Exploration Of The Impact Of Affective Variables On Human Performance In A Live Simulation

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EXPLORATION OF THE IMPACT OF AFFECTIVE VARIABLES ON HUMAN PERFORMANCE IN A LIVE SIMULATION

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Modeling and Simulation in the College of Engineering and Computer Science at the University of Central Florida Orlando, Florida

Summer Term 2013

Major Professors: J. Peter Kineaid
Valerie Sims
ABSTRACT

Live simulations play an important role in allowing users to practice and develop skills they learn in training. Although live simulations are playing an increasingly important role in training, ways to improve them are not well understood or documented. In order to improve the efficacy of live simulation and maximize results from funds spent on training; this research examines the relationship between the affective variables of the participants and their performance in the live simulation.

Prior to participating in the instructor development live simulation used in this study two training preference scales were administered to a group of trainees. These scales measured the trainees’ locus of control and immersion tendencies. During the live simulation the trainees’ performance was evaluated by a panel of expert observers. The trainees also self-reported their performance through the use of a self-rating instrument. Analysis of the data revealed significant positive correlations between the trainees’ internal locus of control and their performance in the simulation, both self-reported ($p=0.026$) and as reported by the expert observers ($p=0.033$). The correlation between immersion tendency scores and performance in the live simulation were mixed; while not always statistically significant they did reveal some slight positive correlation.

This research did provide a number of lessons learned and implications for instructional and simulation developers wishing to employ live simulation in a training environment. These include performance of sub-populations within the greater population of subjects, consideration of roles assigned to participants, and the need to increase presence within the live simulation. Application of these lessons learned can reduce training costs and/or improve the effectiveness of live simulation in a training environment, this in turn can be of significant benefit to instructional and simulation designers. Additionally, understanding these relationships can lead
to better assignments of roles or activities within live simulation and improve the transfer of experience from live simulation training to on the job performance.

However, additional research needs to be conducted in order to make more conclusive statements regarding the most appropriate affective variable that would allow for predicting transfer of the simulated experience to the ‘real’ world, the individuals who would benefit most from live simulation, and to develop additional prescriptive methods for improving live simulation utilized in training environments.
“The doorstep to the temple of wisdom is a knowledge of our own ignorance.”

Benjamin Franklin
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In closing, I would like to acknowledge my father who inspired and encouraged me to question the way things work … and then look for the answers.
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<th>Description</th>
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<tbody>
<tr>
<td>ABD</td>
<td>All but Dissertation</td>
</tr>
<tr>
<td>ATP</td>
<td>Airline Transport Pilot</td>
</tr>
<tr>
<td>CBT</td>
<td>Computer-based Training</td>
</tr>
<tr>
<td>CFII</td>
<td>Certificated Flight Instructor Instrument</td>
</tr>
<tr>
<td>CPT</td>
<td>Certified Performance Technologist</td>
</tr>
<tr>
<td>DV</td>
<td>Dependent Variable</td>
</tr>
<tr>
<td>ELO</td>
<td>Enabling Learning Objective</td>
</tr>
<tr>
<td>EMT</td>
<td>Emergency Medical Technician</td>
</tr>
<tr>
<td>EPSS</td>
<td>Electronic Performance Support System</td>
</tr>
<tr>
<td>HPT</td>
<td>Human Performance Technology</td>
</tr>
<tr>
<td>IDC</td>
<td>Instructor Development Course</td>
</tr>
<tr>
<td>IMT</td>
<td>Immersive Tendency</td>
</tr>
<tr>
<td>IRR</td>
<td>Inter-rater Reliability</td>
</tr>
<tr>
<td>ISD</td>
<td>Instructional Systems Development</td>
</tr>
<tr>
<td>IV</td>
<td>Independent Variable</td>
</tr>
<tr>
<td>KSAs</td>
<td>Knowledge, Skills, and Attitudes</td>
</tr>
<tr>
<td>LCM</td>
<td>Life Cycle Maintenance</td>
</tr>
<tr>
<td>LOC</td>
<td>Locus of Control</td>
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<tr>
<td>LOFT</td>
<td>Line Oriented Flight Training</td>
</tr>
<tr>
<td>LVC</td>
<td>Live, Virtual, and Constructive Simulations</td>
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<tr>
<td>PIC</td>
<td>Pilot in Command</td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
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<tr>
<td>---------</td>
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</tr>
<tr>
<td>ROI</td>
<td>Return on Investment</td>
</tr>
<tr>
<td>SME</td>
<td>Subject Matter Expert</td>
</tr>
<tr>
<td>TLO</td>
<td>Terminal Learning Objective</td>
</tr>
<tr>
<td>VE</td>
<td>Virtual Environment</td>
</tr>
<tr>
<td>WBT</td>
<td>Web-based Training</td>
</tr>
<tr>
<td>WLSPQ</td>
<td>Westerlund Live Simulation Presence Questionnaire</td>
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</tbody>
</table>
CHAPTER 1: INTRODUCTION

1.1 Genesis of the Research

I was the member of a helicopter aircrew that was flying into deteriorating weather. The clouds were closing in, forcing the pilot-in-command to fly increasingly close to the terrain and obstacles on the ground. I knew that based on our current airspeed and reduced visibility, if we saw an obstacle such as a tower or power line, there might not be enough time to avoid a collision. A number of years earlier I had trained this same pilot and had him fly a very similar scenario in a full-motion flight simulator. During that flight scenario the pilot performed as expected and according with his company policy and federal regulations. Therefore after this harrowing flight ended and we were safely back on the ground, I asked the pilot in command why he violated company policy and continued to fly into weather that was below minimums. His response surprised me. “Ken, that simulator scenario was just a game; this is real life.” His company had spent so much time and money to train him and it seemed as if it had made very little difference when he was actually presented with a similar ‘real life’ scenario.

