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## Evaluation of knowledge transfer in an immersive virtual learning environment for the transportation community

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EVALUATION OF KNOWLEDGE TRANSFER IN AN IMMERSIVE VIRTUAL LEARNING  
ENVIRONMENT FOR THE TRANSPORTATION COMMUNITY

A Dissertation

Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
requirements for the degree of  
Doctor of Philosophy

in

The School of Human Resource Education  
and Workforce Development

by

Mary Leah Caillier Coco

B.A., Louisiana State University, 2002

M.S., Louisiana State University, 2005

May 2011

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## **DEDICATION**

This work is dedicated in loving honor of my grandmother, Annie Young Glynn Hebert, whose zeal for learning was unmatched by any. She was a patient, kind, and brilliant woman that was generous beyond all imagination. For the 99 years she graced this world with her presence, the sun shone brighter and the birds chirped louder. I pray this work will be an honor to her name.

I also dedicate this work to my mother and namesake, Mary Leah Cooper Moore, who is a testament on how to love a child through any situation. I am honored when people say I remind them of you. Thank you for loving me no matter what, even when I didn't deserve it. To my father, Donald Mitchell Caillier, whose traits of competitiveness and perfection are surely ever present in me and a major reason I was able to complete my studies. Although he did not always tell me what I wanted to hear, he has always been supportive. Thank you for pushing me to always be the best at whatever I chose to do. For my bonus parents, Larry Landry Moore and Betsy Jones Caillier, thank you both for loving me like you have always had me in your lives. You have each blessed my life in so many ways and helped shape me to be the person I am today.

I also dedicate this work to my grandparents Vergie Mae and Malcolm Caillier, Josephine Wilson Glynn Cooper, and the late Revel Dean Cooper, Sr. Thank you for always telling me you were proud of me and encouraging me to pursue my education, something no one can take away.

To my beautiful daughter, Annie Claire, your sweet spirit is a blessing, and I know your life will touch so many people. To my husband, Jeremy, you have made countless dinners, washed endless loads of laundry, and done so with a willing spirit. Thank you for not giving up on me during this sometimes never-ending journey. I love you both to the end of the earth!

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## TABLE OF CONTENTS

DEDICATION .....	iii
ACKNOWLEDGEMENTS .....	iv
ABSTRACT .....	xii
CHAPTER 1. INTRODUCTION .....	1
Rationale .....	1
Purpose of the Study .....	2
Research Question .....	3
Independent and Dependent Variables .....	3
Objectives .....	4
Limitations .....	5
Significance of the Study .....	5
Definitions of Terms .....	6
References .....	8
CHAPTER 2. LITERATURE REVIEW .....	11
A History of Distance Education .....	11
Immersive Virtual Learning Environments .....	15
Adult Education .....	25
Experiential Learning in the Immersive Virtual Learning Environment .....	31
References .....	39
CHAPTER 3. METHODOLOGY .....	46
Project Creation and Collaboration .....	46
Population and Sample .....	47
Research Implementation .....	47
Data Collection .....	49
Institutional Review Board Approval .....	51
References .....	51
CHAPTER 4. TRAINING SKILLED AND UNSKILLED WORKERS IN AN IMMERSIVE VIRTUAL LEARNING ENVIRONMENT .....	52
Introduction .....	52
Significance of the Study .....	53
Current Research .....	55
Methods .....	58
Data Collection .....	62
Deployment .....	63
Results .....	64
Analysis .....	68
Discussion and Conclusions .....	68
References .....	69

CHAPTER 5. ASSESSMENT OF LEARNING IN A MARGINALIZED POPULATION OF ADULTS IN AN IMMERSIVE VIRTUAL LEARNING ENVIRONMENT .....	71
Introduction.....	71
Immersive Virtual Learning Environments .....	74
Purpose and Objectives.....	78
Data Collection .....	81
Results.....	82
Discussion and Conclusions .....	92
References .....	94
CHAPTER 6. A MEASURE OF PRECISION REGARDING PROCEDURAL TASKS OF NON-TRADITIONAL ADULT LEARNERS IN AN IMMERSIVE VIRTUAL LEARNING ENVIRONMENT .....	99
Introduction.....	99
Immersive Virtual Learning Environment.....	99
Purpose and Objectives.....	102
Methods.....	103
Data Collection .....	108
Results.....	109
Discussion and Conclusions .....	112
References .....	113
CHAPTER 7. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS .....	116
Summary.....	116
Methods.....	117
Findings.....	119
Conclusions and Recommendations .....	123
Future Research .....	126
References .....	128
APPENDIX 1. CHARACTERISTICS OF SEVEN LEVELS OF TAXONOMY OF STUDENT ENGAGEMENT.....	129
APPENDIX 2. BASIC FLAGGING PROCEDURES DEMOGRAPHIC INFORMATION .....	131
APPENDIX 3. BASIC FLAGGING PROCEDURES DEMOGRAPHIC INFORMATION CODING DOCUMENT .....	133
APPENDIX 4. BASIC FLAGGING PROCEDURES PRETEST EXAMINATION BOOKLET .....	135
APPENDIX 5. BASIC FLAGGING PROCEDURES POSTTEST EXAMINATION BOOKLET .....	142
APPENDIX 6. IVLE RESEARCH STUDY QUALITATIVE QUESTIONS .....	149
APPENDIX 7. NATIONAL INSTITUTES OF HEALTH CERTIFICATION .....	152

APPENDIX 8. I/ITSEC PERMISSION LETTER.....	153
VITA .....	155

## **ABSTRACT**

In the year 2009, 667 individuals lost their lives in a highway construction or maintenance work zone (National Work Zone Safety Information Clearinghouse, 2010). Since the year 2003, 6,438 individuals have been killed in a highway construction or maintenance work zone, which is approximately 805 deaths per calendar year (National Work Zone Safety Information Clearinghouse, 2010). This eye-opening and unfortunate statistic points to the need for a re-evaluation of training methodology as it relates to work zone safety. This study reports on the use of virtual learning technology for work-zone training.

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 knowledge transfer and retention (Dede, 2000; Kapp & O'Driscoll, 2010). The visual cues that the learner experiences in the virtual world are so similar to the visual cues in the real world that recall of virtual world lessons stored in memory are triggered by the same cues in the real world. Additionally, the student can experiment, make mistakes, and repeat the activity as often as necessary, achieving a virtual-experiential understanding of the concept that can only be duplicated in real-world experiential learning, which is often not practical (Dede, 2000; Kapp & O'Driscoll, 2010). Such immersive engagement in the learning activity will allow the learners to move beyond the memorization of the presented concepts and into the application and synthesis of the material.

A significant benefit of this research will be a better understanding of how educators can implement this advanced, user-friendly, semi-transparent technology to positively affect the inclusion of marginalized populations into virtual learning environments. This research will

establish a solid theoretical and evidence-based link between use of the virtual world learning environment and improved knowledge transfer and retention for that marginalized population that forms the bulk of the employment pool for military, construction, maintenance, and many other industrial entry-level positions.

# **CHAPTER 1.**

## **INTRODUCTION**

### **Rationale**

In the year 2009 alone, 667 individuals were killed in the United States in highway construction or maintenance work zones. More alarmingly, the total number of individuals killed in a highway construction or maintenance work zone in the U.S. since 2003 is a staggering 6,438 (National Work Zone Safety Information Clearinghouse, 2010). A State Department of Transportation defined a highway construction or maintenance work zone as an area of highway with maintenance, construction, or utility work activities (Louisiana Department of Transportation and Development, 2010). This type of work zone is normally marked by temporary traffic control devices such as signs, channeling devices, barriers, pavement markings, and/or work vehicles. Working in a highway construction or maintenance work zone is a highly physical activity that requires extreme focus, planning, and process implementation (Louisiana Department of Transportation and Development, 2010).

Use of IVLE technology may aid in decreasing the number of work zone fatalities that occur each year by allowing active experimentation in a highway construction or maintenance work zone to occur in a safe and supportive learning environment. Active experimentation within an IVLE will allow learners the opportunity to apply work zone regulations and procedures in a realistic, although simulated, environment. Unlike the real world, a mistake in this virtual environment will not result in the loss of life. Studies indicated that adult learners are more apt to apply encoded instructional knowledge in the IVLE because mistakes can be made without negative consequences, encouraging application and building confidence (Blumel, Termath, & Haase, 2009). Dede (2000) highlighted that simulation and visualization tools, like

an Immersive Virtual Learning Environment (IVLE), can aid students in recognizing patterns, reasoning about physical processes, translating within frames of reference, and envisioning dynamic models.

This research tested the use of 3D technology in an IVLE, which simulated real-world highway work zones. The IVLE supplemented traditional course content and delivery methods to enhance the transfer of work zone safety procedure knowledge. This learning environment consisted of real-life case studies within a 3D virtual world. The research was unique due to the evaluation of the effectiveness of knowledge transfer across a diverse population of learners that had not yet been studied as it relates to IVLE implementation in the classroom. This research expanded the scientific knowledge of adult education involving knowledge transfer in an IVLE. Specifically, that an IVLE may enhance and supplement traditional learning through blended delivery methodology when utilized in a classroom environment with a diverse learner population.

### **Purpose of Study**

The purpose of this research study was to determine if an Immersive Virtual Learning Environment (IVLE) increased the learning transfer of the knowledge obtained in a work zone safety Basic Flagging Procedures course. Studies have shown that learner engagement is paramount to learning success (Lim, Nonis, & Hedberg, 2006). This project hoped to find that through the IVLE, learning engagement was increased as the learners were fully integrated into the work zone safety simulation, with a specific focus on flagging procedures, as though they were actually performing the prescribed duties in accordance with the required rules and procedures. Such engagement in the learning activity allowed the learners to move beyond the memorization of the presented concepts and into the application and synthesis of the material.



As supported by Kolb's (1984) Experiential Learning Theory, the IVLE allowed the adult learners to move from the concrete experience (current knowledge of work zone safety flagging procedures) to reflective observation (reflection on current knowledge of work zone safety flagging procedures as it relate to new materials) to abstract conceptualization (the application of the new knowledge of work zone safety flagging procedures) and lastly to active experimentation (constructing new methods for using the new information on the job) (Swanson & Holton, 2001).

Blumel et al. (2009) stated that any organization's goal should be to provide suitable qualification measures to prepare employees for impending tasks before a new project begins. This study sought to achieve this goal by preparing transportation employees for the utilization of flagging procedures in work zones via the blended delivery method of the IVLE. By allowing the learners to explore flagging procedures as they related to work zone safety through an IVLE, the achieved success of the executable tasks connected to this environment will be evaluated as the measure as to the effectiveness of the IVLE (Blumel et al., 2009). This study did not ask "What can the IVLE do" but rather "What is the IVLE doing?" (Ellaway, Dewhurst, & McLeod, 2004).

### **Research Question**

This study aimed to answer the question: Is an IVLE a more effective method than the traditional method for delivering the procedural content in the "Basic Flagging Procedures" course to aid in the imprinting of the concepts presented regarding maintenance and construction work zones?

### **Independent and Dependent Variables**

The independent variables in this study were: whether or not the students participated in

the traditional or immersive virtual learning environment Basic Flagging Procedures course; education level; years working in highway construction; age; race; and gender. The dependent variables will be: success rate on posttest and precision within the IVLE.

### **Objectives**

The objectives for this research study were as follows:

1. To describe the adult learners that attended the Basic Flagging Procedures course in the southern region of the United States on the following demographic characteristics
  - a) Race
  - b) Gender
  - c) Age
  - d) Highest educational level completed
  - e) Years worked as an adult (18 years old and older)
  - f) Years worked in highway maintenance or construction
  - g) Previous flagger course taken or not
  - h) Type of organization
  - i) Current job title
  - j) Total income in previous year.
2. To compare the traditional course delivery method to the IVLE course delivery method based on pre and posttest scores
3. To determine the precision of participants while in the IVLE through the use of telemetry data
4. To examine the differences in the pre-telemetry measurements to the post-

telemetry measurements

5. To determine if a model exists which would explain a significant portion of variance in overall scale score.

### **Limitations**

Within this research study, there were two limitations to address:

1. A portion of the population has taken this course content previously, thus exposing them to the material and the test prior to this study.
2. Population was limited to participants in the southern portion of Louisiana.

### **Significance of the Study**

This research will contribute fundamentally to the research of an IVLE not only as it relates to the transportation community but also to the research of the marginalized population. The hypothesis that the use of 3D technology to create an IVLE in order to increase the transfer of learning has been evaluated in a number of fields with the findings as to its success varying across the disciplines (Blascovich, Loomis, Beall, Swinth, Hoyt, & Bailenson, 2002; Clarke & Dede, 2005; de Freitas & Oliver, 2006; Jarmon, Traphagan, & Mayrath, 2008). However, the aforementioned studies were conducted with homogenous groups, with this aspect being a fundamental difference in this research study. This project was comprised of a truly heterogeneous group on many levels (e.g. years of experience, technological proficiency, formal education, age, gender, etc.). Research conducted with extremely diverse populations increases generalizability to other populations and aids in supporting that individuals with limited technological skills can succeed scholastically in an environment with learning technology.

The prototype of blended learning utilized in this research project was very specific, but the knowledge gained and the technology developed from this research will have far-reaching impacts for any training where realistic practice is difficult and where realism during training is

invaluable. This research will expand the current empirical knowledge of a virtual learning environment in education, specifically that which deals with knowledge transfer in an IVLE as it enhances and supplements traditional learning through blended delivery methodology. The type of training will transcend subgroups, reducing the intergroup achievement gap, increase participation due to the similarity to massive multiplayer online games, resulting in more students being better prepared for further educational opportunities and careers.

The IVLE also adds an avenue for increasing the knowledge and skill level of the marginalized population. Through the use of this blended methodology, the marginalized population was presented with technological advances in the realm of education that previously may have not been within their reach. By exposing this population to this type of educational element, a decrease in training resistance may be found. If a decrease in training resistance occurs, the likelihood of learning transfer increases, thus, leading to a better-trained population.

### **Definition of Terms**

For the purpose of this research study, the following definitions are offered to assist in the understanding of terminology as it relates to this study:

1. **Immersive Virtual Learning Environment**: An environment that encompasses the user in a real- life, simulated environment (Savin-Badden, 2008). This environment capitalizes on natural aspects of human perception by extending the virtual information in three spatial dimensions, supplements information with other stimuli and temporal changes, and enables individuals to interact with the displayed data (Dalgarno & Lee, 2010).
2. **Presence**: The subjective experiences of being in one place or environment despite physically being situated in another (Witmer & Singer, 1998).

3. Marginalized Population: A portion of the population that is excluded, trivialized, devalued, or relegated to an unimportant or powerless position within a group or society (Merriam-Webster, 2008).
4. Education: “The fundamental method of social progress and reform; a regulation of the process of coming to share in the social consciousness; and that the adjustment of individual activity on the basis of this social consciousness is the only sure method of social reconstruction” (p. 453, Dewey in McDermott, 1981).
5. Avatar: A representation of a person in a virtual environment (Bailenson, Blascovich, Beall, & Noveck, 2006).
6. Socioeconomic Status: An individual's economic position relative to others, based on income, education, and occupation (Merriam-Webster, 2008). Socioeconomic status is used interchangeably with the category “Total Income in the Previous Year,” as indicated in the demographic survey.
7. Course Definition: The “Basic Flagging Procedures” course is designed to offer participants information that is necessary to move vehicles and pedestrians safely and quickly through or around temporary traffic control zones while protecting on-site workers and equipment. Traffic regulation is a pivotal and essential duty of traffic control operations. The role of a traffic regulator/flagger is crucial to the success and safety of well-run traffic operations (Louisiana Transportation Research Center, 2010).
8. Louisiana Department of Transportation and Development: The Louisiana highway department that is responsible for the maintenance of state roadways,

bridges, etc. (Louisiana Department of Transportation and Development, 2010).

9. Local Government: Any parish government entity that is not the LA DOTD but receives primary funding from taxpayer dollars.
10. Private Industry: Any entity that is not federal, state, or local government.
11. Precision: The degree of refinement with which an operation is performed or a measurement stated (Merriam-Webster, 2008).
12. Louisiana Transportation Research Center: “Created by the legislature in 1986, the Louisiana Transportation Research Center (LTRC) conducts short-term and long-term research and provides technology assistance, engineering training and continuing education, technology transfer, and problem-solving services to the LA DOTD and others in the transportation community. The center is largely supported by funding authorized by the Federal Highway Administration. LTRC's goal is to merge the resources of state government and universities to identify, develop, and implement new technology to improve the state's transportation system. LTRC combines the efforts of DOTD and the state's universities to find innovative solutions to Louisiana's transportation problems” (pp. 1-2).

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## **CHAPTER 2.**

### **LITERATURE REVIEW**

#### **A History of Distance Education**

Sumner (2000) stated, “Technology has always had an intimate relationship with distance education because it mediates the separation between teacher and learner through the use of print, radio, telephone, television, audio and videotapes, and computers.” Prewitt (1998) highlighted that two primary forces through history have driven distance education: the need for increased and more democratic access to learning and the availability of successive new technologies for delivery. Casey (2008) stated that distance education has flourished in the United States for three reasons:

1. The great distances of citizens from educational institutions, both geographically and socio-economically
2. The thirst for education
3. The rapid advancement of technology

Distance education is well documented beginning in the 19<sup>th</sup> century in terms of correspondence study (Sumner, 2000). The first documented distance education course was the Pittman Shorthand training program in 1852 (Casey, 2008). Anna Eliot Ticknor founded the Society to Encourage Study at Home in 1873 in an effort to encourage continued education, with a primary female clientele, but this program provided correspondence instruction to 10,000 members over the course of a 24-year period (Casey, 2008; Sumner, 2000). In addition, the University of Chicago created the first collegiate level distance learning program in 1892, which was supported by the United States Post Office through free delivery service (Prewitt, 1998; Casey, 2008). Despite that distance education has three centuries of historical roots, it is still met with

skepticism with primary concerns of quality control (Casey, 2008).

In the early part of the 20<sup>th</sup> century, such correspondence study was prevalent in universities and private schools (Sumner, 2000). By 1921, the University of Salt Lake City, the University of Wisconsin, and the University of Minnesota had been granted the first educational radio licenses (Casey, 2008; Sumner, 2000). With two World Wars, the field of distance education grew profoundly, and the armed services demanded correspondence education for soldiers during World War I and viewed correspondence study as a way to change society after World War II and the Great Depression (Holmberg, 1986, as cited in Sumner, 2000). The use of two-way communication was employed through the integration of broadcast media, cassettes, and some computers (Casey, 2008; Nipper, 1989). The use of televisions as an instructional tool began in 1934 with the University of Iowa (Casey, 2008). The Instructional Television Fixed Service (ITFS) was created by the Federal Communications Commission (FCC) to provide 20 television channels that were available to education institutions for providing a low-cost, fixed-range, subscriber-based system to broadcast courses (Casey, 2008).

The University of Wisconsin continued to be a leader in distance education as they created the Articulated Instructional Media (AIM) Project in 1964 whose goal was to identify, categorize, and systemize distance learning practices while offering direction on how to develop and implement instructional multimedia components to best suit the learner (Casey, 2008). Distance learning was not only flourishing in the United States but abroad as well. The British Open University was established in 1969 based upon a blueprint from the AIM Project to further distance education and has continued to be a leader in the field of distance education (Casey, 2008; Sumner, 2000). The British Open University currently provides 21% of higher education in England and provides a standard for others in the distance learning community (Casey, 2008).

Coastline Community College created, licensed, and implemented the first fully televised college courses in 1970 (Casey, 2008). Unique to Coastline Community College is that it had no actual college campus. Other universities across the United States followed the example set by Coastline Community College, and by 1972 colleges in Miami, FL; Costa Mesa, CA; and Dallas, TX became pioneers in televised college courses (Casey, 2008). Such televised courses sought to recreate traditional classroom settings while providing educational opportunities to an innumerable amount of learners (Prewitt, 1998). Bringing distance education to yet another level, the use of satellite communication was integrated into primarily the business community in the beginning stages during the 1980s (Casey, 2008). Although satellite television was created during the 1960s, it only began being utilized as an educational medium in the 1980s. The National Technological University (NTU) began offering online degree courses in 1982 for continuing and graduate education using satellite technology (Casey, 2008). This type of educational technology promoted system-serving forms of distance education to include: professional accreditation, military training, human resource development, and collegiate courses (Sumner, 2000).

Quite possibly the most significant impact on the field of distance education is that of the World Wide Web, created by Tim Berners-Lee in 1991 (Casey, 2008). The web has provided a platform for online academic instruction, sharing of scholarly data, and providing a plethora of online degree programs. The web has also provided the opportunity for an array of technological advances in the field of distance education, leading to vast opportunities for academic institutions to better meet students' instructional needs (Casey, 2008).

### **Transactional Distance Education**

Transactional distance, as explained by Moore (1993), occurs between teachers and

learners in an environment having the special characteristic of separation of teachers from learners. Moore (1993) also highlighted that this separation leads to special patterns of teacher and learner behaviors, which has a significant impact on teaching and learning. Moore (1993) stated, “With separation there is a psychological and communications space to be crossed, a space of potential misunderstanding between the inputs of the instructor and those of the learner. It is this psychological and communications space that is transactional distance” (p. 1). Communication and psychological spaces between learners and teachers are never identical, thus, transactional distance is a continuous rather than finite, a concept that is relative rather than an absolute (Moore, 1993).

Moore (1993) posited that for successful distance education to occur is dependent upon the institution and the instructor providing appropriate opportunities for dialogue between the teacher and learner. To distinguish dialogue from interaction, Moore (1993) asserted that dialogue is used to describe an interaction or series of interactions that possess positive qualities that other interactions may not have. Furthermore, Moore (1993) stated, “A dialogue is purposeful, constructive, and valued by each party. Each party in a dialogue is a respectful and active listener; each is a contributor, and builds on the contributions of the other party or parties” (p. 2).

