Evaluation of Knowledge Transfer in an Immersive Virtual Learning Environment

Krisanna Machtmes, Ph.D.  
Associate Professor, School of Human Resource Education and Workforce Development  
Louisiana State University and Agricultural and Mechanical College

Mary Leah Coco, M.S.  
Doctoral Student, School of Human Resource Education and Workforce Development  
Louisiana State University and Agricultural and Mechanical College

Glynn W. Cavin, Ph.D.  
Director, Transportation Technology and Education Center  
Louisiana State University and Agricultural and Mechanical College

There are approximately 800 deaths in highway work zones each year (National Work Zone Safety Information Clearinghouse, 2009). This paper reports on the use of virtual learning technology for work zone training, with the goal to increase work zone safety. The use of virtual technologies promises to be an exciting new training method that increases student engagement and subsequent knowledge transfer, and in the context of this study, increase safety awareness as well.

This research tested the use of an Immersive Virtual Learning Environment (IVLE) simulating real-world highway work zones. IVLEs go beyond traditional visual learning by presenting images that combine a new form of visual learning and virtual experiential learning in a way that is more congruent with an individual's visual images stored in memory, thus improving learning transfer and retention. Kapp and O'Driscoll (2010) stated, “The [IVLE] provides a sense of ‘being there’ which, again, ties to visual and mental cues that make the recall and application of the learning that occurs in an [IVLE] more effective.” (p. 54) Such engagement in the learning activity allows learners to move beyond the memorization of the presented concepts and into the application and synthesis of the material. This is the first experiment that we are aware of that used a sample of the trade workforce from government and private sources, who were diverse in education, socioeconomic background, and propensity to use technology. This research expanded the scientific knowledge of adult education, specifically that which deals with knowledge transfer in an IVLE as it enhances and supplements traditional learning.

The purpose of this research study was to determine if an Immersive Virtual Learning Environment (IVLE) increased engagement in the learning activity such that learners moved beyond memorization of presented concepts and into the application and synthesis of the material.

A Brief Review of Immersive Virtual Learning Environment Literature

According to Hobbs, Brown, and Gordon (2006), current practice in higher education is moving away from didactic content delivery to a student-centered model with an increasing emphasis on the skills that support independent, self-directed learning. Virtual worlds provide this type of independent, self-directed learning (Hobbs et. al. 2006). Jarmon, Traphagn, and Mayrath (2009) indicated that the use of virtual worlds can enhance student motivation and engagement, which provides for social interaction, collaboration, increased sense of shared presence, exploration, and creation.

The rationale for using learning in an IVLE in adult education is that it offers advantages over traditional classroom learning by providing real – life practice (Savin-Badden, 2008). “Real life” practice in a
virtual environment in turn depends on what Dede (2010) termed “willing suspension of disbelief” that allows students to become immersed in the virtual environment. Dede (2010) went on to describe immersion as “…the subjective impression that one is participating in a comprehensive, realistic experience (Heeter, 1992; Witmer & Singer, 1994)” (p. 10). The IVLE offers the learner chances to make mistakes without real-world repercussions, but it allows for the real-world repercussions to be experienced in a non-threatening environment (Savin-Badden, 2008).

Virtual worlds seem to provide an ideal vehicle for providing learners with “lived experiences,” while meeting the needs of individuals and society in the 21st century (Twining, 2009). Twining (2009) highlighted that a virtual world will allow for experiencing things that would be difficult or impossible to do in the physical world—both physically and pragmatically.

As identified by Clark and Mayer (2003), an IVLE must guide the learner’s transformation of words and pictures through the sensory and working memories in order for this information to be integrated into the existing knowledge base in long – term memory. For this to occur, Clark and Mayer (2003) note the following must transpire:

- Selection of the important information in the course.
- Management of the limited capacity in working memory to allow the rehearsal needed for learning.
- Integration of auditory and visual sensory information in working memory with existing knowledge in long – term memory by way of rehearsal in working memory.
- Retrieval of new knowledge and skills from long – term memory into working memory when needed later.
- Management of all of these processes via metacognitive skills.

Clark and Mayer (2003) added that for learning transfer to occur, these “e-lessons” must incorporate the context of the job by offering concrete examples to take the abstract concepts into reality. Blumel, Termath, and Haase (2009) reiterated Clark and Mayer’s (2003) position when they stated, “Realistically representing and precisely visualizing the operations facilitates comprehension and hones the ability to transfer practiced procedures to a real work situation” (p. 6).

Methodology

This research project was conducted through a collaborative effort between the Department of Transportation and Development’s Louisiana Transportation Research Center (LTRC), the Louisiana State University School of Human Resource Education and Workforce Development (SHREWD), and the University of Louisiana at Lafayette’s Louisiana Immersive Technologies Enterprise (LITE). The IVLE was designed by the team at LITE with the research driven by the team at LTRC and LSU. The entire team accomplished the tasks of project management, instructional design, context and content development, scripting, technological design, and day-to-day administration, in a fashion similar to that described by Kapp and O’Driscoll (2010).

Upon completion of an intense review of literature, the LTRC team created a problem statement to drive the research study and worked with LITE to ensure the IVLE development and implementation supported the purpose of the research study. Over the course of six months, the LTRC and LITE teams worked closely to ensure the IVLE supported the instructional material and research purpose while still creating an extraordinary IVLE. Another phase of the project collaboration was to include key players from the Louisiana Department of Transportation and Development (LA DOTD) in the pilot testing of the IVLE in the classroom. Those individuals from the LA DOTD that participated in the formal pilot testing included: LA DOTD District Trainers, LA DOTD work zone safety specialists, LA DOTD engineers,
and LA DOTD instructional designers. The pilot testing included two formal class deliveries, which implemented the IVLE into the course along with ten additional pilot testing meetings between the LTRC, SHREWD, and LITE teams.