Another, although fictional, live simulation scenario having real training transfer ramifications involves a simulation presented in an episode from the television series Star Trek. In this simulation a Klingon battle starship is on a path to attack and destroy the unarmed civilian starship, the Kobayashi Maru. In this simulation the student is forced to choose the lesser of two evils. To either enter the Neutral Zone in an attempt to save the Kobayashi Maru thereby violating a treaty with the Klingon’s and potentially starting a war; or to helplessly stand by while the innocent crew and passengers of the Kobayashi Maru are ‘murdered’ by the Klingons. The simulation is designed to let students practice and reinforce key leadership skills, and
provide them with additional insight into how they would react to a ‘no-win’ situation. In the fictional scenario a young James T. Kirk reprograms the simulation so he can save the Kobayashi Maru thereby forgoing any learning that was supposed to occur and not allowing his instructors to assess his reactions to no-win situations. For Kirk ‘winning’ meant changing the simulation to fit his needs, while for the pilot I flew with it was to ‘pass’ the test and not integrate the experience into his schema. On the other hand, ‘winning’ for the live simulation and/or instructional designer, and the people who fund the simulations, would be defined as practicing a particular skill(s) and the acquisition of experience.

Were these simulation scenarios wasted on both Kirk and the pilot I flew with? Are there Kirks out there that should probably not be trained through the use of simulation scenarios? Those are the questions I asked myself as this research took shape.

1.2 Introduction to the Problem

Generally simulations are classified as either: live, virtual, or constructive simulations. Live simulation can be defined as “Real people operating real systems in authentic settings” for the express purpose of gaining experience (Westerlund, Kincaid, & Westerlund, 2010). Live simulations play an important role in allowing a user to practice and develop their cognitive, motor, communication, and attitudinal skills. Examples of these live simulations include instructors conducting a mock training session, realistic flight scenarios (e.g., line oriented flight training (LOFT) missions), mass-casualty exercises, live-fire exercises, sales and customer service exercises, or an exercise requiring a mechanic to use actual automotive test equipment on a motor vehicle.
A large government organization that runs many training programs is one such consumer of live simulation. It uses live simulation in both instructor training programs (Instructor Development Course, Basic Instructor Clinic, and facilitating instructor training course) and leadership training programs (introduction to leadership training and advanced leadership training). The organization recognizes the important role live simulation plays in training programs and was willing to fund research which would document factors to improve live simulation. Due to operational considerations (political and practical) this initial research should focus on the instructor development programs with the ultimate goal of being able to generalize the results to leadership development programs.

Although these simulations are playing an increasingly important role in training; ways to improve live simulation and the factors that improve them are not well understood or well documented. This also includes the psychological factors that could improve the efficacy of live simulation.

Of particular interest are the psychological factors in the affective domain. With respect to training and live simulation; these affective variables include those “dealing with interests, attitudes, values, appreciation, and adjustment” (Krathwohl, Bloom, & Masia, 1970).

1.3 Problem Statement

This lack of understanding and documentation is a problem due to the increasing popularity of live simulations, the resources being expended on them, and the many critical tasks being trained through them. A greater understanding of the variables that can improve the effectiveness of live simulation would be a great benefit to both learners and simulation developers.
Additionally, developing measures that would help determine when live simulation is most beneficial in training or rubrics for modifying training to maximize the effectiveness of the simulation would be extremely beneficial and lead to a higher training return on investment (ROI) for organizations.

1.4 Hypothesis

It is anticipated that there will be a correlation between the subject’s affective variables and their performance in the live simulation.

The data will be examined using a regression analysis between training locus of control (LOC), immersive tendencies, and judgment of performance effectiveness by both trainee and experts to determine the exact relationship between the variables and the students’ performance in the live simulation (see Table 1 below).

<table>
<thead>
<tr>
<th>Table 1: Variables Under Examination</th>
</tr>
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<tbody>
<tr>
<td><strong>Affect</strong></td>
</tr>
<tr>
<td>Locus of control – Score measured by Training Locus of Control Scale (see APPENDIX A: TRAINING LOCUS OF CONTROL SCALE)</td>
</tr>
<tr>
<td></td>
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<tr>
<td>Immersive tendency – Score measured by Immersive Tendency Questionnaire (see APPENDIX B: TRAINING IMMERSION TENDENCIES SCALE)</td>
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</tbody>
</table>
My hypothesis is that, due to affective factors such as immersive tendencies and locus of control, live simulation will benefit some people more than others. Research currently exists which demonstrates a correlation between various psychological variables and virtual simulations (Murray, Fox, & Pettifer, 2007); however, this research examines the relationship between various psychological variables and the benefits derived from live simulation. If relationships exist then guidelines could be developed in order to identify those people that would be most suited to experience live simulation. Therefore live simulation could be targeted to the specific populations that would benefit the most. Additionally, understanding this relationship could lead to better assignments of roles or activities within live simulation which could ultimately improve the transfer of experience from live simulation training to on-the-job performance.

End goals for this research include:

• Providing actionable items to improve the effectiveness of live simulation activities used in the instructor training course and, ultimately, within all of the organization’s training programs that utilize live simulation.

• Suggesting changes in live simulation activities that would promote transfer, integration, and retention of the skills and knowledge gained during training.

