of the Virtual Reality group.

Table 3. Interest and Enjoyment Statistical Results

Between-Subjects Factors

		N
Group	CONTROL	57
	VR	56

Tests of Between-Subjects Effects

Dependent Variable:Interest/Enjoyment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5.400[a]	1	5.400	7.582	.007
Intercept	8.467	1	8.467	11.889	.001
Group	5.400	1	5.400	7.582	.007
Error	79.048	111	.712		
Total	92.796	113			
Corrected Total	84.448	112			

a. R Squared = .064 (Adjusted R Squared = .056)

Legend:

- Type III Sum of Squares: is calculated by comparing the full model, to the full model without the variable of interest.
- Degrees of freedom(df): is the number of values in the final calculation of a statistic that are free to vary.
- Mean Square: is one of many ways to quantify the difference between an estimator and the true value of the quantity being estimated.
- Fixation indices (F): describes the level of heterozygosity in a population; more specifically the degree of (usually) a reduction in heterozygosity when compared to Hardy–Weinberg expectation.
- Significance (Sig): is the amount of evidence required to accept that an event is unlikely to have arisen by chance.

SUMMARY

The results of the VRSS experiment show the significant advantage that the compelling 3-dimensional visual medium of Virtual Reality has in peaking the interest of students. This is a noteworthy finding as many earlier studies have shown that high levels of motivation lead to better student learning in complex cognitive tasks [10, 11,12]. The current focus of research is the use of the OS-BEST virtual reality grid for collaborative and interdisciplinary learning in conjunction with educators in a variety of fields with a focus on motivating groups of students to work together. Figure 4 shows a learning environment for merchandising students using the OS-BEST framework.

Figure 4: An OS-BEST learning environment for group learning

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