Saba (2007) articulated the relationship between structure and dialogue as they relate to transactional distance education. Saba (2007) presented the following hypothesis as it relates to transactional distance, “(a) [W]hen structure increases, transactional distance increases and dialog decreases; (b) [W]hen dialog increases, transactional distance decreases and structure decreases” (p. 45). Peters (2007) asserted that Moore’s theory of transactional distance is primarily descriptive in that it does not recommend a specific model of learning and teaching at a

distance; however, the theory describes three teaching behaviors: dialogue, structure, and autonomy (Peters, 2007). The theory of transactional distance suggests that distance education should be comprised of these three teaching – learning behaviors, which denotes Moore’s desire to innovate and improve distance education and online learning (Peters, 2007). Through his description of dialogue, structure, and autonomy as fundamental components of distance education, Moore provided the resources for improving distance education and enhancing its pedagogical quality (Peters, 2007). Transactional distance theory, as stated by Moore (2007), allows for innumerable hypotheses for research into the following: interactions between course structure, dialogue between students and teacher, and students’ propensity to exercise control of the learning process.

As evidenced in the above literature, distance education has a storied history from the early vocational training of factory workers to current collegiate academic programs (Casey, 2008). Further highlighting the power of distance education, Galusha (1998) stated, “The teacher is no longer the sole source of knowledge but instead becomes a facilitator to support student learning, while the student actively participates in what and how the knowledge is imparted. More than any other teaching method, distance learning requires a collaborative effort between student and teacher, unbounded by the traditional limits of time, space, and single-instructor effort” (p. 4). Technology in distance education is powerful, dynamic, and enriches learning in which time and geographic location disappear (Miltiadou & Savenye, 2003).

### **Immersive Virtual Learning Environments**

The purpose of any learning approach is to achieve the learning objectives set out in the delivered course and ensuring the learning objectives are designed into the created course content (Selim, 2005). Online education is a subcategory of distance education that offers

educational alternatives and provides life-long learning opportunities for those that a traditional learning environment may not work or be possible (Miltiadou & Savenye, 2003). Online education can provide both synchronous and asynchronous learning opportunities. Miltiadou and Savenye (2003) defined synchronous learning opportunities as, “[I]nteraction [that] allows students and instructors to exchange ideas and discuss course topics at the same time through a virtual discussion area” (p. 3). Miltiadou and Savenye (2003) went on to define asynchronous learning opportunities as, “[I]nteraction [that] provides opportunities for active input from all members of the online classroom and supports learner-centered learning environments” (p. 3). In order to expand upon the traditional online learning environment, the virtual learning environment can provide a means for building upon an already solid instructional base. An immersive virtual learning environment, a “fully integrated virtual world,” can offer learning institutions the opportunity to improve “passive distance education” through increased communication, interaction, and learning activities (Schrum & Hong, 2002, p. 58).

Ellaway (2005) stated, “The use of technology-supported teaching and learning in higher education has moved from a position of peripheral interest a few year ago to become a fundamental ingredient in the experience of many if not most students today” (p. 1). The immersive virtual learning environment combines a host of tools and resources into a single system (Ellaway, 2005). Technology provides a means for enabling students to master more complex subjects via significant interactions with resources that extend beyond the traditional classroom walls (Dede, 2000). Dede (2000) stated, “[T]echnology enhanced curricular approaches improve success for all types of learners and may differentially enhance the performance of at-risk students” (p. 1). Although the population in this study is not defined as “at risk,” they are a population that is considered marginalized and often left behind in

educational research due to presumptions of their inability to succeed in a classroom setting. Nonetheless, the design and implementation of an immersive virtual learning environment must be realized through careful design of the learning environment and informed through an analysis of the critical characteristics that enhance learning (Herrington, Reeves, Oliver, & Woo, 2004).

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). It is essential for educators to investigate innovative and engaging teaching methodologies to offer a more fulfilling learning experience (Cobb, Heany, Corcoran, & Henderson-Begg, 2009). Echoed by Jarmon, Traphagn, and Mayrath (2008), they 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. Jarmon et al. (2008) also stated that few empirical studies document learning within virtual worlds. Educators involved with employing groundbreaking pedagogies and curricular are often viewed as innovators and are willing to challenge the boundaries of traditional practices (Dede, 1998). Immersive learning is not new but rather dates back to the days of apprenticeships and distributed education (Johnson & Levine, 2008). Implementation of an IVLE with a marginalized population challenges the traditional educational boundaries while still incorporating historically successful principles of the past (Johnson & Levine, 2008).

The effectiveness and value of an IVLE is not inherent to the IVLE software or platform but rather depends on its use in facilitating and mediating the needs and activities of the instructional material (Ellaway, Dewhurst, & McLeod, 2004). The question to be addressed

regarding an IVLE is not “what can it do” but rather “what is it doing?” (Ellaway et al., 2004, p. 127). IVLE functions exist in a blended relationship with other human activities, independent of whether they are the primary delivery medium or among one of many (Ellaway et al., 2004). The use of an IVLE in adult education offers advantages over learning through real-life practice, as described in the forthcoming sections (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 21<sup>st</sup> century (Twining, 2009, p. 498). Twining (2009) highlighted that a virtual world will allow for the following:

- Experiencing things that would be difficult or impossible to do in the physical world – both physically and pragmatically.
- Experiences in virtual worlds suggest that these are spaces, which encourage playfulness and test boundaries (p. 498).

These “lived experiences” are enhanced through the principle of immersion within the learning environment (Twining, 2009, p. 498). Witmer and Singer (1994) defined immersion as the subjective impression that one is participating in a comprehensive, realistic experience. Clarke and Dede (2005) expanded upon this concept by highlighting that immersion is a “mediated, simulated experiment (such as a virtual environment) which involves the willing suspension of disbelief” (p. 2). The IVLE provides this suspension of disbelief while engaging the learners in a realistic, meaningful context (Herrington, Reeves, & Oliver, 2007). Such suspension of disbelief provides a method for preparing individuals for the necessary recognition of key aspects of tasks associated with real world activities (Clarke & Dede, 2005).

Mestre (2002) presented the following question, “How can education prepare people to recognize the cues that signal application of appropriate knowledge?” (p. 9). Mestre (2002) went



on to states that cues in the problem or environment govern the retrieval of prior information which aids in the transfer and application of the knowledge. Dalgarno and Lee (2010) provided an affordance of an IVLE that states, “3-D VLEs can be used to facilitate learning tasks that lead to improved transfer of knowledge and skills to real situations through contextualization of learning” (p. 21). The contextualized learning is where the cues are provided that aid the learner in applying the appropriate knowledge post learning, which is a key benefit of an IVLE.

A study conducted by the Computing Research Association and the International Society of Learning Sciences in 2005 highlighted that one of the main challenges facing educators is moving from the dominant view of technology being disruptive in the classroom to understanding how to utilize the benefits that technology has to offer within the classroom. The Computing Research Association and the International Society of Learning Sciences (2005) also identified that simulations and models provide insights into scientific concepts and phenomena. However, they did note that a challenge is to lay scientific and technical groundwork to ensure that these simulations positively impact learning, thus limiting the potential negative or distracting impacts.

If an IVLE is designed correctly, the distracting factors can be removed. A key to a well-designed IVLE is expounded upon by Pannese and Carlesi (2007),

If correctly designed, which means that the real working environment needs to be studied in order to reproduce it in the protected simulation environment, this form of exercise offers another double potential: the exercises are repeatable (with the same or slightly different conditions, should something be worth being reconsidered) and at the same time, every simulation experience is unique, as every experience in life is unique! On the other hand, serious games are simultaneously very close to reality (if designed as such)

and multisituational as different aspects of the same situation can be experienced (p. 440).

Properly designed IVLEs, which can be considered serious games, can provide the flexibility and useful knowledge necessary to provide contextualized and anchored learning (Kiili, 2007).

Learning in an IVLE allows for exposure to a wide range of scenarios at a time and pace convenient to the learner while allowing for consistent feedback. The IVLE offers the learner chances to make mistakes without real-world repercussions, but it allows for the virtual-world repercussions to be experienced in a non-threatening environment (Savin-Badden, 2008). An IVLE also offers an opportunity for collaboration where appropriate, as well as offering new opportunities for review of abstract concepts (Savin-Badden, 2008).

Kramer and Schmidt (2001) identified the potential role of technology in education for reconstructing education and learning:

- The same content can be presented using different media types.
- Different perspectives and access to the same topic can be used to provide cognitive flexibility.
- Education software development and knowledge modeling tools facilitate authoring of multimedia education material and technology.
- Interaction provides learners with opportunities for experimentation, context-dependent feedback, and constructive problem solving.
- Asynchronous and synchronous communication and collaboration helps bridge geographical distance.
- Virtual laboratories and environments can be used to offer near authentic situations and opportunities for hands-on experimentation and problem solving.

- Operation sequences and preferred learning paths can be recorded and evaluated (p. 196).

To further support the above-mentioned points, Whitelock, Romano, Jelfs, and Brna (2000) reiterated that an IVLE allows learners to enter a new world that they might not otherwise get to experience. The learners no longer have to be passive spectators in their learning experience but can manipulate their learning environment in a number of ways (Whitelock et al., 2000).

As identified by Clark and Mayer (2003), instruction through an e-lesson, in this study 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) noted 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 et al. (2009) reiterated Clark and Mayer's (2003) position as 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).

Kapp and O'Driscoll (2010) indicated that that an IVLE offers generative learning, providing meaning and insight that challenges the status quo. In order to challenge this status quo, Kapp and O'Driscoll (2010) asserted that although content is critical in developing an effective traditional course context is now the domain when it relates to an IVLE. To further emphasize the pervasiveness of IVLEs, Kapp and O'Driscoll (2010) claimed,

The transformation of the web from a static, one-way conduit of information into a three-dimensional world where people, as avatars, interact, work, and collaborate virtually has undoubtedly arrived. Those who embrace the Immersive Internet to transform the learning experience will thrive, while those who ignore it will become increasingly marginalized by the businesses or students they serve (p. 44).

Blascovich, Loomis, Beall, Swinth, Hoyt, and Bailenson (2002) further stated that, "Virtual worlds are simply synthetic representations of real or imagined physical worlds, albeit without the physical laws of nature necessarily applying" (p. 107). The three-dimensional IVLE provides the "sense of being there" and provides mental and visual cues that "make recall and application of the learning" obtained in the IVLE more effective (Kapp & O'Driscoll, 2010, p. 44). This sense of being there was expounded in the literature as the philosophy of presence (Kapp & O'Driscoll, 2010).

Witmer and Singer (1998) posited there are some necessary conditions for presence to occur: involvement and immersion. Witmer and Singer (1998) defined involvement as it relates to a virtual environment as:

[A] psychological state experienced as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities. Involvement depends on the degree of significance or meaning that the individual attaches to the

stimuli, activities, or events. In general, as users focus more attention on the VE [virtual environment] stimuli, they become more involved in the VE experience, which leads to an increased sense of presence in the VE (p. 227).

To build upon the definition of involvement as it relates to presence in an IVLE, Witmer and Singer (1998) continued on to define immersion as:

[A] psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences. A VE that produces a greater sense of immersion will produce higher levels of presence. Factors that affect immersion include isolation from the physical environment, perception of inclusion in the VE, natural modes of interaction and control, and perception of self-movement (p. 227).

Blascovich et al. (2002) provided that IVLEs hold the promise to increase the actual presence and could hold the key to obscuring the distinction between face-to-face and “electronically mediated social interaction” (p. 111). Persky, Kaphingst, McCall, Lachance, Beall, and Blascovich (2009) defined presence as, “[P]resence is understood as perceiving as reality the VE as opposed to the physical environment encompassing the VE” (p.263). Arguably, Kapp and O’Driscoll (2010), Witmer and Singer (1998), and Blascovich et al. (2002) each asserted that presence is a critical element for a student in order for engagement in the IVLE to not only occur but to effectively occur.

Relating to the principle of engagement, Kapp and O’Driscoll (2010) argued that engagement is a function of interactivity multiplied by immersion as denoted below:

$$I * I = E$$

The philosophy Kapp and O’Driscoll (2010) presented as it relates to engagement claimed that

the learner becomes an active participant in the IVLE. In the IVLE the learning is no longer “disembodied and transactional” but is rather “embodied and experiential” (p. 63). This embodied and experiential learning, according to Kapp and O’Driscoll (2010) allows for, “...the learner to more effectively encode the learning for future recall and provides the cues needed to apply the experience from the 3D world to actual on-the-job performance. In short, [IVLEs] are the ultimate ‘learning by doing’ platform” (p. 63).

A taxonomy of student engagement developed by Bangert-Drowns and Pyke (2001) presented a progressive, seven-level matrix to aid in the evaluation of “behavioral indicators” of engagement. These levels are not hierarchical and do not define determinants for engagement, but the levels do provide a guide for determining the level of engagement of the learner (Bangert-Drowns & Pyke, 2001; Lim, Nonis, & Hedberg, 2006). Table 1, found in Appendix 1, presented this taxonomy of engagement. Determining the level at which the learner is engaged aids in evaluating the overall success of the learning event (Bangert-Drowns & Pyke, 2001). Bangert-Drowns and Pyke (2001) stated, “The taxonomy evolved as a means to describe, not explain, different modes of engagement...The taxonomy of student engagement may be useful for teaching students to identify and initiate appropriate modes of engagement in particular learning and software contexts” (p. 23).

With educational technology, there are varying levels of using the technology in the classroom. An IVLE can be categorized as a simulation that provides a method for modeling a real-world simulation on the computer (de Freitas, 2006). de Freitas (2006) indicated that IVLEs, or simulations, can be used to motivate and engage learners, specifically the underserved groups with low literacy and language levels. de Freitas (2006) also indicated that utilization of an IVLE can allow for skill rehearsal, advance real-life practice, and provide therapy for

cognitive difficulties. In order to ensure engagement and to achieve the maximum benefit from immersion in a virtual learning environment, utilizing a framework for the design and support of the process is critical to the IVLEs success. The Four Dimensional Framework presented by de Freitas and Oliver (2006) offer the following four dimensions in terms of selecting and using educational technology in practice: context, learner specification, representation, and pedagogic model or approach used.

The context of the educational technology is central to the effectiveness of how the game is used (de Freitas, 2006; de Freitas & Oliver, 2006). The context includes where the technology is used, the general environment for game play, and the socio-political context of the technology (de Freitas, 2006). Identifying the learner specifications include aspects such as age, educational background, demographics, previous technology use, and previous learning experiences (de Freitas, 2006). Representation of the educational technology includes the level of immersion and fidelity of the game. Lastly, the pedagogic model or approach used addresses that the learning technology is rarely an isolated learning experience but is rather embedded within a set of activities or processes according to a specific pedagogical approach used, most often Kolb's (1984) experiential learning (de Freitas & Oliver, 2006; Kolb, 1984). This framework offered a beginning point for educators considering using immersive technology in the learning process (de Freitas & Oliver, 2006). Such a framework provides an effective guide for the field of adult education.

### **Adult Education**

Andragogy, as defined by Knowles (1980), is the art and science of helping adults learn, in contrast to pedagogy as the art and science of teaching children. European adult educators coined the word andragogy (circa 1833) as they felt a need to have a label for the new model of

adult education. Andragogy is based on the Greek word *aner* with the stem *andr-* which means “man, not boy” or adult (Knowles, 1980). Knowles (1980) himself argued that andragogy is an integrative concept. In Knowles’ book *Informal Adult Education* (1950), he presented 13 principles of adult teaching. The principles are as follows:

- Students should understand and prescribe to the purpose of the course
- Students should want to learn
- The learning climate should be friendly and informal
- The physical conditions should be favorable
- Students should participate and accept some responsibility for the learning process
- Learning should be related to and should make use of students’ experience
- The teacher should know his/her subject matter
- The teacher should be enthusiastic about subject being taught
- Students should be able to learn at their own pace
- Students should be aware of his own progress and have sense of accomplishment
- Methods of instruction should be varied
- The teacher should have a sense of growth
- The teacher should have a flexible plan for the course

A characteristic common to most of these principles is called “ego-involvement” (p. 36).

According to Knowles (1950),

Ego-involvement is the condition in which a person completely identifies himself—his goals, his values, his interests—with whatever he and his fellow students are doing. He [She] becomes involved with this to the extent of losing himself [herself] in it (p. 36).

Axford (1969) described the adult education process as “one that must be woven into the



fabric of our institutional pattern of living. Continuing education must be made as natural as brushing our teeth” (p. 57). Axford (1969) said the “ideal” adult educator must have the following qualities: be a humane human being, have a nose for needs, be an organizer, be flexible, be a sharer of ideas, be a philosopher of adult education, be a promoter of adult education, be a trainer, be involved, be a leader, be a program planner/catalyst, one who practices what he preaches, have thick skin, and be committed to the adult learning process. All of these characteristics are part of a model of the “ideal adult educator”; however, possessing these qualities is only the beginning of being a successful adult educator. One must also understand the adult learner.

The adult learner is different than the traditional student. To understand the adult learner, educators must be aware of three points: adults have more experiences, adults have different kinds of experiences, and adults’ experiences are organized differently (Axford, 1969). Adults’ experiences drastically vary from those of a child (Knowles, 1950). That being said, adults hold mental models that shape their learning experiences whereas a child comes to the educational experience with little preconceived notions (Knowles, 1950). Therefore, the adult educator is partly responsible for engaging the adult learner in the double-loop learning process in order for alterations within their deeply held image to occur (Axford, 1969).

Is teaching an adult really different? Teaching adults should be different if adults learn differently than children do. Knowles, Holton, and Swanson’s (2005) core assumptions of andragogy evolved from four to six, as indicated below:

- The Need to Know: Adults want to know why they need to learn something before undertaking learning. Adult educators must understand the learners’ desires to know why they should learn, thus making a case for why the learning is

important (Knowles et al., 2005).

- The Learners' Self-Concept: Adults believe they are responsible for their lives (Knowles et al., 2005). Adult learners need to be viewed as capable individuals who are a driving force in their learning.
- The Role of the Learners' Experiences: Adults come into an educational activity with different experiences than do youth (Knowles et al., 2005; Merriam & Caffarella, 2007). Adult learners' experiences are some of the richest tools an adult educator can utilize. However, just as these experiences are rich, they can also be a detriment to the learning experience if they are not utilized properly.
- Readiness to Learn: Adults become ready to learn things they need to know and do in order to cope effectively with real-life situations (Knowles et al., 2005). Adults want to learn how they can utilize the learned information in the present. Although they tend to realize the learning impacts the future, they want to see how they can make the most expeditious use of the learned material(s).
- Orientation to Learning: Adults are life-centered (task-centered, problem-centered) in their orientation to learning (Knowles et al., 2005). They want to learn what will help them perform tasks or deal with problems they confront in their actual life, both personally and professionally (Merriam & Caffarella, 2007).
- Motivation: Adults are responsive to some external motivators, but the most potent motivators are internal. While many adults will claim that the external motivators are the real motivation, if there is no intrinsic value to the learning than the likelihood of learning occurring substantially decreases (Knowles et al., 2005).

In a study conducted by Bale and Dudney (2000), their research revolved around Knowles' core assumptions, which are stated above. Bale and Dudney (2000) set out to discern whether or not adult learners preferred the andragogical approach to teaching adults. During this study, Bale and Dudney (2000) utilized the Student Orientation Questionnaire created by Christian (1982) to closely fit Knowles' assumptions of adult learners, which was an adaptation of the Educational Orientation Questionnaire created by Hadley (1975). Through using this questionnaire, Bale and Dudney (2000) were able to identify that traditional college-age students prefer a hybrid approach to teaching and learning in the classroom, which included the principle of empowerment.

Freire (1972) incorporated the theory of empowerment into his view of education. Coming from an oppressed background, Freire (1972) saw that power was shared, and that the power of many allow for strength and purpose to lead to a common vision. Shared power in learning is exercised in control over curriculum, its contents and methods, and over the coordination of all learning activities (Freire, 1972). Just as Knowles (1984) and Axford (1969) have stated, Freire (1972) concurred that the adult learner must be seen as a decision maker in the learning process. Freire (1972) stated that literacy and other basic skills can be acquired at an astonishing speed when the fostering of these skills is linked with other activities.

### **Understanding the Adult Learner**

Along with understanding the adult educator, comes the responsibility to understand the psychology of the adult (Knowles et al., 2005). Programs are often based on what an individual or small group thinks or ought to be interested in rather than on what the learners really need or want to know (Knowles, 1950). Possibly the most important factor for adult educators to realize is that adults are very different from one another (Merriam & Caffarella, 2007). Each adult

comes to learning experiences with different life experiences, different prejudices, different fears, etc... Adults have motivating forces that drive them to the educational experience. These motivational forces are as follows: physical needs, growth urge, need for security, need for new experience, need for affection, and the need for recognition (Knowles, 1950). These needs are natural, and each adult experiences a need for one or all of these motivational forces. It is crucial that adult educators illuminate the importance to adult learners that these needs be met (Knowles, 1950; Merriam & Caffarella, 2007). The suppression of such desires will lead to fear of education or damage to one's personality (Freire, 1972). The purpose of the teacher is to guide the process of learning that will be meaningful to the student. The teacher is to guide the student through developing his/her own natural potential (Knowles, 1950). Therefore, it is the duty of the teacher to select and organize the teaching material to allow natural potential in students to grow. Vella (2002) claimed that for effective adult learning to occur dialogue must be included in the learning process.

The mission of the adult educator is to describe three distinct sets of needs and goals: needs and goals of individuals, needs and goals of the institution, and needs and goals of society (Knowles, 1980). It is the instructor's mission to help individuals learn what is required for success in whatever need they are struggling (i.e. job placement, job satisfaction, etc...). Institutions also have needs and goals that help define the adult educator's mission. These needs and goals are to be met if the learning process is to succeed. The societal goal implies that the betterment of adults will foster the betterment of society as well (Knowles, 1950; Freire, 1972).