This research attempts to provide some answers to the general research question: Are some affective variables predictive of trainees’ performance in a live simulation? To answer this question the research tests the following two hypotheses:

• Hypothesis 1: There is a statistically significant correlation between a learner’s locus of control and their performance in a live simulation.
• Hypothesis 2: There is a statistically significant correlation between a learner’s immersive tendency and their performance in a live simulation.

1.5 Dissertation Organization

This dissertation is organized into five chapters. Chapter 1 provides the genesis of the research, introductory material including problem statements, and objectives of this research. Chapter 2 provides a review and discussion of current literature surrounding this area of research. Included in the literature review are psychological variables that may influence performance in simulations and the various types of simulation that have been studied for correlations. Chapter 3 details the methods and materials required to conduct this research. Chapter 4 discusses the findings surrounding the dependent and independent variables under examination in this research and their correlations. Chapter 5 discusses conclusions and recommendations arising from this study, and recommendations for future research or investigation in this area.
CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

A review of the literature reveals that live simulations have become increasingly important as a training device. This is especially true for live simulations where they are used to an ever greater extent for the training of military and medical personnel. Also, research is beginning to show that some psychological factors have been positively correlated with performance in virtual (Seropian et al., 2003; Wallach et al., 2009; Witmer and Singer, 1998) and constructive simulations (DeGroot et al., 2009; McKenzie et al., 2003; Patz, 1992). However, there seems to be a void in the literature on the psychological factors that are correlated with performance in live simulations.

2.2 Use of Simulation in Training

Simulation is increasingly being used for training and, according to some researchers, the widespread use of simulations suggests they are viewed “as being valuable learning vehicles and that the use of simulation games stimulates student interest in course content (Badgett, Brenenstuhl, & Marshall, 1978).” Other researchers have found simulations to be “a powerful tool for creating more realistic, experiential learning environments and thereby helping organizations meet these emerging training challenges (Bell, Kanar, & Kozlowski, 2008).”

Ruan (2011) believes the use of simulated “assignments represent a substantial improvement over the formalistic approach” of developing lawyers. He also believes that the “simulated problems allow professors to create client-centered activities, such as client interviewing and counseling, negotiating with adverse parties, and writing advice letters.”
Another study found that simulation is “flourishing” and that live “simulation is probably the most recognized form of simulation in health care (Seropian, Brown, Gavilanes, & Driggers, 2004).” They also found that, due to the unpredictable nature of live simulation and the many ways the participants can react in the simulation, developing and conducting live simulation “requires considerably more resources and skill than other forms of simulation.”

Sogunro (2004) also found that role-playing (live simulation) is an effective training tool and has been used successfully in developing teachers. When discussing teacher training he goes on to say that when teachers “are asked to imagine and behave like another person in a particular situation, they will learn something about the person and/or situation.”

While these studies advocate the use of live simulations they offer little prescriptive advice on ways to improve them.

2.3 Affective Variables

Researchers have advocated a number of various psychological variables that may influence performance in a simulation; that “some sort of information processing and decision making measures such as those provided by the Myers-Briggs Type Indicator” (Patz, 1992) might be a good predictor of performance in a constructive simulation used in a management course. Other researchers have investigated the correlation between personality traits (assertiveness) and a hybrid constructive simulation. Borgatta (1961) found the results were not “directly interpretable” and called for more research.
However, two non-cognitive psychological variables which have been found to correlate with performance in virtual and/or constructive simulations (and may hold promise with live simulation) include:

- Locus of control, and
- Immersive tendencies

2.3.1 Locus of Control

Spector (1982) defines locus of control as: “People attribute the cause or control of events either to themselves or to the external environment.” Another recent study operationally defined locus of control as: “People with an internal locus of control (‘internals’) see themselves as active agents. They feel that they are masters of their fates, and they trust in their capacity to influence the environment. Conversely, those with an external locus of control (‘externals’) see themselves as relatively passive agents, believing that the events in their lives are due to uncontrollable forces (Boone, van Olffen, & van Witteloostuijn, 2005).” This provides a useful definition and insight as to why it may be a promising variable for correlating with performance in live simulations. It is reasonable to assume that participants with high internal locus of control would feel their actions can influence the outcome of the simulation, thereby being more engaged in the simulation and potentially performing better. Initial examination of the literature indicates that locus of control may hold promise in live simulation, as it has been shown to correlate with performance in virtual simulation (Murray et al., 2005).

Boone, van Olffen, & van Witteloostuijn (2005) also found locus of control to be “an important and well-documented personality trait that refers to individual difference in a generalized belief in internal versus external control of reinforcement.” Boone et al. also believe
that ‘internals’ have a “higher information-processing capacity,” that they are better able to collect information when in a decision-making context, and are more action-oriented than ‘externals’. Theoretically, this could provide ‘internals’ with an advantage in their live simulation performance due to greater active information collecting and processing capacity.

Spector (1982) also cites a number of studies that have linked locus of control to “learning and problem solving.” His research has found greater problem-solving skills among internals rather than externals. From his research he believes that this “would lead one to predict better performance by internals in training and in performing.” Spector goes on to say that individuals with a high level of internal control “will only display better performance if they perceive that effort will lead to valued rewards.” He also states that in “many situations, internals may hold higher performance-reward expectancies but not value the rewards.” Spector concludes that “locus of control may be an important personality variable” in helping to “explain behavior.” While his research is primarily focused on workplace behavior; locus of control appears to be an affective variable of considerable interest.