The experimental sample was drawn from the target population of highway workers from state and local government units and from private companies in Louisiana. Fifteen classes were scheduled over a 45 day period (8 treatment and 7 control). The treatment or control decision was assigned to each class by random draw. Subjects were assigned to classes by their parent organization, with no prior knowledge whether the class was treatment or control. Thus, subjects arrived for class unaware if they were in a treatment or control class. The instructional design for control classes retained the existing content and delivery method, the only variable for the treatment classes was to incorporate the IVLE as a supplement to the existing class. All classes received the same instruments, namely a demographic survey and a pre and posttest of the course content. All classes were advised that completion of the instruments was strictly voluntary, no bias would be held against anyone for incomplete instruments or desire not to fill in the instruments at all. All subjects were also reassured that all individually collected data would be protected and maintained in a secure location.

In addition to these data, quantitative data were generated for each student while in the IVLE. These data consisted of spatial (x-y-z coordinate mapped movements) and temporal (time to execute movements) data. These data were used to plot the accuracy of the subject’s solution to problems presented in the IVLE, indicating understanding of the underlying abstract taught concept. Also, these data were used to plot the change in performance over the course of the class indicating how well the subject improved his or her performance while in the IVLE. The impending findings from these data will be presented in forthcoming papers and conferences. Finally, qualitative data were collected to assess the affective response of the subjects to the IVLE. After each treatment class, four or five subjects were interviewed (n = 32), and their responses are being coded and analyzed at the time of this report. Preliminary review indicates a very positive reaction to the IVLE by the subjects. All empirical data will be subjected to the appropriate statistical tests, including measures of central tendency about the mean. Some preliminary findings can be reported at this time.

**Preliminary Statistical Findings**

Demographic data for the combined treatment and control groups (n = 260) indicated that of those responding, the majority of the sample was African-American (60.2%) and that 88.3% were males. It is interesting to note that 75.6% of the sample had a high school degree, GED, or less, and that the largest group of individuals was between the ages of 46 to 64 years (45.8%) of age and had never attended a flagger course (76.5%). A significant number (86.3%) earned $50,000 a year or less.

A t-test was utilized to examine the pretest scores between the control and treatment group to ascertain if there was a statistical difference between the groups prior to treatment. The t-test was not significant (t = .774, p = .440). In practical terms, the computed value of “t” indicates that the groups could be treated as equivalent. The posttest analysis indicated no statistically significant differences between the treatment and control groups (t = -1.335, p = .183), but the control group did have a slightly higher mean than the treatment group (control mean = 89.23, standard deviation = 12.764; treatment mean = 86.88, standard deviation = 13.846). The only demographic variable that showed statistically significant difference in the posttest score was the educational level of the participants. Using the Analysis of Variance (ANOVA) technique to analyze this data indicated a statistically significant Levene’s score (p <.001); thus, a Welch test was used to examine these data, and it confirmed a statistically significant difference between education levels (Welch test 7.53, p <.001).
Conclusion

The research described above provided an innovative method for delivering instruction on a technical topic where active experimentation is critical to the success of knowledge transfer. The Immersive Virtual Learning Environment (IVLE) provided the resources for increasing the knowledge transfer of the material for the learners in the course. This research will contribute fundamentally to the body of knowledge of modeling and simulation as it relates specifically to adult education, and more generally to secondary education. This research is ground-breaking, meaningful, and will save lives.

All educational disciplines will benefit from the results of this research when the theoretical underpinnings, strategies for effective implementation, methodology, metrics, and findings are examined. Exit interviews of participants illuminated the value of this research and the impact of an Immersive Virtual Learning Environment in the “Basic Flagging Procedures” course. However, it must be reiterated that the findings of this research will have a principal impact on the entire field of practice associated with training/education, modeling, and simulation. This IVLE will provide the essential realistic practice for a learner that is not currently achievable without the IVLE but is invaluable to knowledge transfer.

References


About the Presenters

Krisanna Machtmes is an Associate Professor in the School of Human Resource Education and Workforce Development at Louisiana State University and Agricultural and Mechanical College, Baton Rouge, LA. Dr. Machtmes has taught more than thirty distance education courses and continues to lead the way in virtual learning at Louisiana State University. In addition to be a well-respected scholar in her field, Dr. Machtmes is also the recipient of the 2001 Charles A. Wedemeyer Award.
Mary Leah Coco is a doctoral student in the School of Human Resource Education and Workforce Development at Louisiana State University and Agricultural and Mechanical College, Baton Rouge, LA. Ms. Coco brings a strong background in adult education, distance education, and virtual learning environments to this study. Ms. Coco will complete her doctorate in August of 2011. In addition to working to complete her doctorate, Ms. Coco serves as the Training and Development Program Staff Manager at the Transportation Training and Education Center with the goal of assisting and enabling workforce development using principles of Strategic Human Capital Improvement.

Glynn Cavin is the Director of the Louisiana Transportation Research Center’s Transportation Training and Education Center. Dr. Cavin served 24 years on active duty in the USAF before returning to his home town to work in private industry and local government public works. In 2005 he was selected as the first Director of the Transportation Training and Education Center, bringing a state-of-the-art adult continuing education center online, training over 4000 adults yearly. Early in 2006 he began his successful pursuit of his doctorate, and continues research in virtual world learning in addition to his daily activities running the Center.