Holton and Swanson (2001) stated that, "The goal of transfer [of learning] is the full application of new knowledge and skills to improve individual and/or group performance in an organization of community" (p. 245). The first place transfer of learning should take place is

within the classroom. Transference is most likely to occur in the subsequent situations: association, similarity, degree of original learning, and critical attribute element (Leib, 1991). Leib (1991) defined association as a learner's ability to associate the new information with something they already know. He labeled similarity as the learner's ability to take the new information and apply it to similar incidents, which results in a logical pattern. Leib (1991) described the degree of logical learning simply as the fact that the learner's original degree of learning was high. Lastly, Leib (1991) depicted a critical attribute element as the information learned that contains elements which are extremely beneficial on the job.

A study by Miller in 1956 indicated that the amount of information that can be remembered in one exposure is between five and nine times depending on the information. This concept became known as "Miller's Magic Number." The critical aspect of this principle is the connection between a learner's short-term memory (STM) and their long-term memory (LTM) (Miller, 1956). As adult educators, it is critical that learning is relevant and meaningful to ensure that the transfer of information from STM to LTM occurs (Miller, 1956). However, there are negative and positive types of learning transfer. Positive transference occurs when the learners use the behaviors taught in the course (Leib, 1991). Negative transference occurs when the learners do not use the behaviors taught in the course (Leib, 1991). Without a solid foundation upon which to base the practice of adult education, achieving goals can be quite difficult (Knowles et al. 2005; Merriam & Caffarella, 2007; Miller, 1956).

### **Experiential Learning in the Immersive Virtual Learning Environment**

According to Kolb (1984), "Learning is the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping experience and transforming it" (p. 41). Kolb (1984) called this perspective on learning

“experiential” for the following reasons. The first reason is to link “experiential” learning to the works of John Dewey, Kurt Lewin, and Jean Piaget, and the second reason is to call attention to the importance that experience plays in the learning process (Kolb, 1984). As Kolb said, “This differentiates experiential learning theory from rationalist and other cognitive theories of learning that tend to give primary emphasis to acquisition, manipulation, and recall of abstract symbols, and from behavioral learning theories that deny any role for consciousness and subjective experience in the learning process” (p. 20). Kolb (1984) posited experiential learning as a “holistic” perspective on learning that combines “experience, perception, cognition, and behavior” (p. 20).

While Kolb (1984) is one of the most well-known scholars in the field of experiential learning, he drew upon the works of John Dewey, Kurt Lewin, and Jean Piaget in the development of his theory of experiential learning. The work of Dewey is one of the most influential relating to the guiding principles for experiential learning (Kolb, 1984). Dewey proposed that education be designed on the basis of a theory of experience (Kolb, 1984). This theory of experience posited two central systems of belief: continuity and interaction (Kolb, 1984). The presentation of continuity suggests that humans are affected by experience, which is critical for obtaining the skills necessary for living in “society.” Dewey asserted that humans learn from each experience despite if it is positive or negative; these experiences have a critical impact on future experiences (Kolb, 1984). Continuity lies in the concept that these experiences are stored and carried into the future despite if one desires this to occur or not (Kolb, 1984). The concept of interaction builds upon the theory of continuity and offers an explanation of how past experiences interact with the current/present situation (Kolb, 1984). Dewey asserted that the present experience interacts with the past experience to create the current experience. These

systems of belief offer a rationale as to how to individuals can experience situations in profoundly unique manners due to the function of continuity and interaction (Kolb, 1984).

Lewin presented that learning is “best facilitated in an environment where there is dialectic tension and conflict between immediate, concrete experience and analytic detachment” (Kolb, 1984, p. 9). Lewin presented that, “By bringing together immediate experiences of the learner and the conceptual models of the staff in an open atmosphere where inputs from each perspective could challenge and stimulate the other, a learning environment occurred with remarkable vitality and creativity” (Kolb, 1984, p. 10). Lewin and his colleagues can be credited with creating the groundwork for two influential “streams of development” that are critical to experiential learning: values and technology (Kolb, 1984). T-groups and the laboratory method provided a focus on the value of “subjective personal experience in learning,” which contrasts the traditional behaviorist theories, most notably that of Skinner (Kolb, 1984). Kolb (1984) stated of Lewin’s work, “This emphasis on subjective experience has developed into a strong commitment in the practice of experiential learning to existential values of personal involvement, and responsibility and humanistic values emphasizing that feelings as well as thoughts are facts” (p. 11). Just as important as this focus on values was the expanding technology for applied learning. Lewin (as cited in Kolb, 1984) presented that the focus of the technologies was a simulated situation that was designed to create personal experiences understanding. This concept reverberated through adult education theory, as can be seen in the works of Knowles.

Piaget’s theory described how intelligence is “shaped” by experience (Kolb, 1984). Kolb (1984) said of Piaget’s theory that, “Intelligence is not an innate internal characteristic of the individual but arises as a product of the interaction between the person and his or her environment. And for Piaget, action is the key” (p. 12). The work of Bruner in America was

parallel to the work of Piaget and aided in a movement in curriculum development and teaching that focused on “the design of experience-based educational programs using the principles of cognitive-development theory” (Kolb, 1984, p. 12). Much of Bruner’s work consisted of modifications to Piaget’s original work. In both Piaget and Bruner’s work, the results of their experiments echoed that of Lewin’s that when children were “freed from the lockstep pace of memorization” they excelled in the discovery of knowledge, not just in the content (Kolb, 1984). This same notion of the learner being “freed” during the learning experience continues to translate into adult education theory and practice (Kolb, 1984).

Kolb (1984) asserted there are many similarities between Dewey, Lewin, and Piaget’s viewpoints on the learning process. Kolb (1984) presented that experiential learning has six key characteristics, which are shared by Dewey, Lewin, and Piaget as well:

- Learning is best conceived as a process, not in terms of outcomes.
- Learning is a continuous process grounded in experience.
- The process of learning requires the resolution of conflicts between dialectically opposed modes of adaption to the world.
- Learning is a holistic process of adaption to the world.
- Learning involves transactions between the person and the environment.
- Learning is the process of creating knowledge.

Based upon these six characteristics, Kolb (1984) outlined the following regarding the process of learning:

- The emphasis is on the process of adaptation and learning rather than content or outcomes;
- Knowledge is a transformation process that is continuously created and recreated,



not independently acquired or transmitted;

- Learning transforms experience in both objective and subjective forms; and
- To understand learning one must understand the nature of knowledge and vice versa.

The experiential learning model presented by Kolb (1984) can be described as a four-stage cycle with four “adaptive learning modes” – concrete experience, reflective observation, abstract conceptualization, and active experimentation. Kolb (1984) described the four “adaptive learning modes” in the following manner:

- Concrete Experience – learning by experiencing; learning from specific experiences; relating to others; being sensitive to feelings and people.
- Reflective Observation – learning by reflecting; observing before making judgments; viewing things from other perspectives; looking for the meaning of things.
- Abstract Conceptualization – learning by thinking; analyzing ideas logically; planning systematically; acting on an intellectual understanding of a situation.
- Active Experimentation – learning by doing; displaying the ability to get things accomplished; taking risks; influencing people and events through action.

This experiential model presented by Kolb (1984), contained two distinct modes of gaining experience that are related to each other: concrete experience (*apprehension*) and abstract conceptualization (*comprehension*) (Oxendine, Robinson, & Willson, 2004). In addition, there are also two distinct methods of transforming the experience: reflective observation (*intension*) and active experimentation (*extension*) (Baker, Jensen, & Kolb, 2005). These four modes create the four-stage experiential learning cycle presented below.

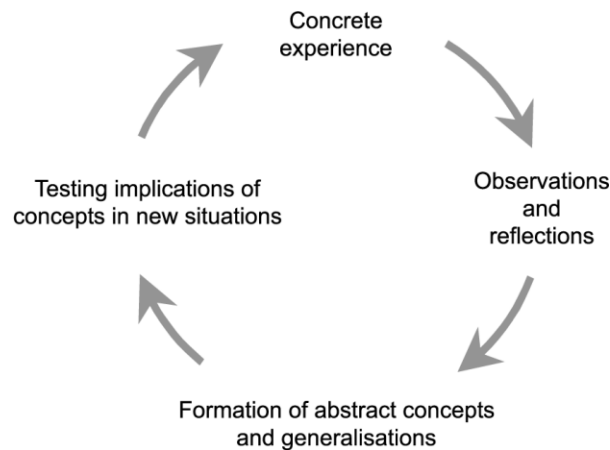


Figure 1. David A. Kolb's Experiential Learning Model – 1984

At the beginning of the experience learning cycle, the learners start with concrete experience, which transitions them to reflect upon their experience. Once the learners have reflected, they enter abstract conceptualization by creating ideas for use in forthcoming events (Kolb, 1984; Oxendine et al., 2004). Oxendine et al. (2004) stated regarding active experimentation, “With these guides in place, the learners actively test what they have constructed leading to new experiences and the renewing of the learning cycle” (p. 4).

Apprehension-Comprehension is a continuum that involves the transformation of experience; one without the other is not an effective means for acquiring knowledge (Baker et al., 2005). The Intension-Extension represents the “transformation” of the experience (Baker et al., 2005). Baker et al. (2002) argued that to transform the experience something must be “done with it,” meaning the experience, because “perception alone is not sufficient for learning” (p. 417).

Oxendine et al. (2004) presented the following steps for integrating experiential learning into the classroom:

1. Set up the experience by introducing learners to the topic and covering basic material that the learner must know beforehand.
2. Engage the learner in a realistic experience that provides intrigue as well as depth

of involvement.

3. Allow for discussion of the experience including the happenings that occurred and how the individuals involved felt.
4. The learner will then begin to formulate concepts and hypotheses concerning the experience through discussion as well as individual reflection.
5. Allow the learners to experiment with their newly formed concepts and experiences.
6. Further reflection on experimentation (pp. 1).

Utilizing these steps during a simulation process, like an Immersive Virtual Learning Environment (IVLE), created a “direct experience” for the learner (Oxendine et al., 2004). This direct experience coincided with the experiential learning process presented by Kolb (1984).

Learning by doing, through experiential learning, is a fundamental platform for IVLEs, and Hew and Cheung (2010) highlighted that in following Kolb’s experiential learning cycle concept, users in an IVLE can act upon the objects which allows them to learn by doing, observe the results of their actions, test their assumptions about the situation, and reflect on their understanding. Dede (1995) noted that the virtual world environment provides the arena for students to “learn by doing” through a real-world representation of the desired environment. As with any training or educational intervention, an IVLE is only as effective as the skills that are transferred (Waller, Hunt, & Knapp, 1998). Hawk and Shah (2007) further expounded on Kolb’s experiential learning by averring that learning is a “holistic set of processes that are continuous” and supported through an IVLE (p. 3). An IVLE allows a learner to complete Kolb’s cycle of experiential learning on a continual basis and is a reflection of the fact that the virtual world like the real world must be learned before it can be exploited (Johnson & Levine, 2008). Jarmon et

al. (2008) recommended that experiential learning be the foundation of any IVLE.

IVLEs provide an effective environment for bridging education and experience, which suggests that this type of environment is “optimal” for experiential learning to occur (Jarmon, Traphagan, Mayrath, & Trivedi, 2009). Jarmon et al. (2009) continued to state that experiential learning in an IVLE allows learners to demonstrate their learning through the creation of real-life problem solving, real-life project creation, and collaboration in a virtual world. There are six facets identified by Jarmon et al. (2009) that facilitate experiential learning in an IVLE:

1. The capacity to host virtual social interactions and collaborations.
2. The capacity to allow users to test hypotheses by applying them to an actual project and doing something active without the risk and cost of the real world.
3. The possibilities for relevance of their virtual actions in the real world.
4. The capacity to allow for various types of abilities to be practiced and demonstrated virtually.
5. The simulation of imagination, exploration, and creativity.
6. An increased sense of personal presence and tangible experience in the virtual world (p. 175).

Jarmon et al. (2009) further stated, “The sense of embodiment in [an IVLE] helped make their [the students] experiences in the virtual environment real and fostered their sense of concrete experiences. This sense of embodied social presence initiated and enhanced the experiential learning cycle” (p. 179).

Thomas and Brown (2009) asserted that in an IVLE learners are able to implement new behaviors, repeat the behaviors to gain experience, observe the outcome, and adjust future behavior based on the outcomes. Through this process, potentially significant and long-lasting

behavior changes can occur (Brown & Thomas, 2009). The ultimate objective of providing an IVLE to learners is to assist in the development and improvement of real-world skills (Cobb, Neale, & Reynolds, 1998). Through an IVLE, learners no longer have to be “passive spectators” in the learning process but can experience and manipulate the presented real-world scenarios in a variety of ways (Persky et al., 2009; Whitelock et al., 2000).

As with experiential learning, the emphasis within constructivism is on a learner’s ability to solve “real-life problems” (Huang, 2002). Dewey (1916) posited the teacher as a “guide” of learning rather than a “director” of learning. Jonassen (2000, as cited in Huang, (2002) indicated that learners can use technology in constructivist learning environments to:

1. Articulate what they know
2. Reflect on what they have learned
3. Support the internal negotiation of meaning making
4. Construct personal representations of meaning
5. Support intentional, mindful thinking

Huang (2002) continued to assert that the appropriate type of technology can aid in facilitating learning if the appropriate choice of material and technology is made. In addition to asserting that the technology choice must be appropriate to ensure effectiveness, Huang (2002) also reinforced the position that the learning experience must be authentic and meet real life experiences. Jonassen (2008) argued, “If schools are to foster meaningful learning, then the ways that we use technologies in schools must change from technology-as-teacher to technology-as-partner in the learning process” (p. 7).

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## **CHAPTER 3.**

### **METHODOLOGY**

#### **Project Creation and Collaboration**

This research project was conducted through a collaborative effort between a state highway department and two universities located in the Southeastern portion of the United States. The researcher at the state highway department and two universities designed the immersive virtual learning environment (IVLE). The researcher 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 researcher created a problem statement to drive the research study and worked with the subject matter experts to ensure the IVLE development and implementation supported the purpose of the research study. Over the course of six months, the researcher 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 state highway department in the pilot testing of the IVLE in the classroom. Those individuals from the state highway department that participated in the formal pilot testing included: state highway department trainers, state highway department work zone safety specialists, state highway department engineers, and state highway department instructional designers. The pilot testing included two formal class deliveries which implemented the IVLE into the course along with 10 additional pilot testing meetings between researcher and the design team.

This design involved an experimental and control group that are both administered pre

and posttests; however, these groups are not randomly selected because they constitute naturally assembled groups (Campbell & Stanley, 1963). Participants received a pretest at the start of the class and a posttest upon class completion. Pretests are beneficial in this design because “they tell us about how the groups being compared initially differ and so alert us to the higher probability that some internal validity threats rather than others may be operating” (Shadish, Cook, & Campbell, 2002, p. 136). Shadish et al. (2002) went on to say that “the strong assumption is that the smaller the difference on the pretest, the less is the likelihood of strong initial selection biases on that pretest operating ...” but they cautioned that other unmeasured variables that exist at the time of the pretest may influence the outcome (p. 136).

### **Population and Sample**

The target population for this research is public (state and local government) and private highway maintenance workers. The accessible population consisted of those workers in the greater metropolitan area of a large southern United States city.

### **Research Implementation**

First, a determination was made as to how many classes of 24 students per class could be held, and what days the training facilities would be available. This resulted in a total of 15 classes and would provide a training opportunity for a maximum of 360 subjects. The researcher randomly assigned experimental or control designation to each of the 15 classes, resulting in eight experimental and seven control classes. This random assignment of the groups to the levels of the treatment was completed through the flip of a coin. Only the researcher knew class designation (i.e. experimental or control), thus participants would not know if they were attending an experimental or control class prior to the start of the class.

Consequently, participants’ only prior knowledge was that they were attending a flagger

safety course. Training managers from public and private organizations in the region were briefed ahead of time that the Basic Flagger Course was being offered, and they were told that some classes would supplement the existing instruction with the new training technology and that others would not. The training managers were assured both classes (control and experimental) would meet the training need, the objectives identified in the course, and that the overall quality of either type of class would not suffer. In addition, they were asked not to discuss the different delivery methods with class participants. The training managers were provided a schedule of the classes and asked to appoint students to the classes on a first-come, first-serve basis. The researcher confirmed attendance with the training managers and then sent a reminder of the schedule approximately 72 hours prior to the class.

The lecture was presented by the same individual for all classes, thus minimizing error due to presentation. The computer skills needed by the participants were minimal; participants operated within the IVLE using one simple input device, similar to those commonly utilized with serious games (e.g. PlayStation 3®, Xbox®). Participants saw themselves as avatars in the IVLE and were able to move their avatars to perform specific flagging training tasks. A robust tracking system was embedded in the software to track the spatial (x-y-z coordinates) and temporal movement of the avatar of each participant. A highly precise and redundant telegraphy data storage system (both hardware and protocol) was developed to allow easy retrieval of the working data for subsequent statistical analysis use by the researchers only. Development of the protocols took place early in the design phase and considered data integrity as well as report generation requirements.

In addition to this data, quantitative data was 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 precision 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 this data will be presented in forthcoming papers and conferences.

Finally, qualitative data was collected to assess the affective response of the subjects to the IVLE. After each treatment class, four or five subjects were asked to volunteer to take part in an interview ( $n = 32$ ). Review of the data indicated an extremely positive reaction to the IVLE by the subjects. All empirical data were subjected to the appropriate statistical tests, including measures of central tendency about the mean.

### **Data Collection**

Data were collected from six sources. The data collection instruments and methods approved by the appropriate Institutional Review Board are as follows:

1. Literature Review
2. Demographic Survey
3. Pretest
4. Posttest
5. IVLE Telegraphy
6. Qualitative Interviews

### **Literature Review**

Although little is currently published regarding the science of applying an IVLE to a diverse group of adult learners, a great deal of published research existed for IVLEs in general, pedagogy in the virtual world, children and young adults learning in the virtual world, and virtual

world design (Kapp & O'Driscoll, 2010).

### **Demographic Survey**

The demographic survey instrument (Appendix 2) was intentionally brief and gathered pertinent information such as age, gender, ethnicity, education level, socio-economic status, and current job title. The coded demographic survey instrument is located in Appendix 3.

### **Pretest/Posttest**

The pretest/posttest were equivalent (Appendix 4 and 5). The purpose of the pretest was to reveal pre-training baseline understanding of flagger techniques and abstract concepts. The posttest was designed evaluate learning transfer.

### **IVLE Telemetry**

A robust tracking system was embedded in the software to track and measure every one-tenth of a second, the spatial (x-y-z coordinates) and temporal movement of the avatar of each participant. A highly precise and redundant telegraphy data storage system (both hardware and protocol) was developed to allow easy retrieval of the working data for subsequent statistical analysis use by the researcher only.

### **Qualitative Interview**

Four to five volunteers from each treatment class participated in one-on-one interviews at the completion of the class, resulting in a total of 32 interviews. Each interviewer, as supervised by the researcher, used the same list of open-ended questions (Appendix 6) and was encouraged to use probing questions whenever the opportunity was present. Interviewers observed all treatment class subjects during the course via closed circuit television to discover behavior such as collaborative efforts and perceived body language. All interviewers had participated in a graduate-level qualitative research methods course that included effective interview techniques.



### **Institutional Review Board Approval**

The researcher has completed the *NIH Office of Extramural Research Protecting Human Research Participants* online course (Appendix 7) and all assessment instruments have been approved by the LSU Institutional Review Board (HE10-4).

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## **CHAPTER 4.**

### **TRAINING SKILLED AND UNSKILLED WORKERS IN AN IMMERSIVE VIRTUAL LEARNING ENVIRONMENT<sup>1</sup>**

#### **Introduction**

This research project evaluated the ability of adult learners to function in a training context using an Immersive Virtual Learning Environment. The unique aspect of this training experiment was that it was designed to evaluate a diverse adult learner population primarily consisting of non-technologically oriented, high school or less, lower socio-economic status adults, often referred to as “blue-collar” workers. Course delivery strategy employed a blended delivery methodology, with the specific focus on the Immersive Virtual Learning Environment (IVLE) technology as the method of blended delivery. The purpose of this research study was to determine if an Immersive Virtual Learning Environment (IVLE) increased the learning transfer of the knowledge obtained in a work zone safety basic flagging procedures course for what can be considered a marginalized population of adult learners.

Scant research has occurred regarding the use of IVLE for blue-collar workers that are perceived to avoid the use of technology and dislike attendance in traditional classrooms or computer based training. However, IVLEs provide a new and powerful method to increase adult learner engagement. As Lim, Nonis, and Hedberg (2006) have stated, adult learner engagement is paramount to learning success. This project hoped to find that through the IVLE, learning engagement would be increased as the adult learners would be fully integrated into the work zone safety simulation, with a specific focus on flagging procedures, as though they were actually performing the prescribed duties in accordance with the required rules and procedures as

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outlined in the classroom instruction. Such engagement in the learning activity would allow the adult learners to move beyond the memorization of the presented concepts and into the application and synthesis of the material.

As supported by Kolb's Experiential Learning Theory, the IVLE allows the adult learners to move from the concrete experience (current knowledge of work zone safety flagging procedures) to reflective observation (reflection on current knowledge of work zone safety flagging procedures as it relates to new materials) to abstract conceptualization (the application of the new knowledge of work zone safety flagging procedures) and lastly to active experimentation (constructing methods for using new information on the job) (Swanson & Holton, 2001). Based on review of current literature and discussions with scholars in the field of virtual learning, active experimentation in work zone safety flagging procedures has never been possible prior to the creation of the implemented IVLE for the transportation community, primarily for safety reasons. This is a particularly relevant point for any training activity attempting to mimic real-world physical activity that occurs in a dangerous environment (e.g. working around heavy equipment, scuba diving, civil engineering projects, or combat).