2.3.2 Correlation of Locus of Control Variables with Live Simulation

Unfortunately, literature correlating the impact of locus of control on performance in a simulation is inconclusive. Badgett, Brenenstuhl, & Marshall (1978) found that LOC and some of the other “factors which are ordinarily considered important determinants of success in a simulation game really have very little influence at all.” Additionally, they found that it could not be “used to predict performance in a simulation game.”
In researching locus of control in a constructive simulation Boone, van Olffen, & van Witteloostuijn (2005) found the results “difficult to interpret” and in a team setting found that they did not perform any better.

Brenenstuhl & Badgett’s (1977) research examined the relationship between locus of control, interpersonal trust, and the students’ academic achievement in the International Operations Simulation (INTOP) game. The researchers found locus of control was not a useful predictor and was unable to discriminate “between high and low performance on any of the multiple criterion.”

2.3.3 Locus of Control Scales

Locus of control also has some previously developed well-established scales which would be useful for measuring this variable in the research participants. One such scale by Spector is presented in APPENDIX E: WORK LOCUS OF CONTROL SCALE (Spector, 1988). Additionally, Duttweiler (1984) has developed the Internal Control Index (ICI) scale “with reasonably good psychometric properties.” The existence of an existing valid scale would help streamline this study by eliminating the need to develop and validate a new scale.

2.3.4 Immersion Tendencies

Additionally, ‘immersive tendencies’ appears to be a psychological variable that warrants further investigation. Some researchers have hypothesized those individuals with high immersion tendencies will experience a more intense learning experience and that intensity “may also impact the extent of transfer of learning.” (Cannon-Bowers & Bowers, 2008). They believe that there are a number of “individual differences” that “influence learning outcomes” and go on to
argue that it is important to consider these “individual differences” during the development of synthetic learning environments and simulations.

Witmer and Singer (1998) 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.” Their research with virtual environments (VE) and virtual simulation leads them to conclude that individuals with “a greater tendency to become involved in a variety of activities as measured by the ITQ (immersive tendencies questionnaire) would report more presence” on their presence questionnaire. Their research on presence reveals a “weak but consistent positive relation between presence and task performance in VEs (Witmer & Singer, 1998).” While their research focuses primarily on virtual simulation they believe that presence, involvement, and immersion may also occur in other media. It is possible that the more immersed a participant is in a live simulation, the more they will experience presence, and the more their performance will improve.

Another recent study found “there exists a positive correlation between human performance and the feeling of telepresence” in a virtual simulation (Pongrac, Leupold, Behrendt, Färber, & Färber, 2007). These authors also expected to find “a high relationship” with immersive tendency; however, they found the data suggested “no significant correlation between immersive tendency.”

Another study that administered the Immersive Tendencies Questionnaire to participants using a virtual simulation game as a teaching tool found that “the game simulation demonstrated potentialities as an educational tool”, but it appeared that immersive tendencies has “no gross effect on the knowledge-transfer process (Ruggeroni, 2001).” They concluded that: “A general
high level of immersion does not mean that a person will be effectively immersed in any situation but in one that is of interest to them.”

2.3.5 Immersive Tendency Scales

Witmer & Singer (1998) have developed well-validated 29 item immersive tendencies questionnaire (APPENDIX F: IMMERSIVE TENDENCY QUESTIONS).

Additionally, they have also developed a 32 item presence questionnaire which is designed to measure presence in virtual environments. For example, some of the questions include:

- “How well could you identify sounds?”
- “How distracting was the control mechanism?”
- “How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?”

2.4 Correlation of Psychological Variables With Simulation Performance

Complete literature surrounding correlation between psychological variables and performance in simulations is generally missing or inconclusive. This is especially acute with respect to correlations between affective variables and live simulation. The previous literature has found some correlations that pertain to virtual or constructive simulations; however, none of these studies examined the correlation of affective variables with performance in a live simulation.

In addition to the lack of research data surrounding affective variables that impact live simulation, a number of researchers have discussed the lack of guidance available to developers of simulations targeted for training. When discussing the lack of conclusive results with respect
to the efficacy of simulation and the variables that impact live simulation, Bell, Kanar, & Kozlowski (2008) state; “that more work is needed to fully realize the potential of training simulations, yet instructional designers are left with little guidance on how to develop an effective system because the factors that influence the effectiveness of simulation-based training remain unclear.” They also state that with respect to research on the effects of simulation in training “research in this area has provided limited insight into the factors that underlie or influence the effectiveness of simulation-based training.

2.5 Conclusions

Correlation literature between affective variables (locus of control and immersion tendencies) and performance in simulations is either missing or inconclusive. This is especially true with respect to live simulations since most of the literature pertains to virtual or constructive simulations. The focus of this research is to help reduce the void in this area of research.
CHAPTER 3: RESEARCH METHODS

3.1 Design

The study is a correlation design using regression analysis to determine the relationships between the independent variables (locus of control and immersion tendencies) and dependent variables (self- and expert-report of simulation performance).

In order to test the hypotheses under investigation, trainee performance in a live simulation conducted by a large organization as part of their instructor development program was measured using evaluation sheets specifically designed to measure changes in the following two dependent variables under examination:

- Trainees self-reporting of their performance in a live simulation. In other words, how do the trainees’ rate themselves in their ability to apply the lesson content to a live simulation?
- Expert-report of the trainee’s performance in a live simulation. In other words, how do experts rate the trainees’ mastery of the lesson content when applied to a live simulation?