### **Significance of the Study**

The research will continue to contribute fundamentally to the understanding of an IVLE as it relates to the transportation community; however, the research also has broad reaching implications in all disciplines where education and training is paramount to organizational success. Use of web 3D technology to create an IVLE in order to increase the transfer of learning has been evaluated in a number of fields, with the findings as to its success varying across the disciplines. However, the aforementioned studies were conducted with homogenous groups, and this is the fundamental difference in this research study. This project was comprised

of a population that was heterogeneous on many levels (e.g. years of experience, technological proficiency, formal education, age, gender, etc.). The accessible population from which the sample was drawn comes from the transportation highway maintenance community, both public and private sector. The result of this research project has a direct impact on future training of these workers, workers in similar fields, and ultimately the safety of the general traveling public. Research conducted with an extremely diverse population leads to increased public and scholastic value as more individuals, scholars, and modeling and simulation developers are able to see themselves benefiting from this research, as well as the potential to reach out to the technologically marginalized population.

The prototype of blended learning utilized in this research project was very specific, but the knowledge gained and the technology developed from this research will have far reaching impacts for any training where realistic practice is difficult and where realism during training is invaluable. This training transcended subgroups, reducing the intergroup achievement gap, increased participation due to the similarity to massive multiplayer online games, resulting in more adult learners being better prepared for the real-world work environment simulated by the IVLE.

The IVLE also provided an avenue for increasing the knowledge level of the marginalized population. Through the use of this blended methodology, the marginalized population was presented with technological advances in the realm of education that previously may have not been within their reach. By exposing this population to this type of educational element, a decrease in training resistance may be found. If a decrease in training resistance occurs, the likelihood of learning transfer increases, thus, leading to a better-trained population.

## **Current Research**

According to Hobbs, Brown, and Gordon (2006), current practice in higher education is moving away from didactic content delivery to an adult learner-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). It is essential for educators to investigate innovative and engaging teaching methodologies to offer a more fulfilling learning experience (Cobb, Heany, Corcoran, & Henderson-Begg, 2009). Echoed by Jarmon, Traphagn, and Mayrath (2008), they indicate that the use of virtual worlds can enhance adult learner motivation and engagement, which provides for social interaction, collaboration, increased sense of shared presence, exploration, and creation. Jarmon et al. (2008) also stated that few empirical studies document learning within virtual worlds. The question to be addressed regarding an IVLE is not “what can it do” but rather “what is it doing?” (Ellaway, Dewhurst, & McLeod, 2004).

The effectiveness and value of an IVLE is not inherent to the IVLE software or platform, but rather depends on its use in facilitating and mediation of the needs and activities of the instructional material (Ellaway et al., 2004). IVLE functions exist in a blended relationship with other human activities, independent of whether they are the primary delivery medium or among one of many (Ellaway et al., 2004). The rationale for using learning in an IVLE in adult education offers advantages over learning through real-life practice (Savin-Badden, 2008).

Virtual worlds seem to provide an ideal vehicle for providing adult 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 the following:

- Experiencing things that would be difficult or impossible to do in the physical

world – both physically and pragmatically.

- Experiences in virtual worlds suggest that these are spaces, which encourage playfulness and test boundaries.

In a study conducted by the Computing Research Association and the International Society of Learning Sciences in 2005, the researchers highlighted that one of the main challenges facing educators is moving from the dominant view of technology being disruptive in the classroom to understanding how to utilize the benefits that technology has to offer within the classroom. Learning in an IVLE allows for exposure to a wide range of scenarios at a time and pace convenient to the adult learner while allowing for consistent feedback. The IVLE offers the adult learner chances to make mistakes without real-world repercussions, but it allows for the virtual-world repercussions to be experienced in a non – threatening environment (Savin-Badden, 2008). An IVLE also offers an opportunity for collaboration where appropriate, as well as offering new opportunities for review of abstract concepts (Savin – Badden, 2008).

Kramer and Schmidt (2001) identified the potential role of technology in education for reconstructing education and learning:

- The same content can be presented using different media types.
- Different perspectives and access to the same topic can be used to provide cognitive flexibility.
- Different media can be synchronized into multi-modal presentations.
- Multimedia components can be networked to hypermedia learning applications according to logic, didactic, or other meaningful relationship components.
- Different customized tours can be superimposed into learning components.
- Education software development and knowledge modeling tools facilitate

authoring of multimedia education material and technology.

- Interaction provides adult learners with opportunities for experimentation, context-dependent feedback, and constructive problem solving.
- Asynchronous and synchronous communication and collaboration helps bridge geographical distance.
- Virtual laboratories and environments can be used to offer near authentic situations and opportunities for hands-on experimentation and problem solving.
- Operation sequences and preferred learning paths can be recorded and evaluated.

To further support the above-mentioned points, Whitelock, Romano, Jelfs, and Brna (2000) reiterated that an IVLE allows adult learners to enter a new world that they might not otherwise get to experience. The adult learners no longer have to be passive spectators in their learning experience but can manipulate their learning environment in a number of ways (Whitelock et al., 2000).

As identified by Clark and Mayer (2003), instruction through an “e-lesson,” in this study an IVLE, must guide the adult 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) noted 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 as they state, “Realistically representing and precisely visualizing the operations facilitates comprehension and hones the ability to transfer practiced procedures to a real work situation.”

## **Methods**

### **Context**

The Louisiana Department of Transportation and Development (DOTD) half-day Basic Flagger Course teaches highway maintenance workers how to safely manage traffic in a temporary work zone. Adult learners learn how to use proper equipment and techniques to capture the attention of motorists; communicate with them via hand signals and signs; and then safely control their movements around construction equipment, hazards, and obstructions.

The pre-experiment four-hour course was taught by an instructor delivering the content using mixed instructional methods (lecture, videos, and PowerPoint) in a traditional classroom setting. Adult learners were encouraged to contribute to discussions, and volunteers were called upon during the course to demonstrate important learning points using flagger equipment. A posttest was administered to evaluate short term learning transfer. The Basic Flagger Course was chosen for this experiment because:

- It is directly related to highway work zone safety.



- It is focused on a physical rather than technical skill, with no practical method to realistically practice skills learned in class.
- The course had not been redesigned in the recent past (it was stable), was pedagogically sound, and the physical skills easily mapped into the virtual world environment.
- A large, diverse population was eligible for the class.

### **Collaborative Effort**

Early and frequent collaboration of a number of organizations was essential to ensure success of this project. First, the project originators sought help from a distance learning and statistics scholar from the Louisiana State University School of Human Resource Education and Workforce Development (LSU/SHREWD). Course managers and instructors from the Louisiana Department of Transportation and Development/Louisiana Transportation Research Center (LTRC) then joined the team, and most importantly, the team expanded to include participation from the University of Louisiana Lafayette, Louisiana Immersive Technology Enterprise (LITE). This team examined various options, considered alternatives, and made early policy and experimental design decisions. Other interested stakeholders and research supporters participated in team meetings as the need arose.

### **Experimental Design**

The target population for this research is public (State and local government) and private highway maintenance workers. The accessible population consisted of those workers in the greater metropolitan area of a large city in Louisiana. This design involves an experimental and control group that are both administered pre and posttests; however, these groups are not randomly selected because they constitute naturally assembled groups (Campbell & Stanley, 1963). Adult learners received a pretest at the start of the class and a posttest upon class

completion. Pretests are beneficial in this design because “they tell us about how the groups being compared initially differ and so alert us to the higher probability that some internal validity threats rather than others may be operating” (Shadish, Cook, & Campbell, 2002, p. 136).

Shadish et al. (2002) went on to say that “the strong assumption is that the smaller the difference on the pretest, the less is the likelihood of strong initial selection biases on that pretest operating ...” but they cautioned that other unmeasured variables that exist at the time of the pretest may influence the outcome (p. 136).

First, a determination was made as to how many classes of 24 adult learners per class could be held and what days the training facilities would be available. This resulted in a total of 15 classes and would provide a training opportunity for a maximum of 360 adult learners. The research team randomly assigned experimental or control designation to each of the 15 classes, resulting in eight experimental and seven control classes. Only the researchers knew class designation (i.e. experimental or control), thus adult learners would not know if they were attending an experimental or control class prior to the start of the class. In fact, the adult learners’ only prior knowledge was that they were attending a flagger safety course. This masking of assignment was useful because Shadish et al. (2002) asserted that “it prevents ... adult learner reactivity to [prior] knowledge of the condition ...” and “efforts by those involved in assignment to influence results ....” (p. 36).

Training managers from public and private organizations in the region were briefed ahead of time that the Basic Flagger Course was being offered, and were told that some classes would supplement the existing instruction with the new training technology of Immersive Virtual World Learning and that others would not. The training managers were assured that the overall quality of either type of class would not suffer, and they were asked not to discuss the different

delivery methods with class adult learners.

The training managers were provided a schedule of the classes and asked to appoint adult learners to the classes on a first-come, first-serve basis. One of the senior researchers confirmed attendance with the training managers and then sent a reminder of the schedule approximately 72 hours prior to the class.

The lecture was presented by the same individual for all classes, thus removing error associated with the instructor. Computer skills (fluency) of the adult learners were minimal; adult learners operated within the IVLE using one simple input device, similar to those commonly utilized with serious games (e.g. PlayStation 3®, Xbox®). The adult learners were engaged in the IVLE through the use of avatars as they performed specific flagging training tasks. A robust tracking system was embedded in the software to track the spatial (x-y-z coordinates) and temporal movement of the avatar of each adult learner. Development of the data storage and retrieval protocols took place early in the design phase and considered data integrity as well as report generation requirements.

Although this study reports solely on the initial qualitative findings, the research design includes ongoing studies of the quantitative data, a more in-depth study of the emergent qualitative themes, and a longitudinal study of knowledge transfer and retention which will be presented in subsequent papers.

### **IVLE Design**

The research team and the immersive technology team began by carefully reviewing the existing Basic Flagger course and gaining a thorough understanding of the abstract concepts, desired teaching outcomes, adult learner characteristics, instructor requirements, and subject matter expert opinions. Then the portions of the course content that would best match the

teaching advantages of the virtual learning environment were chosen. Once that was completed, the immersive technology team developed “story boards” to illustrate virtual world design and planned functionality for each scene and presented those to the research team and instructional team for approval. A working IVLE prototype was developed and tested by a pilot group; minor problems and suggested improvements emerged and the immersive technology team then perfected the IVLE, incorporating those suggestions that enhanced the IVLE.

### **Data Collection**

The data collection instruments and methods used (and those approved by the Louisiana State University Institutional Review Board) are as follows:

- Literature Review
- Demographic Survey
- Pretest
- Posttest
- IVLE Telemetry
- Video Recording of Experimental Classes
- Structured Interviews

### **Literature Review**

There is little research regarding the science of implementing an IVLE with a diverse group of adult learners, a great deal of published research existed for IVLEs in general, pedagogy in the virtual world, children and young adults learning in the virtual world, and virtual world design.

### **Demographic Survey**

The demographic survey instrument was intentionally brief and gathered pertinent

information such as age, gender, ethnicity, education level, socio-economic status, organization type, and current job title.

### **Pretest/Posttest**

The pretest and posttest were equivalent. The purpose of the pretest was to reveal pre-training baseline understanding of flagger techniques and abstract concepts. The posttest was designed to evaluate learning transfer.

### **IVLE Telemetry**

A robust tracking system was embedded in the software to track and measure every one-tenth of a second the spatial (x-y-z coordinates) and temporal movement of the avatar of each adult learner. A highly precise and redundant telemetry data storage system (both hardware and protocol) was developed to allow easy retrieval of the working data for subsequent statistical analysis use by the researchers only. At time of publication of this paper, the data has not been analyzed and results from this analysis will be presented later.

### **Deployment**

At the beginning of each class, one of the senior researchers would welcome the adult learners and explain the compelling safety need for the course. The researcher then briefly described the instruments that would be administered. All subjects were advised that participation was strictly voluntary, that anyone could leave at any time, and that full completion, partial completion or refusal to complete the instruments at all was permissible. All subjects were assured that all data would be summative, and that all instruments would be treated as confidential and carefully protected in compliance with the National Institute of Health, human subjects' research requirements and guidelines.

At the beginning of each experimental class, use of the input devices was carefully

explained to the adult learners. Two IVLE events then began which allowed each adult learner to choose their avatar, followed by time to practice movement of their avatar. After completion of these events, instruction began, mixing IVLE events into the course delivery at appropriate times. The 13 IVLE events required the adult learners to complete one or more tasks. Although no time limit was embedded in each event, the instructor could end an event and proceed with training at his discretion. In order to reduce artificial pressure on adult learners, they were unaware that spatial and temporal tracking of their avatars was occurring in each event.

At the conclusion of each class, both experimental and control, the adult learners were thanked for their participation and reminded of the importance of what they had learned as it related to work zone safety. Although all adult learners were asked to discuss the lessons learned about safety, experimental class adult learners were asked not to discuss the IVLE technology after leaving the training facility. Also, four to five adult learners from each experimental class volunteered to participate in structured interviews.

## **Results**

Demographic data for the combined treatment and control groups ( $n = 305$ ) indicated that of those responding, the majority of the sample was African-American (64.3%) and that 88.3% were males. It is interesting to note that 76% 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 (46.6%) of age and had never attended a flagger course (77.4%). A significant number (87%) earned \$50,000 a year or less.

## **Qualitative**

The researchers for this study were trained on observational techniques prior to the commencement of the study. Thus, each researcher understood both the research project and the

treatment they would be observing. This allowed for stronger creditability of the findings. There were always two or more observers for each experimental class, which allowed for more detailed observations of the class. There were eight experimental classes with a combined total of 24 observers. The camera that recorded the experimental class could scan the classroom for better viewing of the adult learners.

The experimental class was videotaped in order to provide the researchers with the opportunity to observe body language during the treatment and not intrude on the actual study. There was a room located in the training site that allowed researchers to remotely view the experimental class in real time; eliminating what could have been perceived by the adult learners as an intrusive presence in the classroom. Viewing the experimental class in real time, thus, enabled the researchers to take copious notes on the body language of each adult learner from the minute they stepped into the class and saw the computers until they left the class at the conclusion of the training session. The researchers were careful to note whether any of the adult learners had any type of smart phone with them.

The researchers noted that various adult learners were apprehensive as they stepped into the training room and found themselves faced with rows of computers, as evidenced by the visible stiffening of their bodies and markedly slowness to their steps. The observers noted that the adult learners spoke among themselves about the computers and what kind of training awaited them. As expected, the first adult learners to arrive chose seats in the back of the classroom, and the later arrivals were forced into the front of the class. The observers also noted that the adult learners seemed surprised to see a game controller.

There were several research assistants in the classroom to help the adult learners log on to the computers with their pre-assigned logon id and password. One of the senior researchers

explained to the adult learners that the game controller's operation was very similar to that of a joystick in the heavy equipment that they may operate on the job, such as a "trackhoe." That bit of advice seemed to help many of the adult learners with the operation of their game controller. Many of the adult learners expressed concerns that they had never worked on a computer before and were quite concerned.

Once each adult learner was logged on and the treatment began the observers could see that some adult learners struggled with their game controllers as they completed the initial simulation levels (events). Individuals that appeared to read the on-screen instructions slowly, also seemed to take the most time to complete events. Their uncertainty of the game controller and their slowness to complete events were noted. Adult learners that struggled in the class were occasionally assisted by their fellow adult learners, who in a few cases actually completed the event for them. The observers were able to note this external adult learner assistance, and those instances will be included in both quantitative and qualitative future analyses to ascertain if there was any impact on the results.

Age was not a variable that could be used to categorize the adult learners on their behavior in the treatment class. Some individuals that were older completed the events more quickly than younger adult learners. Race was not a factor during observations either. There were limited observations on female adult learners due to the relatively small number of women in the class.

As the adult learners gained experience by completing events, the observers reported a notable change in body language; adult learners visibly leaned forward in their chairs and competed with their neighbor as to how quickly they could complete an event. Adult learners seemed to become more animated as the events continued.



It was interesting to note that even though many of the adult learners were initially very apprehensive about participating in computer based training, almost 95% of the adult learners were found to have some type of smart phone. During the actual training, many of the adult learners were observed using their smart phones in various fashions: texting, scanning email, sending text messages, and reviewing websites.

At the completion of the training, another call for interview volunteers was mentioned and generally a minimum of four individuals volunteered.

## **Interviews**

Doctoral and master's degree candidates who completed various courses in research methods, including qualitative methods such as how to compose good follow-on probing questions, conducted the interviews. Interviewers consisted of various races and nationalities. The interviewers took notes and audio-taped the interviews for later transcription. All the interviewers used carefully designed initial questions to all adult learners interviewed. Interviews were conducted with a representative cross-section of the experimental sample, to include race, age, socio-economic status, and educational level. The initial review of the transcripts (which formed the basis of this study) clearly revealed the richness of the responses.

The interviews took place in a quiet room, and the adult learners gave permission for the interviews to be taped. Questions asked ranged from why they chose a particular avatar to how realistic did this training appear to them. Every adult learner interviewed stated that this was a new and engaging way to have training. Approximately 40% of the adult learners had never used a computer before but almost 80% had used a game controller in some fashion prior to this training.

## **Analysis**

Consistent themes emerged from the interviews:

- Safety,
- Being more engaged,
- Increase the interactions within each event,
- Lack of details on the trucks.

The safety issue was consistent in all of the interviews; every adult learner felt they walked away with an understanding about the need to increase their safety in their workplace. They felt they needed to be more careful on curves and making sure they are watching traffic closer, especially since more people are texting while they are driving.

This was a pilot study, and though the simulation scenes were realistic they were limited in road conditions and complexity of roadway (rural two-lane road and only during the daytime). Most of the adult learners wanted to increase the complexity, such as being on a four-lane highway with construction going on in one lane and the traffic having to be diverted into another lane. Adult learners felt much more engaged in their learning than the traditional class that consists of a PowerPoint presentation. These adult learners had participated many times in the traditional flagger course and felt that it was boring and a waste of their time. They really enjoyed being an active adult learner and felt they learned more as well. Many of the adult learners noted the lack of details on the trucks – such as lack of rotating lights and no people actually in the cars and a lack of diversity of vehicle type.

## **Discussion and Conclusions**

In summary the data from this pilot study does indicate that the adult learners perceived that they benefited more from engaged learning treatment than from the traditional classroom.

For several of them this is the first time they had attended a flagging training and felt that because they actually got to place themselves in the simulations they would be able to transfer this knowledge to the workplace much better than if they had just read a training book.

The simulations did heighten their concern for their safety and did seem to leave them with a need to pay more attention to their flagging and their own safety. The adult learners indicated that one of the simulation events did have a situation in which a flagger is severely injured during horseplay and that it would help remind everyone to take their job seriously.

The concern that was expressed throughout this project that individuals with limited education and computer skills could not learn in this environment was unfounded. Regardless of age or education level or familiarity with computers each individual was able to complete the training after spending some time familiarizing themselves with the controller. Concerns regarding simulation on computers can be put to rest if the program developers use game controllers instead of keyboards. This simple change opens up simulation training to a whole new population and allows for active learning which is critical for knowledge transfer and usability.

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## **CHAPTER 5.**

### **ASSESSMENT OF LEARNING IN A MARGINALIZED POPULATION OF ADULTS IN AN IMMERSIVE VIRTUAL LEARNING ENVIRONMENT**

#### **Introduction**

Distance education began over 100 ago, is not a new phenomena, and truly holds the promise of offering “high quality” education anywhere at any time (Anderson, 1999; Pauls, 2003). In a study conducted by Allen and Seaman (2008), they found enrollment in distance education, specifically online learning, courses are growing at a “significantly faster” rate than enrollment in higher education in general. Allen and Seaman (2008) cited the following statistics from more than 2,500 colleges and universities:

- Approximately 3.5 million students were taking at least one online course during the fall of 2006 term, which they indicate is a 10 % increase over the year 2005.
- A growth rate of 9.7 % for online enrollments clearly exceeds the 1.5 percent growth rate for the overall higher education student population.
- Close to 20 % of all United States higher education students were taking at least one class online during the fall of 2006.

This consistent increase of students in online, or distance education, courses serves as an indicator as to the needs of current and incoming students (Allen & Seaman, 2008).

Quoting Shin (2003), “If those who have studied the distance education literature are in accord on any one point, it is probably this: psychological distance is more important than physical distance” (p. 69). A student’s engagement in the “interpersonal relationship” may be “as much as, or possibly more significant than, sheer frequency of contacts or interaction activities” (Shin, 2003). Moore (1997) states that it is the separation of the learners and teachers that has the most profound effect upon not only teaching but clearly also the learning of the

students. Moore (1997) says, “Psychological and communications spaces between any one learner and that person’s instructor are never exactly the same. In other words, transactional distance is a continuous rather than a discrete variable, a relative rather than absolute term” (p. 22). Through the inclusion of an instructor in conjunction with an immersive virtual learning environment (IVLE), it was possible to increase the dialogue between the learners and their teachers, which served as a method for reducing the transactional distance within the IVLE (Moore, 1997).

Successful distance education initiatives require a collaborative process of bringing together specialists in a variety of areas in order to design the most effective distance education material and learning environment (Moore, 1997). However, Moore (1997) does present six distinct processes that must be structured into each distance education program:

1. Presentation – the presentation of information, exhibition of skills, or demonstration of attitudes and values.
2. Support of the learner’s motivation – having a clear and well-designed curriculum for an instructor to deliver can aid in creating and often maintaining a student’s motivation.
3. Stimulate analysis and criticism – building in activities that challenge “higher order cognitive skills” can be taxing but highly beneficial to the learner.
4. Give advice and counsel – providing a means by which learners can utilize the instructional materials to answer questions but also have access to the instructor through a variety of means of communication.
5. Arrange practice, application, testing, and evaluation – students must be provided with an opportunity to apply what has been learned in the course.
6. Arrange for student creation of knowledge – students must be provided with an

opportunity to engage in dialogue with the instructor and other learners in order to facilitate knowledge creation.

Galusha (1998) highlighted that distance learning is student-centered learning, thus ensuring the criteria explicated by Moore (1997) are addressed in the creation of a distance learning program aids in reducing potential barriers, namely transactional distance.