The two independent variables for this research include the trainees’:

- Locus of control, as measured on a Training Locus of Control scale (APPENDIX A: TRAINING LOCUS OF CONTROL SCALE)
- Immersive tendency, as measured on a Training Immersive Tendency scale (APPENDIX B: TRAINING IMMERSION TENDENCIES SCALE)
3.2 Participants

Twenty participants (ten males and ten females), completed the live simulation exercise. Demographic data other than gender was not collected; however, the course instructors and expert observers estimated the participants ranged in age from 25 to 55 years old with a mean age of 35. All participants were currently filling instructor positions within their organization and volunteered to attend the training program. No incentives or bonuses were offered to the participants, or was their becoming a training facilitator contingent on their passing the training. None of the participants failed the training program.

3.3 Materials

3.3.1 Instructor Training Course

The training facilitator development course was a nine day in-residence course held in Orlando, Florida. The course included 42 hours of instruction and practice, and was designed to teach the participants how to perform the role of a facilitating instructor. Course topics included background on the design and development of the on-line training programs, configuration management, cooperative learning, group dynamics, techniques for monitoring groups in action, intervention strategies, setting up and maintaining trainee data in the course registration system, facilitating the training to small groups, administering and scoring the performance-based tests, and handling life cycle maintenance (LCM) updates. Between 1998 and 2011 the training facilitator course has been delivered 37 times, training over 750 individuals. The course provides participants with an opportunity to become familiar with the instructional methods required to facilitate the organization’s online computer-based training (CBT) modules, and qualifies them to teach those online modules to the organization’s employees.
3.3.2 Instructor Training Course Design

Prior to development of the instructor training course an instructional systems design (ISD) project team conducted an analysis to determine the job requirements of the new instructor position and learning required to qualify instructors as facilitating instructors. This analysis involved creating a checklist of instructor responsibilities to implement the online modules successfully. There are essentially four tasks involved with the duty of facilitating the online modules. The checklist served as an outline for the instructor’s course guide which is the primary resource for details about the role of the facilitating instructor.

Additionally, the ISD team met with field office management and stakeholders to identify their needs and perceptions of the role of the facilitating instructor. The project team created a position description from those meetings to help management identify candidates for the role.

A learning analysis was also conducted which led to the development of the course’s terminal and enabling learning objectives. The ISD team divided the content of the instructor’s course guide into four lessons covering the role of the facilitating instructor. Because cooperative learning is such an important instructional method in the design of the online CBT modules, the facilitating instructor course is also structured cooperatively to model what the participants (their students) will be experiencing when they go through the training. The course integrates a variety of delivery approaches, including facilitator-led instruction, cooperatively-structured small group activities, experiential learning, and individual performance assessment.

The cooperative learning method used is based on the work of Drs. David and Roger Johnson of the Cooperative Learning Institute at the University of Minnesota. All course facilitators have extensive background and experience in instructor-led training and are qualified through multiple certifications to teach cooperative learning. All instructor training course
facilitators are adjunct members of the Cooperative Learning Institute at the University of Minnesota.

3.3.3 Online CBT Training Modules

The organization’s online computer-based training (CBT) modules are unique in that they synthesize the latest design principles of web-based training (WBT), cooperative learning, and performance-based assessment. The instructors-in-training need to acquire both an understanding of the “look-and-feel” of the modules and an understanding of how their students will be interacting with the computer and with their cooperative learning groups in order to complete their assigned modules.

Since many of the modules were developed using cooperative learning as an instructional strategy it was determined that specially trained instructors would be required in order to facilitate the new online CBT modules to the target population of students. Key to the effectiveness of a module is the critical cooperative interactions between the students, as mentioned above. Facilitating these interactions requires the use of skilled, specially trained facilitating instructors.

3.3.4 Training Facilitating Instructors

According to the instructor’s course guide, facilitating instructors:

“...should not only have a good understanding of the “look-and-feel” of the course but also of how the trainees will be interacting with the computer and with each other to complete their assigned tasks.”

Throughout the entire training session the instructors in training are given opportunities to practice and receive feedback on their use of certain group skills designed to enhance their
performance as facilitating instructors and to help them work together more effectively during training. Among these skills are encouraging participation, checking for understanding, contributing ideas and opinions, as well as giving and receiving feedback.

In order to become a facilitating instructor, current classroom instructors attend this training course where they “develop proficiency in facilitating cooperative learning in a multimedia environment.” The course guide goes on to say that the course is designed to provide the new facilitating instructors with the information and practice they will need to develop that proficiency.

### 3.3.5 Learning Objectives of the Live Simulations

The course is designed to teach classroom instructors and senior technicians how to become cooperative learning facilitators. The three terminal learning objectives (TLO) for the course are:

- **TLO 1.0**: Define, describe, and identify the five essentials elements of cooperative learning
- **TLO 2.0**: Manage the learning environment
- **TLO 3.0**: Apply evaluation procedures

TLO 2.0 includes the four enabling learning objectives (ELOs) which support the achievement of TLO 2.0 (Table 2):
Table 2: Live Simulation Objectives