With the documented evolution of technology since the inception of distance education, there has been a clear transition from one-way to two-way communication in distance education, as supported in the findings of Allen and Seaman (as cited in Sumner, 2000). A distinct benefit of two-way communication over the one-way communication is the ability for interactivity between the teachers and learners which can increase the feedback delivered and received for all parties involved, thus encouraging learners to construct his or her own learning (Baggaley, 2008; Sumner, 2000). The constructivist philosophy as applied to distance education and presented by Baggaley (2008) serves as a critical reminder that “learning should be an active rather than rote process” (p. 43).

As stated by Hobbs, Brown, and Gordon (2006), “Current practice in Higher Education is moving away from didactic content delivery, to transfer of discrete, abstract, decontextualised concepts towards constructivist, student-centred models with increasing emphasis on the skills that support independent, self-motivated learning” (p. 2). In support of Hobbs et al. (2006), Dickey (2003) affirmed that along with the creation of new tools for distance education has come a shift in the learning paradigms from the objectivist perspective to the constructivist perspective in order to support the belief that knowledge is constructed rather than transmitted. Papert (1980) argued that knowledge must be built by the learner, which allows learners to develop personal interpretations of their role within the world and through which they are involved in certain

actions.

The constructivist perspective posits technology as a cognitive medium and a tool for knowledge acquisition and exploration (Hay & Barab, 2001). If the constructivist viewpoint is adopted, Hein (1991) argued that learners must be provided with the following opportunities:

- To interact with sensory data
- To construct their own world

These points asserted by Hein (1991) provide that educators should provide “learners with learning situations that channel their ideas into the meaning of the experience” (pp. 7).

Constructivism in practice challenges the educator to redefine the classroom in order to allow such knowledge construction to take place (Lefoe, 1998). Implementation of the constructivist perspective through an immersive virtual learning environment requires a learner act/collaborate in this world as an avatar in order to construct the learning, which is facilitated by an educator (Dede, 1995).

### **Immersive Virtual Learning Environments**

In a study conducted by Ketelhut, Nelson, Clarke, and Dede (2010), the researchers highlighted that the bottom third of middle school students they studied already had given up on themselves as learners. Ketelhut et al. (2010) stated, “These students are disengaged from schooling and typically are difficult to motivate even by good teachers using conventional inquiry-based pedagogy” (p. 2). Although the population studied during the Basic Flagging Procedures course was not comprised of middle school students, one could certainly argue that the adult learners in the study would mirror those middle school students studied by Ketelhut et al (2010). The delivered sample of the immersive virtual learning environment (IVLE) study was comprised of a population where 76% had obtained only a high school degree, GED, or less in terms of education. This demographic characteristic is not uncommon in the highway



construction and maintenance profession as this field is extremely labor intensive in a harsh environmental condition (Coco, Cavin, & Machtmes, 2010).

Current studies on IVLE technology in the classroom are centered upon children, higher education institutions, technical professions (e.g. engineering, architecture, computer science), and the medical community (Blascovich et al., 2002; Blumel, Termath, & Haase, 2009; Clarke & Dede, 2005; Cobb, Heaney, Corcoran, & Henderson-Begg, 2009; Cobb, Neale, & Reynolds, 1998; Cooner, 2010; Dieterie & Dede, 2006; Ellaway, 2005; Ellaway, Dewhurst, & McLeod, 2004; Hobbs et al., 2006; Jarmon, Traphagan, & Mayrath, 2008; Jarmon, Traphagan, Mayrath, & Trivedi, 2009; Ketelhut et al., 2010; Lim, Nonis, & Hedberg, 2006; Lu & Chiou, 2010; Twining, 2009; Ullberg, Monahan, & Harvey, 2010; Wagner & Ip, 2009; Wang & Wang, 2008; Whitelock, Romano, Jelfs, & Brna, 2000). Although these studies provided a solid research foundation for IVLEs in the classroom, their findings have minimal generalizability to the marginalized adult population. Research findings from a highly technical population with advanced academic degrees provide limited generalizability to a marginalized adult learner population. Creating a foundation of IVLE research for the marginalized adult learner population aids in moving the educational technology field toward a more inclusive body of knowledge, which provides significant scholarly and academic advances of IVLEs.

Virtual worlds provide a number of advantages to the learning process and those impacted by the learning process:

- Provides simulation of costly real-world resources
- Creates collaborative tasks for groups or the performance of tasks on an individual level
- Activities that carry a degree of danger in the real world are mitigated through

“virtual tasks” (Foss, 2009, p. 556)

To highlight the power of an IVLE to deliver training for critical cognitive skills, Tichon (2007) posited that IVLEs successfully replicate real-world situations in a manner that allows for effective performance measurement of success. As with most learning activities, the goal is to enhance the learning performance by encouraging those impacted by the learning experience to delve into the knowledge (Chen, Chen, & Kinshuk, 2009). Adamo-Villani and Wright (2007) stated regarding IVLE technology in the classroom, “[It can] bridge the gap between the concrete world of nature and the abstract world of concepts and models” (p. 1). Bridging this gap between the abstract and concrete is a distinct benefit of an IVLE.

Dede (2000) poignantly articulated that technology needs to be more than just a novelty in the classroom, but the technology should provide an effective means of reaching the desired educational objectives. Dede (2000) stated, “Using sophisticated telecommunications, knowledge networking in online virtual communities of practice using advanced tools to solve real world problems is practical and sustainable for many curricular topics” (p. 284).

Schneckenberg, Ehlers, and Adelsberger (2010) provide that IVLE technology provided for five specific learning characteristics:

1. Learning has become ubiquitous
2. Learners increasingly take the role of organizers
3. Learning is a lifelong process
4. Learning takes place in communities
5. Learning is informal (p. 2)

Schneckenberg et al. (2010) asserted that despite this knowledge of these learning characteristics, current educational practices have been slow to respond. As indicated above by Dede (2000),

the use of IVLE technology provides powerful opportunities for adult learners to be involved in real world scenarios, which can assist in enabling the development of these five learning characteristics.

An IVLE has the full capability to engage the adult learner in the entire experiential learning process (Kolb, 1984). Schneckenberg et al. (2010) argued that IVLEs integrate a constructivist perspective into the experiential learning realm which enables the learner to engage fully in the experiential learning process. The IVLE utilized in this study utilized Kolb's (1984) holistic process regarding the design and implementation of the learning activities.

Oxendine, Robinson, and Willson (2004) presented the following steps for integrating experiential learning into the classroom:

1. Set up the experience by introducing learners to the topic and covering basic material that the learner must know beforehand.
2. Engage the learner in a realistic experience that provides intrigue as well as depth of involvement.
3. Allow for discussion of the experience including the happenings that occurred and how the individuals involved felt.
4. The learner will then begin to formulate concepts and hypotheses concerning the experience through discussion as well as individual reflection.
5. Allow the learners to experiment with their newly formed concepts and experiences.
6. Further reflection on experimentation (pp. 1)

Utilizing these steps during a simulation process, like an Immersive Virtual Learning Environment (IVLE), creates a "direct experience" for the learner (Oxendine et al., 2004, pp. 2).

This direct experience coincides with the experiential learning process presented by Kolb (1984). IVLEs provide an effective environment for bridging education and experience, which suggests that this type of environment is “optimal” for experiential learning to occur (Jarmon et al., 2009). Jarmon et al. (2009) continued to state that experiential learning in an IVLE allows learners to demonstrate their learning through the creation of real-life problem solving, real-life project creation, and collaboration in a virtual world.

### **Purpose and Objectives**

The purpose of this research was to determine which method of teaching flagging knowledge and skills to adult learners was the most effective. The experimental method was used in the IVLE to teach flagging techniques and abstract concepts. The second method or control group was to teach flagging techniques and abstract concepts using the traditional way via an instructor and audio-enhanced PowerPoint slides. The study addressed the following objectives:

1. To describe selected demographic characteristics of adult learners taking a mandatory flagger course: age, gender, ethnicity, education level, socio-economic status, current job title, number of year working as an adult, number of years working in construction/ highway maintenance, and whether or not they had previously taken a flagging course.
2. To compare adult learners who took the flagger course via the IVLE to adult learners that took the traditional course on pre and posttest scores as measured by the flagger course assessment.
3. To compare the post measurement scores of learners that participated in the IVLE course to those learners that took the course in the traditional format on the following

variables: age, gender, ethnicity, education level, socioeconomic status, current job title, number of years working as an adult, number of years working in construction/highway maintenance, and whether or not they had previously taken a flagging course.

4. To determine if a significant relationship exists between posttest scores on the flagger course assessment and the following selected demographic variables: age, gender, ethnicity, education level, socio-economic status, current job title, number of year working as an adult, number of years working in construction/ highway maintenance, and whether or not they had previously taken a flagging course.
5. To determine if a model exists that can explain a significant amount of variance in the posttest score from the following demographics: age, gender, ethnicity, education level, socio-economic status, current job title, number of year working as an adult, number of years working in construction/ highway maintenance, and whether or not they had previously taken a flagging course.

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 led by the first author. This research was approved by the Louisiana State University Institutional Review Board (HE10-4).

This design involved an experimental and control group that were both administered pre and posttests; however, these groups were not randomly selected because they constituted

naturally assembled groups (Shadish, Cook, & Campbell, 2002). Participants received a pretest at the start of the class and a posttest upon class completion. Pretests, according to Shadish et al. (2002), are beneficial in this design because “they tell us about how the groups being compared initially differ and so alert us to the higher probability that some internal validity threats rather than others may be operating” (p. 136). Shadish et al. (2002) went on to say that “the strong assumption is that the smaller the difference on the pretest, the less is the likelihood of strong initial selection biases on that pretest operating,” but they cautioned that other unmeasured variables that exist at the time of the pretest may influence the outcome (p. 136). The target population for this research was public (state and local government) and private highway maintenance workers. The accessible population consisted of those workers in the greater metropolitan area of a large southern United States city.

First, a determination was made as to how many classes of 24 students per class could be held, and what days the training facilities would be available. This resulted in a total of 15 classes and provided for a maximum of 360 subjects. The researcher randomly assigned experimental or control designation to each of the 15 classes, resulting in eight experimental and seven control classes. The treatment class was approximately four hours long with the extra time used spent with participants familiarizing themselves with the IVLE technology. The control class was approximately three hours long as there was no advanced technology utilized in this course.

The same instructor was used for all classes, thus minimizing error due to presentation. To ensure that only minimal computer skills were necessary prior to the course, participants operated within the IVLE using one simple input device, similar to those commonly utilized with serious games (e.g. PlayStation 3®, Xbox®). The controller was also remarkably similar in

operation to “joysticks” that participants use when they operate heavy construction equipment, thus providing a sense of familiarity that served to minimize anxiety during the experiment. Participants had a choice of both male and female avatar options; thus allowing participants to choose the avatar with which they most closely identified. In addition, the avatar allowed the participants to perform specific flagging training tasks. To ease navigation of the avatars within the virtual world for the participant, a “first-person view” was selected as recommended by Kapp and O’Driscoll (p. 224). The participants could rotate the view through a full 360-degree range and could look up and down through a 180-degree view. This was most similar to what a person can do in the real world (and coincidentally similar to the freedom of view of a heavy equipment operator). Thus the participant could see all around him/herself, and could see precisely where they were standing.

### **Data Collection**

The data collection instruments and methods approved by the Louisiana State University Institutional Review Board were as follows:

1. Demographic Survey
2. Pre and Posttest

#### **Demographic Survey**

The demographic survey instrument, developed by the researcher, was intentionally brief, and gathered pertinent information such as age, gender, ethnicity, education level, socio-economic status, current job title, number of year working as an adult, number of years working in construction/ highway maintenance, whether or not they had previously taken a flagging course, the organization they worked for currently, and the current job title.

#### **Pretest/Posttest**

The pretest/posttest was developed by the instructional designers of the course and have

been used throughout the state for the past several years. The pretest/posttest were identical. The purpose of the pretest was to reveal pre-training baseline understanding of flagger techniques and abstract concepts. The posttest was designed evaluate learning transfer.

### **Results**

In order to ensure data quality, an exploratory and descriptive analysis was conducted to check for coding errors, outliers, missing data, data consistency, distribution of the data, and extract important variables. The levels of measurements utilized were also verified to ensure the correct measurement was constructed. A select number of cases were chosen, cases 1 – 50 and 250 – 305, during this exploratory analysis and compared to the Excel file containing the non-manipulated data. The minimum and maximum scores/values were determined in each field and compared against the possible range of values to ensure the data correctly reflected the findings.

An independent samples t-test was used to examine the pretest and posttest scores between the control and treatment group to ascertain if there was a statistical difference between the groups prior to and post treatment. An analysis of covariance (ANCOVA) was utilized to further ensure equivalence between the control and experimental groups so the researcher could confirm there were no preexisting differences between the groups despite the randomization. The pretest was the covariate in the ANCOVA. In both the independent samples t-test and ANCOVA, the significance level was set at .05.

Lastly, correlation and multiple regression were utilized in this data analysis procedure. According to Hinkle, Wiersma, and Jurs (2002), multiple regression is a statistical technique that involves predicting criterion variables (posttest score) by examining the relationships between the various predictor variables (demographic variables). The demographic variables of race, educational level, gender, and previous flagging course were recoded into dummy variables prior



to analysis. The possible correlations range from +1 to -1. A zero correlation indicates that there is no relationship between the variables. A correlation of -1 indicates a perfect negative correlation, meaning that as one variable goes up, the other goes down. A correlation of +1 indicates a perfect positive correlation, meaning that both variables move in the same direction together (Hinkle et al., 2002). Multiple regression can be defined as an extension of simple linear regression involving more than one independent variable (Hinkle et al., 2002). This technique was used to predict the value of a single dependent variable from a weighted, linear combination of independent variables. Consider multiple regression as a means of seeking the linear combination of independent variables that maximally correlate with the dependent variable (Hinkle et. al, 2002).

### **Objective One**

Demographic data for the combined treatment and control groups (n = 305) indicated that of those responding, the majority of the sample was male (88.3%). The largest ethnic group category was African-American (64.3%), the second largest category was White/Non-Hispanic (33.4%), while there were two respondents in the Other category, and one each in the American Indian/Alaskan and Asian categories. It is interesting to note that 76.0% of the overall 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 (46.6%) of age and had never attended a flagger course (77.4%). In regard to years working as an adult (18 years or older), the data showed that 27.0% had been working between 26 and 35 years, which was the largest group. As far as the number of years worked in highway or maintenance construction, 74.4% had worked 15 years or less, which denotes the largest group in the data. A significant number (87.0%) earned \$50,000 a year or less. The sample size in the IVLE group was 165 (54.0%) whereas the control group had a

sample size of 140 individuals (45.0%).

## **Objective Two**

Pretest mean score for the control group was 78.19, with standard deviation of 14.00. Pretest mean score for the experimental group was 76.10, with a standard deviation of 15.08. 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 statistically significant ( $t=1.23$ ,  $p=.22$ ). In practical terms, the computed value of “t” indicated that the groups could be treated as equivalent. Posttest mean score for control was 89.23, standard deviation of 12.76. Posttest mean score for experimental group was 85.03, standard deviation 14.97. The posttest analysis indicated statistically significant differences between the treatment and control groups ( $t = -2.59$ ,  $p=.01$ ). The pretest score was used as covariate to examine the posttest scores. An ANCOVA was utilized to further examine this data to ensure the finding was true and that preexisting differences could not account for this finding. There was a statistically significant interaction between the fixed factor and the posttest score indicating that the slopes were not parallel, and thus, the pretest scores could not be used as a covariate ( $F(1, 294) = 6.14$ ,  $p= .01$ ). Due to this finding, the forthcoming data results and analysis will focus on the treatment group only.

## **Objective Three**

Analysis of frequency distribution for categories of the variable “Age” resulted in the following four categories:

- Category One: 18 – 29
- Category Two: 30 – 45
- Category Three: 46 – 64

- Category Four: 65 and greater

Age category one contained a sample of  $n=24$ , with the posttest mean score of 91.88 and a standard deviation of 12.67. Age category two contained a sample of  $n=51$ , with a posttest mean score of 84.90 and a standard deviation of 11.98. Age category three, which contained the largest sample ( $n=73$ ), had a posttest mean score of 83.84 with a standard deviation of 16.04. Age category four contained a sample of  $n=4$ , with a posttest mean score of 87.50 and a standard deviation of 18.48. The Levene's statistic was not statistically significant. Using the Analysis of Variance (ANOVA) technique to analyze the data, results indicated no significant differences between the mean posttest scores by age groups at the .05 two-tailed level ( $F=1.965$ ,  $p=.122$ ).

In regard to analysis of the demographic variable "Gender," males comprised the largest group of the sample with  $n=136$ , while women comprised a sample of  $n=20$ . The mean score on the posttest for males was 84.96, with a standard deviation of 15.06. For females, the mean score on the posttest was 87.25, with a standard deviation of 12.29. Using the independent samples t-test technique to analyze the data, results provided no significant differences between the mean posttest scores for gender at the .05 two-tailed level, with  $p=.518$ .

Due to the small numbers of individuals in other ethnic groups ( $n=4$ ), they were placed into the category of African American for data analysis purposes. As indicated previously, the largest ethnic group, denoted as "Race" in the demographic survey, within the sample was African American ( $n=103$ ), while the White/Non-Hispanic groups comprised a sample of  $n=52$ . The mean score on the posttest for African Americans was 82.67, with a standard deviation 15.46. The White/Non-Hispanic group had a higher mean posttest score of 90.19, with a standard deviation of 11.83. Using the independent samples t-test to analyze this portion of the sample, a significant difference between the posttest scores of African Americans and

White/Non-Hispanic groups ( $t = -3.35$ ,  $p = .001$ ).

All participants were compared on the variable education. Education was captured in three categories:

- Category One: Some High School or Graduated High School or GED
- Category Two: Technical Degree or Associates Degree
- Category Three: Bachelor's Degree, Master's Degree, or Other

Education category one contained the largest sample size ( $n = 115$ ), with a posttest mean score of 84.09 and a standard deviation of 15.44. Education category two contained the next largest sample ( $n = 13$ ), with a posttest mean score of 91.54 and a standard deviation of 10.28. Lastly, education category three contained the smallest sample ( $n = 12$ ), with a posttest mean score of 91.25 and a standard deviation of 12.27. The Levene's Test of Homogeneity of Variance was not significant. Using the ANOVA technique to analyze this data, findings indicated that the F test was not significant,  $F = 2.50$ ,  $p < .086$ .

For the demographic factor "Socioeconomic Status," analysis of frequency distribution provided three categories of socioeconomic status:

- Category One: \$0 – \$24,999
- Category Two: \$25,000 – \$49,999
- Category Three: \$50,000 – Greater

Socioeconomic status category one contained a sample of  $n = 51$ , with a mean posttest score of 87.45 and a standard deviation of 13.05. Category two contained the largest sample ( $n = 72$ ) which had a mean posttest score of 84.52 and a standard deviation of 15.18. The third socioeconomic status category ( $n = 15$ ) had a mean posttest score of 91.00 and a standard deviation of 7.36. Using the ANOVA data analysis technique, there is not a significant

difference between the three socioeconomic status categories on posttest score ( $F=1.655$ ,  $p=.195$ ).

Levene's Test of Homogeneity of Variance was noted to be significant with an  $F = 4.705$  (4, 133)  $p = <.001$  for the categories of the variable "Number of Years Working as an Adult."

Welch statistical analysis for number of years working as an adult was utilized after determining unequal variances among categories of the variable,  $F = 3.311$  (4, 24.745)  $p = <.026$ . The categories of the variable are as follows:

- Category One: 0-4 years
- Category Two: 5-15 years
- Category Three: 16-25 years
- Category Four: 26-35 years
- Category Five: 36 plus years

The highest posttest mean score arose in the group of individuals working in category two ( $n=37$ ), with a posttest score of 90.54 and a standard deviation of 9.19. Category one ( $n=5$ ) participants had a mean posttest score of 72.00 with a standard deviation of 22.52. Category three ( $n=30$ ) participants presented a mean posttest score of 80.83 with a standard deviation of 16.72. Category four ( $n=43$ ) participants had a mean posttest score of 86.16 and a standard deviation 11.84. Lastly, category five ( $n=23$ ) participants had a mean posttest score of 91.08 and a standard deviation of 9.16.

The variable "Number of Years Worked in Highway Construction or Maintenance" was determined to be statistically significant in the Levene's Test of Homogeneity of Variance with  $F = 2.791$  (4, 140)  $p = <.029$ . Welch statistical analysis for the numbers of years worked in highway construction or maintenance ensued after determining unequal variances among

categories of the variable,  $F = 5.116 (4, 11.697) p = <.013$ . The categories of this variable are as follow:

- Category One: 0-4 years
- Category Two: 5-15 years
- Category Three: 16-25 years
- Category Four: 26-35 years
- Category Five: 36 plus years

The highest posttest mean score arose in the group of individuals working in category four ( $n=5$ ), with a posttest score of 97.00 and a standard deviation of 4.47. Category one ( $n=48$ ) participants had a mean posttest score of 87.71 with a standard deviation of 12.76. Category two ( $n=57$ ) participants presented a mean posttest score of 87.02 with a standard deviation of 11.83. Category three ( $n=32$ ) participants had a mean posttest score of 82.19 and a standard deviation 16.79. Lastly, category five ( $n=3$ ) participants had a mean posttest score of 80.00 and a standard deviation of 20.00.

The final demographic factor analyzed, “Previous Flagger Course,” yielded statistically significant results in the independent samples t-test ( $t=3.097, p=.003$ ). The largest group in the sample ( $n=118$ ) had not attended a previous flagger course while 36 individuals noted they had attended a previous flagger course. For those individuals that had not taken a previous flagger course, the posttest mean was 83.98 with a standard deviation of 15.65. Individuals that had taken a previous flagger course achieved a higher posttest mean of 90.42 with a standard deviation of 8.97.