<table>
<thead>
<tr>
<th>ELO</th>
<th>Action</th>
<th>Criteria</th>
</tr>
</thead>
</table>
| **ELO 2.1: Prepare to facilitate** | You will prepare for facilitation by completing the tasks on the checklist. | The completed checklist will include the following as a minimum:  
• Identification of pre-course task requirements  
• Identification of pre-class set up requirements  
• Development of a plan for briefing trainees  
Ability to meet the requirements for performing pre-course tasks will be evaluated by the preparation partner according to their training checklist. Ability to meet the requirements for setting up and briefing will be evaluated in the following objective. |
| **ELO 2.2: Set up for training/brief trainees** | You will properly set up for training and will effectively brief the small group about the mini-lesson. | You must set up and brief the mini-lesson in accordance with the requirements for setting up and briefing on the Facilitation Assessment Form. Ability to meet the requirements will be determined through self-evaluation and through peer and facilitator observation and feedback. |
| **ELO 2.3: Manage group interaction** | You will recognize effective group management skills using appropriate observation, monitoring, and identify appropriate intervention techniques, as necessary. | You must be able to recognize and respond appropriately to trainees’ cues for task work/teamwork intervention. Ability to recognize and respond appropriately to cues will be evaluated by the peer observer and through feedback from the group. Ability to meet the overall requirements for observing, monitoring, and intervening will be determined through self-evaluation and through peer and facilitator observation and feedback. |
| **ELO 2.4: Debrief group interaction** | You will provide acting-trainees with observational data on individual participation and group interaction using notes from mini-lesson. | Your observation data must include positive feedback on individual and group strengths and identify areas in which the group might set goals for improvement. Ability to meet the requirements for debriefing group interaction will be determined through self-evaluation and through peer and facilitator observation and feedback. |

During the training for TLO 2.0 students must take part in a live simulation (role playing exercise) as both an instructor facilitating a computer-based lesson and as a trainee taking the lesson. As stated in the course guide the student’s successful mastery of TLO 2.0 will be
evaluated “through self-evaluation and through peer and facilitator observation and feedback.”

Central to the training for this TLO is the live simulation ELO during which they are to practice in as authentic setting as possible the material they learn in the classroom portion of the training. In addition to affording the students an opportunity to practice the skills they are learning, the live simulation is necessary in order to assess mastery of both the Action and Criteria parts of the ELOs. Without live simulation the students would only be able to be assessed at a lower declarative knowledge level of mastery rather than an application level (Westerlund & Kincaid, 2009).

3.3.6 Training Facilities

The training facility utilized for the live simulation was a large, approximately 20 by 40 foot, hotel conference room. This allowed the students to be broken into five cooperative learning groups. Each cooperative learning group was provided with a computer workstation that allowed the students to complete an actual portion of the online computer-based training. The groups consisted of four students: one playing the role of the facilitating instructor and three performing as students in a typical cooperative learning group. The facility was large enough for each of the five groups to conduct their live simulation simultaneously while not disturbing the other groups (Figure 1).
While participants playing the role of students (indicated by the three white chairs per group in Figure 1) progressed through the CBT, the participant playing the role of facilitating instructors (indicated by the single blue chair per group in Figure 1) monitored the students’ progress and facilitated the training session. The participants who were playing the role of facilitating instructor in the live simulation were also provided with pen and note-taking paper as well as their training materials which they could refer to as needed.

As the groups performed the live simulation three expert observers (indicated by plan view of a person in Figure 1) circulated throughout the room, as unobtrusively as possible, taking notes and scoring the participants who were playing the role of the facilitating instructor (blue chairs). Expert observers were frequently able to monitor two or more groups simultaneously.
3.3.7 Participant Materials

The course’s ISD team designed and developed the following two primary resources for the participants to use in the course: the facilitating instructor’s guide and the participant’s course notebook. The course guide provides a detailed outline of the roles and responsibilities of the facilitating instructor, pre-course tasks, course implementation tasks, evaluation procedures, and life-cycle maintenance procedures for the modules. These sections provide instructions and suggestions for setting up and managing the learning environment, administering and scoring tests, and updating the online CBT materials. Appendices to the guide include instructor tools (e.g., instructor’s checklist and evaluation procedures job aid, points of contact, security issues, the latest version of the user’s manual for the software that hosts the online training modules, and the “The Nuts and Bolts of Cooperative Learning” book.

The participant’s notebook is a binder containing the course schedule, objectives, assignments, cooperative exercise instructions, and handouts used during the instructor training course. There are also materials that supplement the activities and exercises contained within the participant’s notebook. These materials include a demonstration package of the module hosting software, mini-lesson package, evaluation scenarios, and an online module life-cycle maintenance exercise.
3.4 Procedure

3.4.1 Introduction

Figure 2 depicts the steps required to collect data used in this investigation along with the sub-tasks. It also depicts the steps required to collect data used in this investigation along with the sub-tasks.

![Diagram of the Data Collection Process]

**Figure 2: Steps in the Data Collection Process**
3.4.2 Training Style Inventories

Students attending the instructor training course completed two brief inventories to assess specific psychological variables that influence their learning styles. These brief independent variable (IV) questionnaires were administered as part of the student registration process on the first day of training. The first inventory was designed to assess their locus of control. This inventory was based upon Spector’s (1988) *Work Locus of Control Scale* (APPENDIX E: WORK LOCUS OF CONTROL SCALE) but was modified to meet the organization’s requirement to avoid the focus being on work to a more generic version of training locus of control. In other words, a more generic “life” or “training” term was substituted for the term “work” in the inventory. The inventory contained 17 six-point scaled questions with responses that ranged from “Disagree very much” to “Agree very much.”

The second inventory was a modification of the second version of the *Immersive Tendencies Questionnaire* (Witmer & Singer, 1998) (APPENDIX F: IMMERSIVE TENDENCY). This inventory was modified, at the organization’s request, to omit items they felt were inappropriate and it included questions designed to assess the participants’ immersion tendencies. This inventory contained 31 seven-point scaled questions with responses that ranged from “Never” to “Often”.