#### **Objective Four**

In determining the effect size regarding the correlation coefficients, findings were interpreted

using Davis' (1971) scale:

- Correlation Coefficient of .70 or higher indicates a very strong association
- Correlation Coefficient of .50-.69 indicates a considerable association
- Correlation Coefficient of .30-.49 indicates a moderate association
- Correlation Coefficient of .10-.29 indicates a low association
- Correlation Coefficient of .01-.09 indicates a negligible association

The correlations were calculated between selected variables and the participants' posttest mean score. A negative low association existed ( $r = -.224$ ,  $p = .007$ ) between the participants' education level (some high school or high school/GED) and the participants' posttest mean score. A positive low association existed ( $r = .113$ ,  $p = .111$ ) between the participants' education level (technical or associates degree) and the participants' posttest mean score. A positive negligible association existed ( $r = .029$ ,  $p = .379$ ) between the participants' gender and posttest score. A negative low association existed ( $r = -.112$ ,  $p = .113$ ) between participants' years working as an adult (18 years or older) and posttest score. A negative negligible association existed ( $r = -.045$ ,  $p = .312$ ) between the participants' years working in highway maintenance or construction and participants' posttest score. A negative low association existed ( $r = -.124$ ,  $p = .089$ ) between participants' previous flagging course attendance and the posttest mean score.

### **Objective Five**

The data were checked for normality, linearity, outliers, and homoscedasticity prior to fitting the regression model. Descriptive statistics are the following page, which are presented in Table 1.

Table 1 Descriptive Statistics

	Mean	Std. Deviation	N
Posttest score	87.9412	11.22595	119
Some high school and high school or GED	.7983	.40295	119
Technical or Associates Degree	.1092	.31326	119
Sex	1.13	.343	119
Age	42.23	12.242	119
Yrs. Wk. Adult	22.66	12.232	119
Yrs. Wk. Hwy/Mt. Constr.	9.433	8.0720	119
Pr. Flagging Crs.	1.75	.436	119

In running the multiple regression using the Stepwise model, the results indicated one variable that entered into the regression model, shown in Table 2:

- Education (Some High School and High School or GED)

Table 2 Variables Entered/Removed<sup>a</sup>

Model	Variables Entered	Variables Removed	Method
1	Some high school and high school or GED		Stepwise (Criteria: Probability-of-F-to-enter $\leq .050$ , Probability-of-F-to-remove $\geq .100$ ).

a. Dependent Variable: posttest score

In addition, Table 3 indicates the multiple regression model summary for the one predicted models. The linear regression model was fit to the data and the results are presented in Table 3. Standardized residuals were plotted against predicted values and showed no significant departures from homoscedasticity. Furthermore, the residuals were normally distributed. The Pearson correlation was computed across the variables of:

- Education
- Gender
- Age



- Years Working in Construction/Highway Maintenance
- Whether or Not Participants Had Previously Taken a Flagging Procedures Course

In Model 1, the  $R^2$  value predicts a 5.0 percent change in the criterion variable from the predictor variables. The Adjusted  $R^2$  value provides how well the model generalizes, and the difference between the  $R^2$  value and the Adjusted  $R^2$  value is 0.008.

Table 3 Model Summary<sup>b</sup>

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.224 <sup>a</sup>	.050	.042	10.98809	.050	6.164	1	117	.014	1.805

a. Predictors: (Constant), Some high school and high school or GED

b. Dependent Variable: posttest score

Table 4 indicates that for each predicted model there is a statistically significant F,  $F=6.164$   $p=.014$ . The data in Table 4 improves our ability to predict the criterion variable based upon the predictor variables that entered as significant into the regression models above.

Table 4 ANOVA<sup>b</sup>

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	744.229	1	744.229	6.164	.014 <sup>a</sup>
	Residual	14126.360	117	120.738		
	Total	14870.588	118			

a. Predictors: (Constant), Some high school and high school or GED

b. Dependent Variable: posttest score

The data in Table 5 indicates model was statistically significant at the .05 level. The B values, the slope, provide information about the relationship between the criterion variable (posttest score) and the predictor variables that were identified as significant in the regression. The relationship between education level and posttest score is negative. These values for the

slope tell us how Y will increase or decrease with each one-unit change in X. The significance values also indicate that these values are making a significant contribution to the predicted models. The standardized B values indicate the number of standard deviations that the criterion variable will change as a result of one standard deviation change in the predictor variable(s).

Table 5 Coefficients<sup>a</sup>

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations		Collinearity Statistics		
	B	Std. Error	Beta			LB <sup>b</sup>	UB <sup>c</sup>	Zero-order	Partial	Part	Tol <sup>d</sup>	VIF
1 (Constant)	92.917	2.243		41.426	.000	88.475	97.359					
Some high school and high school or GED	-6.232	2.510	-.224	-2.483	.014	-11.204	-1.261	-.224	-.224	-.224	1.00	1.00

a. Dependent Variable: posttest score

b. LB = Lower Bound

c. UB = Upper Bound

d. Tolerance

### **Discussion and Conclusions**

This research adds to the body of literature that demonstrates there is no difference between face-to-face instruction versus technology-led instruction in the classroom, more specifically with the marginalized population. The demographics for the accessible population contained primarily African Americans, and this study's sample mirrored the accessible population. A significant amount of learning occurred across all ethnicities. Individuals who previously attended a course on flagging procedures scored significantly higher on the posttest than those individuals that had no prior opportunity to attend a flagging procedures course. Assessment of the learning indicates that individuals, despite demographic differences, were capable of learning within an IVLE. Those individuals with some high school or high

school/GED scored approximately six points below those individuals with higher education levels. For future studies similar to this one, it will be critical for the control group to be executed in the same time frame as the experimental group. The researcher was unable to locate any previous empirical literature that utilized this given population of marginalized adult learners, with the assumptions of limited computer skills and limited education. 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 (IVLE) provided the resources for increasing the knowledge transfer of the material for the learners in the course.

Efforts must be made to increase the use of the IVLE technology in learning environments where real-life simulation is key to the success of learning abstract concepts. This likely will require a shift in organizational culture regarding how certain populations are taught, but it is clear that individuals of varying levels of education and background can succeed in this type of learning environment. Future research should explore the integration of IVLE technology in the classroom with marginalized learners as this type of “active experimentation” can aid in the encoding of certain concepts that are more easily recalled when necessary (Kolb, 1984). As stated by Kotrlik and Redmann (2009), “Technology education research should explore factors that may impact individual or collective learning in a technology supported learning environment” (p. 9). Educators must begin to integrate meaningful technology into the classroom to assist learners in developing the necessary skills for success in both the learning environment but also learning transfer initiatives (Kotrlik & Redmann, 2009).

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. 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.

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## **CHAPTER 6.**

### **A MEASURE OF PRECISION REGARDING PROCEDURAL TASKS OF NON-TRADITIONAL, ADULT LEARNERS IN AN IMMERSIVE VIRTUAL LEARNING ENVIRONMENT**

#### **Introduction**

Immersive Virtual Learning Environments (IVLEs) are extensively used in training, but as indicated by Rose, Attree, Brooks, Parslow, and Penn (2000), few rigorous scientific investigations regarding the transfer of learning have been conducted. Measurement of learning transfer through evaluative methods is key for determining the likelihood of equivalent performance post-training intervention (Rose et al., 2000). Sowndararajan, Wang, and Bowman (2008) stated that, “Research has shown that immersive virtual environments (VEs) are beneficial for training motor activities and spatial activities, but it is unclear whether immersive VEs are beneficial for purely mental activities, such as memorizing a procedure” (p. 1). More important than the IVLE technology is the element of” higher critical thinking that IVLEs can provide to learners” (Gerber & Scott, 2010, p. 1). Gerber and Scott (2010) stated, “Fostering critical thinking is fundamental to the mission of formal education, including higher education” (p. 1). IVLEs are often implemented through the use of game-based technology, which is argued to “hold the promise for fostering critical thinking skills and other 21<sup>st</sup> century skills” (Gerber & Scott, 2010, p. 1).

#### **Immersive Virtual Learning Environment**

The role of a highway flagman is one that involves high order problem solving and decision making skills due to variables such as weather conditions, traffic complexity, multifaceted geographic settings, and multiple lane intersections impact a flagman’s final decision as to construction and/or maintenance work zone design and implementation (Louisiana Department of Transportation and Development, 2010). For this reason, it is critical for flaggers

to receive highly transferable training so they can perform to the best of their ability. The safety of both the traveling public and fellow work zone employees hinges upon the flagger's understanding and utilization of the information presented in construction and/or maintenance work zone training courses. Training for construction and maintenance work zone flaggers is generally conducted away from a work zone in a traditional classroom setting (Louisiana Department of Transportation and Development, 2010). During many of these training sessions, handouts, slide shows, and lectures encompass the vast majority of the training material. Within the flagging courses, the participants are encouraged to stand up and provide examples or manually indicate the proper procedure for a certain activity; however, not every participant will take part in such activities nor will all feel comfortable participating (Louisiana Department of Transportation and Development, 2010).

Primarily, IVLE training research has been focused on the traditional learners, such as college students or highly educated professionals (Whisker et al., 2003). Marginalized groups, such as those with low literacy rates and below average educational attainment, have been largely ignored within the field of IVLE research (Coco, Machtmes, Cavin, & Ndinguri, nd). Among the reasons for such an omission exists questions of how to deliver effective training to these groups as well as how to measure achievement and retention of material before and after training. Additionally, apprehension in regards to training such marginalized groups may arise from fear that training efforts may be met with anxiety from educators, which may result in ineffective instruction. Therein, the problem lies in how to appeal to these groups of workers so they find the training environment less frustrating and threatening. Through the removal of the barriers that confined groups from learning in the past, training and development can break new ground and appeal to a more diverse audience. One way to accomplish such an undertaking is to

incorporate interactive virtual training environments into the instructional classrooms so that workers can learn by experience instead of simply through traditional lecture and test taking-based instruction (Kapp & O'Driscoll, 2010).

Through the use of IVLEs, it is now possible for the training community to deliver realistic instruction to workers in a more hands-on, highly transferable setting, especially to those considered in the marginalized population (Bellotti, Berta, De Gloria, & Primavera, 2010). Broady, Chan, and Caputi (2010) highlighted that there is a stereotypical view that older adults are technologically deficient. As defined by Broady et al. (2010), individuals that took part in the research chronicled below can be categorized as the “older population.” In addition, Broady et al. (2010) presented an argument by Eisma et al. (2004) which posited that older individuals would be more willing to be more involved with technology based on the premise they were provided with the reasoning behind the benefits of the proposed technology. Arguably, this finding by Eisma et al. (2004) is critical in guiding research focused on diverse populations in dispelling the myth that some populations are not successful in technology-based training.

Blunt (2007) stated, “Over the past 25 years, games have evolved from black-and-white blips made by hobbyists into a complex multi-billion dollar industry. Over the past five years, interactive digital entertainment — computer and video games, has made significant strides in developing immersive worlds, interactive stories, massively multiplayer on-line communities, while tackling a broader range of themes and human experience” (p. 2). With advances in video game and other simulated virtual environment technology, this type of hands-on training has become more accessible than ever before (Dede, 2000). Meliza, Goldberg, and Lampton (2007) stated, “The introduction of game-based training has expanded the scope of virtual training and made it more widely available because of the games relatively low cost” (p. 1). Through the use

of technology such as immersive virtual environments, similar to those found in SecondLife® and World of Warcraft®, training participants can take an active role in their learning. “Users must be enabled to perform every relevant action they would in the real world in the simulated environment” (Blumel & Jenewin, 2005 as cited within Blumel & Haase, 2010, p. 2). This type of technology gives participants a chance to make mistakes and gain a better understanding of the work environment without any threat of bodily harm or negative repercussions or judgments about their performance (Hummel et al., 2010).

As argued above, IVLE technology adds considerable value to the learning experience; however, measuring the learning that is occurring in the IVLE is indispensable to research. Through the use of gaming telemetry and precision monitoring technology, it is now possible for the training community to better understand not only what subject matters the participants are learning but also the manner in which they are learning to apply the information to real-life scenarios (Dede, 2000).

### **Purpose and Objectives**

The purpose of this research was to examine the transfer of knowledge to real-world situations while participants were engaged in an IVLE. The IVLE was used to teach basic flagging techniques and abstract concepts as they related to construction or maintenance highway work zones. The study addressed the following objectives:

1. To describe selected demographic characteristics of adult learners in the experimental group on the following criteria: age, gender, ethnicity, education level, socio-economic status, number of year working as an adult, number of years working in construction/ highway maintenance, and whether or not they had previously taken a flagging course.

2. To determine the precision of participants while in the IVLE through the use of telemetry data.
3. To examine the differences in the participants' pre-telemetry measurements to the post-telemetry measurements.

### **Methods**

The Louisiana Department of Transportation and Development sponsored a quasi-experimental research study regarding the use of IVLE technology during the “Basic Flagging Procedures” course. Through randomization procedures, participants were assigned to either the control or experimental group. Over the course of two months, seven control (n=140) and eight experimental (n=165) classes took place. All classes were delivered by the same instructor, which allowed for the instruction to remain consistent. Participants within the control group received traditional classroom instruction which did not involve the use of computers or virtual environments. The experimental groups' training was also primarily focused on the use of IVLE technology as it related to instructional concepts; however, learners assigned to the experimental classes also had instructor-led training. For the control group, the assessments used to measure knowledge and learning transfer were an equivalent pretest and posttest. While these same measures were utilized within the experimental group, additional information regarding how they performed within the IVLE was also collected through a database that tracked 1/10<sup>th</sup> of each second of movement within the IVLE and answer choices.

During the experimental group classes, participants first received a tutorial regarding operation of the gaming controller, which was the device used during the class to manipulate avatar movement, see Figure 3. The controllers used for IVLE training were standard gaming controllers commonly used in other gaming system technology (e.g. Playstation ®). Learners

also received instruction on how to orient themselves within the virtual environment using controller joysticks to direct both the avatar's body and head orientation within the IVLE. The game controllers were also equipped with buttons used for selecting an item or position the participants' avatar within the virtual environment. As defined by Bailenson, Blascovich, Beall, and Noveck (2006), an avatar is a representation of a person in a virtual environment. The avatar in the IVLE allowed the participants to execute the procedural tasks that are utilized in a highway construction or maintenance work zone. Additionally, the environment provided within the IVLE consisted of well defined, sharp images that were easy for participants to view and manipulate, see Figures 4, 5, and 6. After the brief introduction to the IVLE, each participant was asked to select an avatar of their choice to represent themselves within the virtual training environment. There were three male and three female avatars from which each participant could choose. Participants were encouraged to select an avatar, see Figure 2, with whom they identified in order to heighten their connection with the avatar and subsequent training/learning transfer within the IVLE.



Figure 2. Depiction female and male avatar in the IVLE

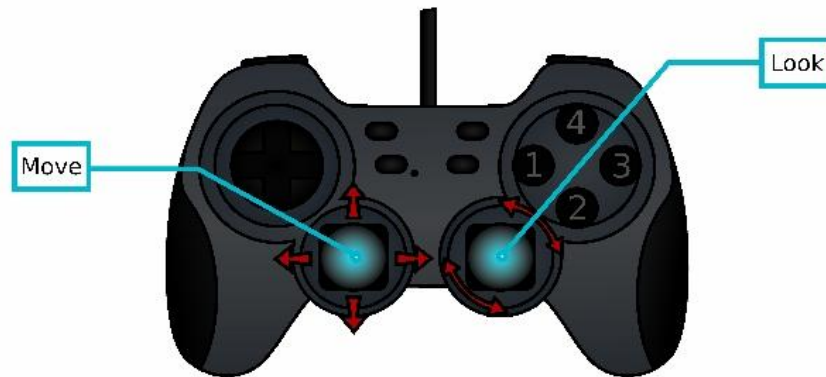


Figure 3. Game controller used by participants in the IVLE

Within each experimental group, class participants received traditional, face-to-face lecture from the instructor before watching a simulated representation of an avatar performing a certain task or set of tasks within the IVLE. After viewing these scenes, the participants were asked to use the controllers and avatars to perform the same highway safety procedures. Activities within the IVLE training course ranged from selecting the correct attire for a highway construction or maintenance flagger to positioning the avatar flagger at the correct location along various work zone configurations.

The IVLE was set up to have various training scenes that required participants to complete a task, such as placing their avatar in the correct location for properly directing traffic through a highway construction or maintenance zone. The participants were informed of what task to complete, at which point they would begin manipulating their controllers and moving their avatar to the correct position. In order to ascertain if the participants placed their avatar in the correct location, the architects of the IVLE, under direction of the researcher, had developed a predetermined mathematical grid, which represented the correct placement of the avatar for each task. In the repeated levels, the mathematical grid was narrower, which required more precision from the participants regarding placement of the respective flagger(s). In the

context of this research, a level is defined as the overarching scene in which the participants were required to perform specific tasks. The levels are explained below:

- Level 28: Served as a pretest measurement with the task requiring the participants to position a single flagger at the correct location while demonstrating the correct traffic signals with their arms.
- Level 50: Served as the posttest for Level 28 requiring the participants to complete the same tasks.
- Level 34: Served as a pretest measurement with the task requiring participants to place a single flagger in a short duration and low speed work zone.
- Level 51: Served as the posttest measurement for Level 34 requiring the participants to complete the same task.
- Level 35: Served as a pretest measurement with the task requiring participants to place three flaggers in the correct locations in a sight-obstructed work zone.
- Level 52: Served as the posttest measurement for Level 35 requiring participants to complete the same tasks.
- Level 36: Served as a pretest measurement that required participants to place two flaggers in a long duration and high-speed work zone.
- Level 53: Served as a posttest measurement for Level 36 which required participants to complete the same tasks.

Each participant would move their avatar to the place they perceived to represent the correct placement for their avatar; they would then select the denoted button to determine if they were in the correct location or not. After pushing the selection button on the game controller, a



comment statement would appear that informed the participant if they were in the correct spot or not.

Participants could move in any direction throughout the IVLE before using their controller to denote that they were choosing a spot within the environment as their desired position. Each experimental group participant completed the same levels and tasks within each level; however, activity within the IVLE was done at separate computer terminals and independently from other group members. All movement within the IVLE was monitored along with each position selection. When a participant made an incorrect position selection, they were notified of the incorrect selection and directed to continue placing the avatar within the simulated environment until the correct location or action was chosen. Once a correct selection was made, the participants would then finish that activity or scene and advance to a blank screen until their fellow classmates completed that scene.



Figure 4. Flagger in the IVLE displaying the appropriate stop position at the beginning of the work zone cone taper



Figure 5. Third person point of view of a work zone with two flaggers



Figure 6. Flagger in the curve of a work zone

### **Data Collection**

Running in the background of each participant computer terminal was a sophisticated data collecting and tracking system that assessed the avatar flaggers' movements every  $1/10^{\text{th}}$  of a second. This software ran unobtrusively retrieving raw data regarding participant movement within each of the interactive IVLE scenes. In order for the instructor to track participants' progress in each interactive IVLE scene, a dashboard ran on his computer monitor providing him with feedback regarding when each participant completed each level in order to aid him in gauging the appropriate amount of time spent in each level. From the time an interactive portion of the training began until the participants each passed that level, the tracking program measured both the time and precision of the participants' movements within the IVLE. While time was

measured, the researchers were also highly concerned with the precision of avatar flagger placement within the IVLE. In terms of this research, precision is defined as the degree of refinement with which an operation is performed or a measurement stated (Merriam-Webster, 2008). If a participant moved directly from point A to point B, his movement within the IVLE was considered highly accurate. If a participant moved from point A down the road toward point C only to turn and move back toward, eventually reaching, point B, then his movement within the IVLE was considered less accurate. Tichon (2007), stated “Event based training in VR allows novices to be trained to recognize all relevant cues and thereby increases the likelihood of their being able to also head off a problem before it develops. Presenting real-world problems in VR provides a means whereby trainees can gain experience coping with complex operations” (p. 287).

Additionally, telemetry information was used not only to track right and wrong answers, but also to assess how close to the desired target within the IVLE all of the “correct” responses were. While correct answers were all accepted and passed to the next level, some answers were considered more correct or closer to desired location than others. “Predetermining the link between final performance measures and training events in the construction phase of VTEs (virtual training environments) results in performance assessment which is constant across trainees and therefore supports cross comparison of results” (Tichons, 2007, p. 287).

Demographic data were collected through a researcher-created instrument and administered at the start of the class to each participant for completion. All demographic surveys were coded with participant student numbers to ensure confidentiality.

## **Results**

Although there were a multitude of levels within the IVLE, the levels analyzed consisted

of those levels which were repeated by each participant. The levels, which were repeated, were those levels that contained interactive scenarios through which the participants would evaluate the work zone situation and then place the flagger(s) in the correct location based on the environmental scenario.

### **Objective One**

Demographic data for the combined experimental group (n = 165) indicated that of those responding, the majority of the sample was male (86.1%). The largest ethnic group category was African-American (64.8%); the second largest category was White/Non-Hispanic (31.5%), while there was one respondent each in the Other and American Indian/Alaskan categories. It is interesting to note that 76.8% of the overall sample had a high school diploma, GED, or less, and that the largest group of individuals was between the ages of 46 to 64 years (50.0%) of age and had never attended a flagger course (76.3%). In regards to years working as an adult (18 years or older), the data showed that 31.3% had been working between 26 and 35 years, which was the largest group. Regarding the number of years worked in highway or maintenance construction, 72.0% had worked 15 years or less, which contains the largest group in the data. A significant number of participants (88.8%) earned \$50,000 a year or less.