The *Training Locus of Control Inventory* is presented in APPENDIX A: TRAINING LOCUS OF CONTROL SCALE and the *Training Immersion Tendencies Questionnaire* is presented in APPENDIX B: TRAINING IMMERSION TENDENCIES SCALE.

Immediately prior to passing out the inventories for their completion the course instructors read Script #1 (Table 3).
Table 3: Evaluation Scripts

<table>
<thead>
<tr>
<th>Script#1</th>
<th>Text of Script</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read by instructor training course instructor(s) immediately prior to passing out the learning style questionnaires at the start of the course.</td>
<td>I have two learning preferences questionnaires I'm going to ask you to fill out. We are trying to see which one is better. Those of you who have attended IDC will recall how an understanding of the learning preferences of your participants can help you better structure your learning activities. There are no right or wrong answers so please answer freely knowing your answers will not be shared with your home office.</td>
</tr>
</tbody>
</table>

These learning preference questionnaires were completed days prior to the administration of the live simulation in order to decouple the solicitation of the participants’ learning style from their performance on the live simulation.

3.4.3 Live Simulation Exercise

The simulation was formally divided into two parts, Part 1 and Part 2. Part 1 included the student receiving and reviewing the materials for their mini-lesson. During this portion of the simulation students were allotted 30 minutes to review the materials in their mini-lesson package, one hour to plan and “script” their briefing, and 30 minutes to practice and rehearse their briefing with a partner.

Approximately six hours were allocated for the live simulation (Part 2) portion of the training. This time was allocated so that each student would have roughly 90 minutes to role play the part of the facilitator and 4.5 hours to role play the part of a student. This research focused on the training and live simulation required during Part 2 of the exercise in order for students to achieve TLO 2.0; more specifically ELOs 2.2 through 2.4.

Participants in the facilitating instructor course were assigned to five heterogeneous cooperative training groups based on their experience with the organization, familiarity with the
online CBT modules, and previous training experience. Prior to the simulation the course instructors read script #2 presented in Table 4.

### Table 4: Evaluation Scripts

<table>
<thead>
<tr>
<th>Script #2</th>
<th>Text of Script</th>
</tr>
</thead>
</table>
| Read by training instructor(s) on the day of the live simulation exercise as part of the students’ simulation instructions. | The organization has an ongoing program of evaluating training events. One of the focuses this year is on Simulations, so neutral contractors will be observing today and they're going to ask you to complete a brief survey after your turn as ‘Instructor’. The formal term for what they are interested in is "engagement in simulations," and that means that they aren't evaluating you, or even this particular activity so much as getting some baseline information in order to look for ways to improve how the organization conducts training. So there are no wrong or right answers, and no individual data will be provided to office, or even me, so please respond freely and honestly.  

<Note: Hand out questionnaires at this point >

You can see these questionnaires only solicit basic information about your experience completing this activity and there are no right or wrong answers.

Following your turn as the ‘Instructor’ please complete the questionnaire; and then you can hand them directly to the neutral contractors. We really appreciate your help with our continuous training improvement efforts. |

While students participated in the live simulation portion of their activities, expert observers documented their performance using an expert observer scale (APPENDIX D: LIVE SIMULATION OBSERVER’S CHECKLIST). This unobtrusive observation was completed simultaneously by three trained observers on the day when the live simulation activities were scheduled.
3.4.4 Participant Coding

Immediately following completion of the live simulation exercise, participants were required to complete a survey on their performance in the simulation exercise. In order to ensure the exercise was fresh in their minds the instrument was completed prior to their taking a break. This data collection instrument consisted of a level one (Kirkpatrick, 1994) questionnaire with 27 semantic differential scaled items which students used to rate their impression of the activity and beliefs about training activities in general and one open-ended response item for trainees to comment on: “What specific aspects of the exercise, if any, differed from the real world?” This survey is presented in APPENDIX C: PARTICIPANT’S SIMULATION PERFORMANCE.

The forms were then handed to neutral third-party contractors for scoring. None of the identified self-reported data were made available to course instructors so participants would feel confident that their responses would not have an impact on their class performance.

3.4.5 Expert Coding

Simulation performance data were collected and coded by individuals who were experts in interviewing and training observation. Three experts were chosen to provide expert coding in order to:

- Ensure complete coverage due to the number of simultaneous live simulation sessions that were going to occur
- Provide coverage in case of unexpected absences
- Allow for inter-rater reliability (IRR) analysis

Expert observers received IRR training and used a checklist (APPENDIX D: LIVE SIMULATION OBSERVER’S CHECKLIST) to record the participant’s score. The checklist
provided the experts with items to be rated, a built-in job aid listing behavioral markers (to help standardize ratings), and space for taking notes. The expert observers rated participants on the five checklist questions that dealt with their behaviors in the simulation (Table 5) using a six-point scale. The scale ranged from “Disagree very much” (1) to “Agree very much” (6).

<table>
<thead>
<tr>
<th>Item</th>
<th>Item to be Rated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Does not &quot;break character&quot; while in the simulation</td>
</tr>
<tr>
<td>2</td>
<td>Demonstrates he/she takes the simulation seriously</td>
</tr>
<tr>
<td>3</td>
<td>Monitors his/her behaviors and improves over the course of the simulation</td>
</tr>
<tr>
<td>4</td>
<td>Treats other performers in the live simulation as appropriate for the simulation</td>
</tr>
<tr>
<td>5</td>
<td>Overall, the performer performs well</td>
</tr>
</tbody>
</table>

Item number five was a roll-up of the performer’s technical behavior items which were specified by the expert observer who was a subject matter expert (SME) in this type of live simulation. These items were unique to the live simulation used in this study and would vary based upon the specific simulation. For example, if a mass-casualty live simulation were being evaluated then a SME familiar with the specific behavioral indicators for this simulation would have to assist in the development of these items.
Table 6 details the qualifications for the three expert raters.