### **Objective Two**

Level 28 was repeated as Level 50 which required the participants to place a single flagger in the appropriate location in the work zone and then select the appropriate hand signal for the oncoming traffic. Level 34 was repeated as Level 51 which required participants to place a single flagger in a short duration and low-speed work zone. Level 35 was repeated as Level 52 which prompted the participants to place multiple flaggers in the correct locations within the work zone. The scenario(s) did not indicate to the participants what the correct number of

flaggers was to be, but they were prompted to place multiple flaggers and were asked the number of flaggers they believed were necessary in the scenario. Levels 35 and 52 required the participants to place three flaggers in the appropriate location within a site-obstructed work zone. The last comparison levels were Level 36 which was compared to Level 53. Levels 36 and 53 required the participants to place two flaggers in the long duration and high-speed work zone, with the same prompts for placements as in Levels 35 and 52.

A distance integral was calculated for each participant on Levels 28/50, 34/51, 35/52, and 36/53. This distance integral tracked the placement of each participants' avatar as they moved to their desired target for correct flagger placement. Due to extreme skewness in the data and in order to reduce the impact of outliers in the data, a nonlinear transformation using a base 10 logarithm was utilized (Warner, 2008). Warren (2008) stated, "This type of data transformation can bring outlier values at the high end of a distribution closer to the mean" (p. 155). After the nonlinear transformation was utilized, a paired samples t-test was implemented for data analysis.

The distance integral mean for Level 28 was 2516.51, with standard deviation of 3487.33. The distance integral mean for Level 50 was 2643.70, with a standard deviation of 4769.73. The paired samples correlation for Levels 28 and 50 were highly correlated ( $r=.476$ ,  $p=<.001$ ); however, the paired samples t-test for Levels 28 and 50 was not statistically significant ( $t=-.350$ ,  $p=.727$ ). The distance integral mean for Level 34 was 1433.36, with standard deviation of 1944.63. The distance integral mean for Level 51 was 1559.95, with a standard deviation of 3658.04. The paired samples correlation for Levels 34 and 51 were highly correlated ( $r=.215$ ,  $p=.010$ ); however, the paired samples t-test for Levels 34 and 51 was not statistically significant ( $t=-.403$ ,  $p=.688$ ). The distance integral mean for Level 35 was 5074.17, with standard deviation of 4443.47. The distance integral mean for Level 52 was 3478.45, with a

standard deviation of 4912.24. The paired samples correlation for Levels 35 and 52 were highly correlated ( $r=.334$ ,  $p < .001$ ); additionally, the paired samples t-test for Levels 35 and 52 was statistically significant ( $t= 3.217$ ,  $p=.002$ ). Lastly, the distance integral mean for Level 36 was 3142.33, with standard deviation of 2716.69. The distance integral mean for Level 53 was 2327.23, with a standard deviation of 2400.39. The paired samples correlation for Levels 36 and 53 were highly correlated ( $r=.277$ ,  $p=.004$ ); also, the paired samples t-test for Levels 36 and 53 was statistically significant ( $t=2.744$ ,  $p=.007$ ).

### **Discussion and Conclusions**

The participants in this research study were individuals who represented a marginalized population. A majority of these participants had either a high school degree/GED or less. All of the participants, even with limited educational attainment, were able to complete all levels of the training in the IVLE. The telemetry data displayed significant skewness regarding the distance integral.

The participants' distance integral mean scores did not decrease between Levels 28/50 or between Levels 34/51. Though the increases in their mean scores were not large between the repeating levels (the repeated levels simulated a pre/posttest), the standard deviations did get larger for each of the repeated levels. Data from Levels 35/52 and Levels 36/53 showed a decrease in the distance integral mean from Level 35 to Level 52 and from Level 36 to Level 53, with a statistically significant change. These findings indicated that participants were able to transfer their learning to the real world environmental scenario. The skewness of the data appeared to be a function of the fact that some of the participants did not complete their tasks right away in each scenario. The distance integral continued to increase at a constant value regardless of the fact the avatar was unmoving in the scenario.

In conclusion, this research demonstrates that an IVLE can be successful in delivering training to a marginalized population. Computer skills are not necessary for successful training in an IVLE environment as game controllers can be used and these controllers mimic the systems used to operate heavy equipment, which was utilized in daily work tasks within the accessible population. Due to the fact that each participant had an individual computer for this training, they were able to fully participate in the training without fear of judgment by others participants in the training while the application of their learning could be captured. In normal training events, only one or two individuals generally opts to participate in table top work zone scenarios while other participants watch. Thus, the trainer is unable to measure whether or not each individual can apply his or her knowledge. This training allowed the participants to practice placement of flaggers in the construction or maintenance work zone locations without any the risks they would normally encounter in the real world due to the traveling public, dangerous weather conditions, obstructed lines of sight, or machinery. The final conclusion for this study might be that since this population had a positive experience with a training event in an IVLE they are likely were more apt to be open to additional training through this type of instructional delivery system.

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## **CHAPTER 7.**

### **SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS**

#### **Summary**

##### **Purpose**

This study sought to answer the question: Is an Immersive Virtual Learning Environment (IVLE) a more effective method for delivering the procedural content in the “Basic Flagging Procedures” course to aid in the imprinting of the concepts presented regarding maintenance and construction work zones?

##### **Independent and Dependent Variables**

The independent variables in this study were: whether or not the students participated in the traditional or immersive virtual learning environment Basic Flagging Procedures course; education level; years working in highway construction; age; race; and gender. The dependent variables will be: success rate on posttest and precision within the IVLE.

##### **Objectives**

The objectives for this research study were as follows:

1. To describe the adult learners that attended the Basic Flagging Procedures course in the southern region of the United States on the following demographic characteristics
  - a) Race
  - b) Gender
  - c) Age
  - d) Highest educational level completed
  - e) Years worked as an adult (18 years old and older)

- f) Years worked in highway maintenance or construction
  - g) Previous flagger course taken or not
  - h) Type of organization
  - i) Current job title
  - j) Total income in previous year.
2. To compare the traditional course delivery method to the IVLE course delivery method based on pre and posttest scores
  3. To determine the precision of participants while in the IVLE through the use of telemetry data
  4. To examine the differences in the pre-telemetry measurements to the post-telemetry measurements
  5. To determine if a model exists which would explain a significant portion of variance in overall scale score.

## **Methods**

### **Population and Sample**

The target population for this research is public (state and local government) and private highway maintenance workers. The accessible population consisted of those workers in the greater metropolitan area of a large southern United States city.

### **Research Implementation**

First, a determination was made as to how many classes of 24 students per class could be held and what days the training facilities would be available. This resulted in a total of 15 classes and would provide a training opportunity for a maximum of 360 subjects. The researcher randomly assigned experimental or control designation to each of the 15 classes, resulting in

eight experimental and seven control classes. This random assignment of the groups to the levels of the treatment was completed through the flip of a coin. Only the researcher knew class designation (i.e. experimental or control), thus participants would not know if they were attending an experimental or control class prior to the start of the class.

Consequently, participants' only prior knowledge was that they were attending a flagger safety course. Training managers from public and private organizations in the region were briefed ahead of time that the Basic Flagger Course was being offered, and they were told that some classes would supplement the existing instruction with the new training technology and that others would not. The training managers were assured both classes (control and experimental) would meet the training need, the objectives identified in the course, and that the overall quality of either type of class would not suffer. In addition, they were asked not to discuss the different delivery methods with class participants. The training managers were provided a schedule of the classes and asked to appoint students to the classes on a first-come, first-serve basis. The researcher confirmed attendance with the training managers, and then sent a reminder of the schedule approximately 72 hours prior to the class.

The lecture was presented by the same individual for all classes, thus minimizing error due to presentation. The computer skills needed by the participants were minimal; participants operated within the IVLE using one simple input device, similar to those commonly utilized with serious games (e.g. PlayStation 3®, Xbox®). Participants saw themselves as avatars in the IVLE and were able to move their avatars to perform specific flagging training tasks. A robust tracking system was embedded in the software to track the spatial (x-y-z coordinates) and temporal movement of the avatar of each participant. A highly precise and redundant telegraphy data storage system (both hardware and protocol) was developed to allow easy retrieval of the

working data for subsequent statistical analysis use by the researchers only. Development of the protocols took place early in the design phase and considered data integrity as well as report generation requirements.

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 precision 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 asked to volunteer to take part in an interview ( $n = 32$ ). Review of the data indicated an extremely positive reaction to the IVLE by the subjects. All empirical data were subjected to the appropriate statistical tests, including measures of central tendency about the mean.

## **Findings**

### **Qualitative Findings**

These data from this pilot study did indicate that the adult learners perceived that they benefited more from being engaged in their learning during the experimental class than from traditional classrooms. For a majority of the participants, this was the first time they had attended a flagging training and felt that because they actually got to place the avatars in the simulations they would be able to transfer this knowledge to the workplace much better than if they had just read a training book. Participants noted that the simulations did heighten their concern for their

safety, as well as the traveling public's safety, and left them feeling as though they needed to pay more attention to their flagging and the rules and regulations of construction and maintenance work zones.

The concern that was expressed throughout this project that individuals with limited education and computer skills could not learn in this environment was unfounded. Regardless of age or education level or familiarity with computers, each individual was able to complete the training after spending some time becoming familiar with the technology utilized in the experimental group. Concerns regarding simulation on computers can be put to rest if the program developers use game controllers instead of keyboards. This simple change opens up simulation training to a whole new population and allows for active learning which is critical for knowledge transfer and usability.

### **Quantitative Findings**

This research added to the body of literature that demonstrates there is no difference between face-to-face instruction versus technology-led instruction in the classroom, more specifically with the marginalized population. The demographics for the accessible population contained primarily African Americans, and this study's sample mirrored the accessible population. A significant amount of learning occurred across all ethnicities. Individuals who previously attended a course on flagging procedures scored significantly higher on the posttest than those individuals that had no prior opportunity to attend a flagging procedures course. Assessment of the learning indicated that individuals, despite demographic differences, were capable of learning within an IVLE. Those individuals with some high school or high school/GED will score approximately six points below those individuals than individuals with higher education levels. For future studies similar to this one, it will be critical for the control

group to be executed in the same time frame as the experimental group. The researcher was unable to locate any previous empirical literature that utilized this given population of marginalized adult learners, with the assumptions of limited computer skills and limited education. 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 (IVLE) provided the resources for increasing the knowledge transfer of the material for the learners in the course.

Efforts must be made to increase the use of the IVLE technology in learning environments where real-life simulation is key to the success of learning abstract concepts. This likely will require a shift in organizational culture regarding how certain populations are taught, but it is clear that individuals of varying levels of education and background can succeed in this type of learning environment. Future research should explore the integration of IVLE technology in the classroom with marginalized learners as this type of “active experimentation” can aid in the encoding of certain concepts that are more easily recalled when necessary (Kolb, 1984). As stated by Kotrlik and Redmann (2009), “Technology education research should explore factors that may impact individual or collective learning in a technology supported learning environment” (p. 9). Educators must begin to integrate meaningful technology into the classroom to assist learners in developing the necessary skills for success in both the learning environment but also learning transfer initiatives (Kotrlik & Redmann, 2009).

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. 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.

The participants in this research study were individuals who represented a marginalized population. A majority of these participants had either a high school degree/GED or less. All of the participants, even with limited educational attainment, were able to complete all levels of the training in the IVLE. The telemetry data displayed significant skewness regarding the distance integral.

The participants' distance integral mean scores did not decrease between Levels 28/50 or between Levels 34/51. Though the increases in their mean scores were not large between the repeating levels (the repeated levels simulated a pre/posttest), the standard deviations did get larger for each of the repeated levels. Data from Levels 35/52 and Levels 36/53 showed a decrease in the distance integral mean from Level 35 to Level 52 and from Level 36 to Level 53, with a statistically significant change. These findings indicate that participants were able to transfer their learning to the real world environmental scenario. The skewness of the data appeared to be a function of the fact that some of the participants did not complete their tasks right away in each scenario. The distance integral continued to increase at a constant value regardless of the fact the avatar was unmoving in the scenario.

In conclusion, this research demonstrated that an IVLE can be successful in delivering training to a marginalized population. Computer skills are not necessary for successful training in an IVLE environment as game controllers can be used and these controllers mimic the systems used to operate heavy equipment, which was utilized in daily work tasks within the accessible population. Due to the fact that each participant had an individual computer for this training, they were able to fully participate in the training without fear of judgment by others participants



in the training while the application of their learning could be captured. In normal training events, only one or two individuals generally opts to participate in table top work zone scenarios while other participants watch. Thus, the trainer is unable to measure whether or not each individual can apply his or her knowledge. This training allowed the participants to practice placement of flaggers in the construction or maintenance work zone locations without any of the risks they would normally encounter in the real world due to the traveling public, dangerous weather conditions, obstructed lines of sight, or machinery. The final conclusion for this study might be that since this population had a positive experience with a training event in an IVLE they likely were more apt to be open to additional training through this type of instructional delivery system.

### **Conclusions and Recommendations**

Although research into technology, specifically IVLEs, has occurred in various disciplines, this research focused on the marginalized population which until this research occurred had been excluded from empirical research. The current body of literature provided a theoretical foundation in reference to critical benefits that can be garnered through the use of IVLE technology in the classroom. The purpose of this research was to answer the question: Is an Immersive Virtual Learning Environment (IVLE) a more effective method for delivering the procedural content in the “Basic Flagging Procedures” course to aid in the imprinting of the concepts presented regarding maintenance and construction work zones? This question has been addressed through various data analysis techniques, both through quantitative and qualitative methods.

#### **Conclusion 1**

Based on the findings of this study, the researcher concluded that participants who took

part in the experimental group displayed progressive improvement in the application of the flagging procedures while in the IVLE, as denoted in the IVLE telemetry data. Learners in the marginalized population can benefit from the experiential learning that occurs while in the IVLE as it fosters the necessary application of principles, rules, and regulations that are associated with flagger duties in construction or maintenance work zones.

## **Conclusion 2**

The researcher also concluded that participants who participated in the experimental class were more engaged in the learning process than they had been in traditional style classes, as denoted in the qualitative interviews. Such engagement in the classroom is critical not only for learning transfer but for application of the principles when returning to the work site (Bangert-Drowns & Pyke, 2001). Blascovich, Loomis, Beall, Swinth, Hoyt, and Bailenson (2002) provided that IVLEs hold the promise to increase the actual presence and could hold the key to obscuring the distinction between face-to-face and “electronically mediated social interaction” (p. 111). Persky, Kaphingst, McCall, Lachance, Beall, and Blascovich (2009) defined presence as, “[P]resence is understood as perceiving as reality the VE as opposed to the physical environment encompassing the VE” (p.263). Arguably, Kapp and O’Driscoll (2010), Witmer and Singer (1998), and Blascovich et al. (2002) each asserted that presence is a critical element for a student in order for engagement in the IVLE to not only occur but to effectively occur. The findings of the qualitative portion of this research not only supported the assertions of these researchers but confirmed that those individuals within the marginalized population are as equally as engaged through the use of technology as other learning populations.

## **Conclusion 3**

From the findings in this study, the researcher concluded that despite the lack of literature

relating to research of the marginalized population within an IVLE, this population can be and was successful through this type of educational intervention as demonstrated by the results of the distance integrals in the telemetry data. One can make various assumptions as to why this population has yet to be studied in regards to IVLE technology in the classroom; however, those assumptions are not nearly as critical as the fact that the marginalized population can succeed and learn through this type of instructional technology. Components of a successful program for the marginalized population include:

- Ensure that the IVLE contains a variety of engaging experiential learning activities that foster the encoding of the principles for the participants (Kolb, 1984).
- Encourage feedback regarding the realism of the IVLE in relation to the actual work environment (Kapp & O'Driscoll, 2010).
- Foster a healthy desire for problem solving and decision making for the learners since mistakes within the IVLE can aid in the ultimate understanding of the critical principles (Ellaway, 2005).
- Create an inclusive learning environment that removes any potential boundaries of apprehension for the learners as many individuals are intimidated by the classroom in general, which could be increased through the use of technology (Kapp & O'Driscoll, 2010).

### **Future Program Recommendations**

As with any research, there are lessons gained by taking part in the various stages of conducting an experiment of any type. Some of the critical recommendations from this research, as it relates to a marginalized population, are as follows:

- Ensure the content for the chosen course is extremely specific. In order to transform a traditional style course into an IVLE, minutia is paramount for IVLE architects. Such levels of specificity also aid instructional designers in integrating and IVLE into a traditional classroom environment.
- Assessment instruments should be designed to address the information delivered in the course content and written in a manner which is utilized audience appropriate language.
- Utilize a team of subject matter experts to aid in the refinement of the IVLE.
- Institute a minimum of five pilot testing sessions for the IVLE with the panel of subject matter experts, instructional designers, IVLE architects, and a selection of individuals that are representative of the accessible population.
- Document all processes throughout the progression of the project to allow for information to be readily accessible at any point.
- Gain buy-in from all stakeholders that will be impacted by the implementation of an IVLE in an educational environment.
- Develop a community of practice to engage in scholarly discussions regarding research progress, as well as aiding in staying abreast of the newly published research in the area of study.

### **Future Research**

The further development of research into utilizing IVLE instructional technology with the marginalized population is critical to the refinement of future programs with this population.

Areas of future research include, but are not limited, to the following:

- Determine the ideal level of immersion while utilizing IVLE technology in the classroom with the marginalized population. Does an ideal level of immersion exist within the IVLE that will reduce participants' cognitive load while increasing learning transfer and allowing the learners to encode the necessary cues and clues for application in the work environment?
- Compare participant success in the IVLE based upon level of immersion. Does participant success in the IVLE depend upon the level of immersion?
- Include the pre and posttests in the IVLE and eliminate the traditional paper tests, and compare the results of those individuals that took the IVLE tests to those that took the traditional paper tests. Are those individuals that take the pre and posttests in the IVLE more successful than those individuals that take the traditional paper tests?
- Expand research to include surrounding states that have varying demographics and compare the results of those individuals' success rate in the IVLE based on select demographic characteristics. Does success in the IVLE differ in surrounding states based upon the varying demographics?

While IVLE instructional technology is widely used and highly accepted in the fields of K-12, the United States Military, the medical community, and collegiate environments, this type of instructional technology has not been utilized for instruction with the marginalized population. This type of technology is cost feasible and positively impacts the engagement of learners, as well as positively impacting the knowledge transfer to real-life scenarios. IVLE technology is as successful as face-to-face instruction with the marginalized population and quite possibly will aid in the long-transfer of knowledge for participants versus short-transfer of knowledge.

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## APPENDIX 1

### CHARACTERISTICS OF SEVEN LEVELS OF TAXONOMY OF STUDENT ENGAGEMENT

Bangert – Drowns & Pyke, 2001

<b>Taxonomy Level</b>	<b>Type of Engagement</b>	<b>Quality of Learning</b>	<b>Descriptive Indicators</b>
7	Literate Thinking	Integrating new knowledge with person values and beliefs	Students reflect on the meaning of the software's navigational, operational, or content structure. This reflection requires the students to access their prior knowledge, experience, personal beliefs, values, and feelings. At this level, the students can entertain alternative interpretations of the content and use these understandings to reflect on personal experience.
6	Critical Engagement	Self-initiated and systematic knowledge-building	Students create their own goals to test the limitations and possibilities of the software and their understanding of the content. The students manipulate the software features and try to alter the functionalities to better their experience achieve their objectives. This suggests that the students are engaged in critical thinking.
5	Self-Regulated Interest	Developing software and content expertise in areas of interest	Students achieve a heightened state of personal interest and excitement. According to Csikszentmihalyi (1991) and as stated in Kondratt and Sulz (2001), this is a state of flow, which is characterized as intense concentration and excitement. At this flow state, students find it enjoyed and become absorbed in their activities (Kondratt & Sulz, 2001).
4	Structure-Dependent Engagement	Developing schema for content comprehension	Students exhibit competence and compliance with the software demand characteristics. They are able to orderly explore the range of software options and perform tasks in a routine and competent manner. However, students don't engage in nonroutine or exploratory tasks. Lee and Anderson (1993) terms this as cognitive engagement.
3	Frustrated	Developing schema for	Students possess clear goals when working with the software

	Engagement	software use	but are unsuccessful in completing them. The students understand that the software enables the goals they are after. However, due to the lack of navigational and operational competence, the students are unable to use the software effectively. Lim and Chai (2004) term this the loss of task – orientation.
2	Unsystematic Engagement	Acquiring disconnected facts about software and content	Students seem confused or “lost.” They possess unclear goals when working with the software. They move from one incomplete activity to another without any apparent reason.
1	Disengagement	None	Students stop working with the software or maintain disinterested random activity as a cover for mental and emotional withdrawal. In the most extreme case, students will avoid the computer itself.



## APPENDIX 2

### BASIC FLAGGING PROCEDURES DEMOGRAPHIC INFORMATION

Please provide the following information:

1. What is your race? (Please select all that apply)

- ☐ White (non-Hispanic)
- ☐ Black or African American
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ American Indian or Alaskan Native
- ☐ Hispanic or Latino
- ☐ Asian
- ☐ Other: \_\_\_\_\_

2. What is your sex?                      ☐ Male                      ☐ Female

3. What was your age on your last birthday? \_\_\_\_\_

4. What is the highest level of education you have achieved?

- ☐ Some High School
- ☐ High School or GED
- ☐ Technical Degree
- ☐ Associates Degree
- ☐ Bachelor's Degree
- ☐ Master's Degree
- ☐ Other (specify): \_\_\_\_\_

5. How many years have you worked as an adult (18 years old & older)? \_\_\_\_\_

6. How many years have you worked in highway maintenance or highway construction? \_\_\_\_\_

7. Have you previously taken a flagger course?                      ☐ Yes                      ☐ No

8. What kind of organization do you work for?

- ☐ Federal
- ☐ City or Parish

- State
- Private Company

9. What is your current job title? \_\_\_\_\_

10. What was **your** total income last year (this is not your combined household income):

- \$0 — \$24,999
- \$25,000 — \$49,999
- \$50,000 — \$99,999
- \$100,000 — \$149,999
- \$150,000 — \$199,999
- \$200,000 & Higher

### APPENDIX 3

#### BASIC FLAGGING PROCEDURES DEMOGRAPHIC INFORMATION CODING DOCUMENT

Please provide the following information:

1. What is your race? (Please select all that apply)

- |   |  |
|---|--|
| <b>1</b> – <input type="checkbox"/> White (non-Hispanic)                      | <b>5</b> – <input type="checkbox"/> Hispanic or Latino |
| <b>2</b> – <input type="checkbox"/> Black or African American                 | <b>6</b> – <input type="checkbox"/> Asian              |
| <b>3</b> – <input type="checkbox"/> Native Hawaiian or Other Pacific Islander | <b>7</b> – <input type="checkbox"/> Other: _____       |
| <b>4</b> – <input type="checkbox"/> American Indian or Alaskan Native         |  |

2. What is your sex?                      **1** – ☐ Male                      **2** – ☐ Female

3. What was your age on your last birthday? \_\_\_\_\_

- 1** – 18 to 29
- 2** – 30 to 45
- 3** – 46 to 64
- 4** – 65 Plus

4. What is the highest level of education you have achieved?

- |  |  |
|--|--|
| <b>1</b> – <input type="checkbox"/> Some High School       | <b>1</b> – <input type="checkbox"/> High School or GED |
| <b>2</b> – <input type="checkbox"/> Technical Degree       | <b>2</b> – <input type="checkbox"/> Associates Degree  |
| <b>3</b> – <input type="checkbox"/> Bachelor's Degree      | <b>3</b> – <input type="checkbox"/> Master's Degree    |
| <b>3</b> – <input type="checkbox"/> Other (specify): _____ |  |

5. How many years have you worked as an adult (18 years old & older)? \_\_\_\_\_

- 1** – 0 to 4 years
- 2** – 5 to 15 years
- 3** – 16 to 25 years
- 4** – 26 to 35 years
- 5** – 36 Plus

6. How many years have you worked in highway maintenance or highway construction? \_\_\_\_\_

- 1** – 0 to 4 years

- 2 – 5 to 15 years**
- 3 – 16 to 25 years**
- 4 – 26 to 35 years**
- 5 – 36 Plus**

7. Have you previously taken a flagger course?      **1** – ☐ Yes                      **2** – ☐ No

8. What kind of organization do you work for?

- |  |  |
|--|--|
| <b>1</b> – <input type="radio"/> Federal | <b>3</b> – <input type="radio"/> City or Parish  |
| <b>2</b> – <input type="radio"/> State   | <b>4</b> – <input type="radio"/> Private Company |

9. What is your current job title? \_\_\_\_\_

10. What was **your** total income last year (this is not your combined household income):

- 1** – ☐ \$0 — \$24,999
- 2** – ☐ \$25,000 — \$49,999
- 3** – ☐ \$50,000 — \$99,999
- 4** – ☐ \$100,000 — \$149,999
- 5** – ☐ \$150,000 — \$199,999
- 6** – ☐ \$200,000 & Higher

## APPENDIX 4

### BASIC FLAGGING PROCEDURES PRETEST EXAMINATION BOOKLET

#### INSTRUCTIONS

1. DO NOT MARK IN THIS TEST BOOKLET.

***For DOTD Employees:*** Write your name, date, ISIS number, gang, and district / section number on the answer sheet only. Return this test booklet with your answer sheet to the instructor/facilitator upon completion.

***For Non – DOTD Employees:*** Write your name, date, and agency name on the answer sheet only. Return this test booklet with your answer sheet to the instructor/facilitator upon completion.

2. Each question has only **ONE** answer.
3. Place your answer to each question on the answer sheet provided.
4. Maximum time allowed for this examination is 4 hours.

## **PRETEST BASIC FLAGGING PROCEDURES**

(ETRN No. M 4001 D)

CHOOSE THE CORRECT ANSWER. Each question has only **ONE** answer:

1. The primary hand-signaling device used by DOTD is the:
  - a. Yellow paddle
  - b. Yellow flag
  - c. Red flag
  - d. STOP/SLOW sign paddle
  
2. When flagging, you should:
  - a. Stand behind the work truck
  - b. Stand in the shade
  - c. Stand where you are highly visible
  
3. When flagging you should:
  - a. Stand in the lane of oncoming traffic
  - b. Stand with your body parallel to the traffic lane so you can move your head freely in both directions
  - c. Stand with your back to oncoming traffic
  
4. Flag use should be limited to:
  - a. Emergency situations
  - b. Short duration locations which can best be controlled by a single flagger
  - c. Distances over 300 feet
  - d. Both a and b
  
5. If the flagger is facing traffic in a stationary position, with the flag extended horizontally across the traffic lane, he or she intends to:
  - a. Slow traffic
  - b. Stop traffic
  - c. Motion to proceed
  - d. Alert traffic

6. When stopping traffic with the flag extended across the traffic lane, you should also \_\_\_\_\_, for greater emphasis.
- a. Raise your free arm with the palm toward approaching traffic
  - b. Wave the flag
  - c. Use the paddle
7. You are facing the traffic with the flag and arm lowered from view of the driver. If you motion with the free arm, the traffic should:
- a. Stop
  - b. Proceed
  - c. Slow to a stop
8. How would you stop traffic with the sign paddle?
- a. You will face traffic and turn the STOP face toward traffic with the paddle close to the body.
  - b. You will face traffic and turn the STOP face toward traffic with your arm extended and the free arm raised for emphasis.
  - c. You will face traffic and turn the SLOW face toward traffic and your free arm raised for emphasis.
9. You are facing traffic, extending the flag out to the side at shoulder level. You slowly bring the flag arm down parallel to your leg so that you are waving the flag in a sweeping motion, down and up. What are you telling traffic?
- a. Slow down
  - b. Stop
  - c. Speed up
10. How would you motion traffic to proceed using the sign paddle?
- a. Turn the STOP face toward traffic and motion with the free hand
  - b. Turn the SLOW face toward traffic with arm extended and raise your free hand
  - c. Turn the SLOW face toward traffic, arm extended horizontally away from the body and use your free hand to motion traffic ahead.

11. You are standing with the SLOW side of the sign paddle facing traffic. You are telling traffic to:
- a. Continue at normal speed
  - b. Slow down
  - c. Stop
12. Who is responsible for positioning the flagger in the correct location?
- a. District or traffic operations engineer
  - b. Foreman
  - c. District maintenance engineer
13. When in a work zone, you must not:
- a. Engage in conversations with co-workers while on duty
  - b. Use a flag and sign paddle at the same time
  - c. Use a red flag under normal conditions
  - d. All of the above
14. Where does a single flagger stand?
- a. On the shoulder, opposite and at the midway point of the work site
  - b. At the beginning of the cone taper
  - c. On the shoulder 100 feet past the work site
15. In a work site, a single flagger:
- a. Must remain at the same position through the duration of the work day
  - b. Can move along with work site as necessary
  - c. Can move along the work site only with the approval of the highway foreman / supervisor
16. When two flaggers are used, the flagger in the barricaded lane at the start of the lane closure is known as the \_\_\_\_\_.
- a. Lead flagger
  - b. Second flagger



17. The second flagger stands on the shoulder of the \_\_\_\_\_ traffic lane.
- a. Open
  - b. Barricaded
18. The second flagger stands approximately \_\_\_\_\_ feet beyond the work site.
- a. 50
  - b. 100
  - c. 200
19. When two flaggers are necessary, the lead flagger should:
- a. Not worry about seeing the second flagger
  - b. Be able to see the second flagger
  - c. Two flaggers won't ever be necessary
20. If you are the second flagger, you should:
- a. Stand with your shoulders and back to the open traffic lane
  - b. Turn your entire body to face on-coming traffic
  - c. Stand with your shoulders parallel to the traffic lane in order to be able to look in both directions as needed

**PRETEST**

**ANSWER SHEET**

**BASIC FLAGGING PROCEDURES  
ETRN NO. M 4001 D**

**DOTD Employees:**

Full Name \_\_\_\_\_ Date \_\_\_\_\_

ISIS \_\_\_\_\_ Gang \_\_\_\_\_

District/Section \_\_\_\_\_ Grade \_\_\_\_\_

**Non - DOTD Employees:**

Full Name \_\_\_\_\_ Date \_\_\_\_\_

Agency Name \_\_\_\_\_ Grade \_\_\_\_\_

Write the letter corresponding to the correct multiple choice answer in the examination booklet.

1. \_\_\_\_\_

11. \_\_\_\_\_

2. \_\_\_\_\_

12. \_\_\_\_\_

3. \_\_\_\_\_

13. \_\_\_\_\_

4. \_\_\_\_\_

14. \_\_\_\_\_

5. \_\_\_\_\_

15. \_\_\_\_\_

6. \_\_\_\_\_

16. \_\_\_\_\_

7. \_\_\_\_\_

17. \_\_\_\_\_

8. \_\_\_\_\_

18. \_\_\_\_\_

9. \_\_\_\_\_

19. \_\_\_\_\_

10. \_\_\_\_\_

20. \_\_\_\_\_

## **PRETEST**

### **ANSWER KEY**

#### **BASIC FLAGGING PROCEDURES**

##### **ETRN No. M 4001 D**

1. D (Slide 33)
2. C (Slide 11)
3. B (Slide 50)
4. D (slide 62)
5. B (Slide 64)
6. A (Slide66)
7. B (Slide 67)
8. B (Slide 48)
9. A (Slide 69)
10. C (Slide 53)
11. B (Slide 56)
12. B (Slide 17)
13. D (Slide 105, 35, 33)
14. A (Slide 75)
15. B (Slide 75)
16. A (Slide 83)
17. A (Slide 86)
18. B (Slide 86)
19. B (Slide 80)
20. C (Slide 89)

**APPENDIX 5**  
**BASIC FLAGGING PROCEDURES POSTTEST**  
**EXAMINATION BOOKLET**

**INSTRUCTIONS**

1. DO NOT MARK IN THIS TEST BOOKLET.

***For DOTD Employees:*** Write your name, date, ISIS number, gang, and district / section number on the answer sheet only. Return this test booklet with your answer sheet to the instructor/facilitator upon completion.

***For Non – DOTD Employees:*** Write your name, date, and agency name on the answer sheet only. Return this test booklet with your answer sheet to the instructor/facilitator upon completion.

2. Each question has only **ONE** answer.
3. Place your answer to each question on the answer sheet provided.
4. Maximum time allowed for this examination is 4 hours.

## **POSTTEST BASIC FLAGGING PROCEDURES**

(ETRN No. M 4001 D)

CHOOSE THE CORRECT ANSWER. Each question has only **ONE** answer:

1. How would you motion traffic to proceed using the sign paddle?
  - a. Turn the STOP face toward traffic and motion with the free hand
  - b. Turn the SLOW face toward traffic with arm extended and raise your free hand
  - c. Turn the SLOW face toward traffic, arm extended horizontally away from the body and use your free hand to motion traffic ahead.
  
2. You are facing the traffic with the flag and arm lowered from view of the driver. If you motion with the free arm, the traffic should:
  - a. Stop
  - b. Proceed
  - c. Slow to a stop
  
3. When two flaggers are used, the flagger in the barricaded lane at the start of the lane closure is known as the \_\_\_\_\_.
  - a. Lead flagger
  - b. Second flagger
  
4. You are facing traffic, extending the flag out to the side at shoulder level. You slowly bring the flag arm down parallel to your leg so that you are waving the flag in a sweeping motion, down and up. What are you telling traffic?
  - a. Slow down
  - b. Stop
  - c. Speed up
  
5. When flagging you should:
  - a. Stand in the lane of oncoming traffic
  - b. Stand with your body parallel to the traffic lane so you can move your head freely in both directions
  - c. Stand with your back to oncoming traffic

6. How would you stop traffic with the sign paddle?
- You will face traffic and turn the STOP face toward traffic with the paddle close to the body.
  - You will face traffic and turn the STOP face toward traffic with your arm extended and the free arm raised for emphasis.
  - You will face traffic and turn the SLOW face toward traffic and your free arm raised for emphasis.
7. Flag use should be limited to:
- Emergency situations
  - Short duration locations which can best be controlled by a single flagger
  - Distances over 300 feet
  - Both a and b
8. The primary hand-signaling device used by DOTD is the:
- Yellow paddle
  - Yellow flag
  - Red flag
  - STOP/SLOW sign paddle
9. When stopping traffic with the flag extended across the traffic lane, you should also \_\_\_\_\_, for greater emphasis.
- Raise your free arm with the palm toward approaching traffic
  - Wave the flag
  - Use the paddle
10. You are standing with the SLOW side of the sign paddle facing traffic. You are telling traffic to:
- Continue at normal speed
  - Slow down
  - Stop
11. If you are the second flagger, you should:
- Stand with your shoulders and back to the open traffic lane
  - Turn your entire body to face on-coming traffic

- c. Stand with your shoulders parallel to the traffic lane in order to be able to look in both directions as needed
12. Who is responsible for positioning the flagger in the correct location?
- a. District or traffic operations engineer
  - b. Foreman
  - c. District maintenance engineer
13. The second flagger stands approximately \_\_\_\_\_ feet beyond the work site.
- a. 50
  - b. 100
  - c. 200
14. When in a work zone, you must not:
- a. Engage in conversations with co-workers while on duty
  - b. Use a flag and sign paddle at the same time
  - c. Use a red flag under normal conditions
  - d. All of the above
15. If the flagger is facing traffic in a stationary position, with the flag extended horizontally across the traffic lane, he or she intends to:
- a. Slow traffic
  - b. Stop traffic
  - c. Motion to proceed
  - d. Alert traffic
16. Where does a single flagger stand?
- a. On the shoulder, opposite and at the midway point of the work site
  - b. At the beginning of the cone taper
  - c. On the shoulder 100 feet past the work site
17. When flagging, you should:
- a. Stand behind the work truck
  - b. Stand in the shade

- c. Stand where you are highly visible
18. When two flaggers are necessary, the lead flagger should:
- a. Not worry about seeing the second flagger
  - b. Be able to see the second flagger
  - c. Two flaggers won't ever be necessary
19. In a work site, a single flagger:
- a. Must remain at the same position through the duration of the work day
  - b. Can move along with work site as necessary
  - c. Can move along the work site only with the approval of the highway foreman / supervisor
20. The second flagger stands on the shoulder of the \_\_\_\_\_ traffic lane.
- a. Open
  - b. Barricaded



**POSTTEST**  
**ANSWER SHEET**

**BASIC FLAGGING PROCEDURES**  
**ETRN NO. M 4001 D**

**DOTD Employees:**

Full Name \_\_\_\_\_ Date \_\_\_\_\_  
ISIS \_\_\_\_\_ Gang \_\_\_\_\_  
District/Section \_\_\_\_\_ Grade \_\_\_\_\_

**Non - DOTD Employees:**

Full Name \_\_\_\_\_ Date \_\_\_\_\_  
Agency Name \_\_\_\_\_ Grade \_\_\_\_\_

Write the letter corresponding to the correct multiple choice answer in the examination booklet.

- |           |           |
|-----------|-----------|
| 1. _____  | 11. _____ |
| 2. _____  | 12. _____ |
| 3. _____  | 13. _____ |
| 4. _____  | 14. _____ |
| 5. _____  | 15. _____ |
| 6. _____  | 16. _____ |
| 7. _____  | 17. _____ |
| 8. _____  | 18. _____ |
| 9. _____  | 19. _____ |
| 10. _____ | 20. _____ |

## **POSTTEST**

### **ANSWER KEY**

#### **BASIC FLAGGING PROCEDURES**

##### **ETRN No. M 4001 D**

1. C (Slide 53)
2. B (Slide 67)
3. A (Slide 83)
4. A (Slide 69)
5. B (Slide 50)
6. B (Slide 48)
7. D (slide 62)
8. D (Slide 33)
9. A (Slide66)
10. B (Slide 56)
11. C (Slide 89)
12. B (Slide 17)
13. B (Slide 86)
14. D (Slide 105, 35, 33)
15. B (Slide 64)
16. A (Slide 75)
17. C (Slide 11)
18. B (Slide 80)
19. B (Slide 75)
20. A (Slide 86)

## **APPENDIX 6**

### **IVLE RESEARCH STUDY QUALITATIVE QUESTIONS**

1. Each student participant in this program should be at LTRC prior to the start of the training class so that they may meet with either Mary Leah or Glynn or Jenn.
2. You will be allowed into the computer room prior to the flaggers.
3. You should be observing them as they walk into the classroom – observe their behavior when walking into the classroom (you will be observing them in general so it is not important as to whether you have a name – just group watching)
  - a. Observe at them to see if they have any type of technology devices attached to them such as cell phones or beepers.
  - b. Do they stay in the class or turn around and back out
  - c. Do they start talking to each other and say – hey I cannot use a computer or any other negative technology talk
4. Dr. Cavin will start the class and give the introduction to the flaggers. He will be soliciting interview participants at this time.
  - a. Student participants will stay in the class until after the flaggers have completed their free play on the computers
  - b. Free play is when the participants get to try out the game controllers and learn how to move their avatar around on the computer
  - c. After you leave the classroom – Mary Leah or Jenn or Glynn will direct you into an observation room where you will be able to observe the class during the training.
  - d. During this observation time you will be given a sheet that will identify each computer station by a number and thus you may record your observation by noting which computer each person is sitting at during the class training

5. Following the completion of the class – each student will be assigned to a flagger who is volunteering to participate in the interview – you will be given a quiet place to interview.

### **Interviewing the Flagger Participant**

1. Introduce yourself and make sure the participant is comfortable.
2. Remind them that you are interviewing in order to get information concerning the IVLE training they just completed. No information obtained during this interview will be shared with their supervisors.
3. Remind them that they may stop the interview at any time and ASK them if you may tape record their responses to your questions.
4. Start the tape and introduce yourself on tape and ask the flagger participants if you may record them while the tape is running
  - a. Ask them to introduce themselves with their first name only on the tape.
  - b. Proceed to ask the interview questions – probe if something seems interesting
  - c. Keep the interview to 30 minutes if possible
  - d. After the interview is complete thank the participant and turn off the recorder and go and find Mary Leah

### **Questions for the Flagger Participants**

Explain to the Flagger participant that the training they just participated in was a simulation – meaning it should have been similar to the work they do as flaggers.

Give each person enough time to think through the questions and answer them – do not rush them. Ask additional questions just not these questions – probe their answers

1. How long have you been a flagger – ask additional questions about their training if you want to here – this is breaking the ice?
2. How did you like the simulation?
3. How did the game controller work – was it difficult – had they used one before – had they ever played computer games before this training?
4. Did you choose an Avatar that looked like you – did the avatar's look life like
5. Were the simulation situations similar to your actual work experience? If not why not – if yes – what did they like about it – any particular scenes?
6. How did this training compare to other flagger training you have attended before – did it help with understanding the materials?
7. Are you better prepared to be a flagger after this training exercise?
8. How could we improve the simulation – any and all suggestions
9. How could we improve this training?
10. Would you recommend this training session to a co-worker

## APPENDIX 7

### NATIONAL INSTITUTES OF HEALTH CERTIFICATION



## APPENDIX 8

### I/ITSEC PERMISSION LETTER

**From:** Barbara McDaniel [mailto:bmcdaniel@NDIA.ORG]  
**Sent:** Monday, January 31, 2011 8:43 AM  
**To:** MaryLeah Coco  
**Subject:** RE: Fw: Letter of Permission (UNCLASSIFIED)

Good Morning, Mary Leah,

Your letter of request was forwarded to me. We are most pleased to grant your permission to include your I/ITSEC paper as part of your dissertation. Is this your 2010 paper, or one you intend to submit for 2011?

If using a paper from 2010 or prior, please proceed with the stipulation that we receive a copy of the portion of the document that references I/ITSEC.

**Barbara McDaniel | Director, Conferences and Programs**  
**National Training and Simulation Association (NTSA) | I/ITSEC Coordinator**  
**2111 Wilson Boulevard Suite 400 | Arlington, VA 22201**  
**Office: 703.247.2569 | Cell: 703.447.4239 | FAX: 703.243.1659**

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**I/ITSEC Website: <http://www.iitsec.org>**  
**I/ITSEC 2011: Nov 28-Dec 1**  
**I/ITSEC 2012: Dec 3-6**  
**I/ITSEC 2013: Dec 2-5**  
**I/ITSEC 2014: Nov 17-20 (NOTE CHANGE IN PATTERN TO PRE-THANKSGIVING IN 2014)**  
**I/ITSEC 2015: Nov 30-Dec 3**

-----Original Message-----

**From:** MaryLeah Coco [mailto:MaryLeah.Coco@LA.GOV]  
**Sent:** Tuesday, January 25, 2011 4:11 PM  
**To:** Gritton, Kent  
**Subject:** Letter of Permission

Kent,

Good afternoon. I hope all is well for you. I am sure you are gearing up for the upcoming submissions for I/ITSEC 2011. I am writing in the hopes you can assist me with a minor endeavor. The I/ITSEC paper is going to be included within my dissertation as one of my chapters, but I need a letter from I/ITSEC granting me permission to include it within my document. Would it be possible for you to assist me with this or guide me in the appropriate direction? Thank you so much.

Mary Leah Caillier Coco, M.S.  
LTRC/TTEC  
Training & Development Program Staff Manager  
4099 Gourrier Avenue  
Baton Rouge, LA 70808  
Phone: 225-767-9167



## **VITA**

Mary Leah Caillier Coco was born in Zachary, Louisiana, on March 30, 1980 to Mary Leah Cooper Moore and Donald Mitchell Caillier. She is a 1998 graduate of Parkview Baptist School. In 2002, she earned a Bachelor of Arts degree from Louisiana State University, and in 2005 she earned a Master of Science from Louisiana State University. Mary Leah is the truly blessed mother of Annie Claire Coco and wife of Jeremy Joseph Coco. She is also the proud step-daughter of Betsy Jones Caillier and Larry Landry Moore as well as the older sister of Mary Katherine Moore. Mary Leah is honored to be the Godmother of Colin David Puig and aunt of Claire Elizabeth Puig. She was awarded the degree of Doctor of Philosophy in the Louisiana State University Spring 2011 Commencement Ceremony.