Table 6: Expert Rater Qualifications

<table>
<thead>
<tr>
<th>Rater</th>
<th>Education</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater A</td>
<td>M.S. in Instructional Systems Design, Boise State University; M.S. in Modeling &amp; Simulation, University of Central Florida</td>
<td>24 years instructional development, 10 years developing and conducting live simulations, five years conducting IRR training for aviation standardization pilots and instructors.</td>
</tr>
<tr>
<td>Rater B</td>
<td>Ph.D. in Cognitive Psychology, University of South Florida</td>
<td>Seven years developing and delivering college-level instruction. One year delivering instruction training.</td>
</tr>
<tr>
<td>Rater C</td>
<td>ABD in Educational Evaluation, University of Florida</td>
<td>Program evaluator with three years conducting field work and interviews.</td>
</tr>
</tbody>
</table>

3.4.6 Formative Course Evaluation

Participants were also required to complete a Daily Climate Form which solicited feedback on the overall pace and flow of the course as well as content and opportunities for practical application. On the last day, the course, course instructors meet individually with the participants in order to provide them with individualized feedback on their performance during the live simulation. Course instructors also discussed the participant’s overall course self-assessments; this included reviewing why the student rated themselves below “good” (“fair” or “poor”) on any aspect of the training and developing a plan for continued development in those areas in need of development. At the completion of training, students also completed formative course evaluations.

None of these data or feedback was available to this study. However, course instructors and the course’s ISD team reviewed these data in order to make needed adjustments to the course. Over the past 13 years this course has been taught, the ISD team has made several
improvements to the course to meet the needs of participants more effectively based on various evaluation data and facilitator observations.
CHAPTER 4: FINDINGS

4.1 Introduction

In order to investigate the problem space surrounding the correlation between variables in the affective domain (Krathwohl, Bloom, & Masia, 1970) and application of KSAs obtained through live simulation; the following null hypothesis is theorized:

\( H_0: \) Affective variables do not play a role in participants’ integration of experiences gained during live simulation into their schema.

In order to test the null hypothesis this study investigated the following two alternate hypotheses:

1. \( H_1: \) A learner’s internal locus of control is correlated with their performance in a live simulation.
2. \( H_2: \) A learner’s immersive tendency is correlated with their performance in a live simulation.

4.2 Descriptive Statistics

4.2.1 Introduction

Data were collected as described in Section 3.0 (methods section) on the following independent and dependent variables listed in Table 7 below.

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant’s training locus of control</td>
<td>Self-reported performance in the live simulation</td>
</tr>
<tr>
<td>Participant’s immersion tendency</td>
<td>Expert observer’s reported performance in the live simulation</td>
</tr>
</tbody>
</table>
Characterizing and describing these variables, and determining their probability
distributions is essential if we are to further use these data to develop constructive simulation
models or agents within virtual simulations that behave in a manner consistent with the ‘real
world.’ In particular, “probability and statistics are needed to understand how to model a
probabilistic system, validate the simulation model, choose the input probability distributions,
generate random samples for these distributions, perform statistical analyses of the simulation
output data, and design the simulation experiments” (Law, 2007).

4.2.2 Participant’s Internal Locus of Control

Participants’ responses from their training locus of control instrument were recorded then
a point value ranging from 1-6 was assigned to each of their responses. The data set was
complete except in one instance where participant number 19 omitted a response to question
number 10. To complete the data set for this individual the mean of their other responses (5.06)
was substituted for the null response.

Next, participant’s responses for survey items that had reverse scoring were transposed in
order to ensure that a score of six (agree very much) would be a maximum internal locus of
control score for all items. For example, a person with a high internal locus of control would
disagree very much with item number five (“Getting what you want out of life is mostly a matter
of luck?”), giving it a score of one. Before analysis the score for this item was reversed so a
response providing one point was converted to a score of six points. Of the 17 items on the
instrument eight of them needed to be transposed before calculating a total score.

A total score for each participant was calculated by summing each participant’s
individual items; thereby yielding an overall training locus of control score.
The first row in Table 8 lists the 20 participants and the second row lists their overall LOC score (sum of their 17 instrument items).

Table 8: Participants’ Overall LOC Score

<table>
<thead>
<tr>
<th>Participant</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOC Score</td>
<td>94</td>
<td>79</td>
<td>75</td>
<td>80</td>
<td>70</td>
<td>87</td>
<td>78</td>
<td>71</td>
<td>97</td>
<td>66</td>
<td>79</td>
<td>86</td>
<td>68</td>
<td>89</td>
<td>92</td>
<td>88</td>
<td>93</td>
<td>81</td>
<td>86</td>
<td>82</td>
</tr>
</tbody>
</table>

Figure 3 presents box plots for the 20 participants’ overall locus of control scores on the instrument.

Figure 3: Box Plot of Participant’s LOC Scores
The mean of the participants’ LOC scores was 82.05 with a standard deviation of 8.99. Table 9 and Figure 4 present the descriptive statistics for the participants’ overall training locus of control scores.

### Table 9: Descriptive Statistics for LOC Scores

<table>
<thead>
<tr>
<th>N</th>
<th>Mean</th>
<th>SE Mean</th>
<th>StDev</th>
<th>Variance</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>82.05</td>
<td>2.01</td>
<td>8.99</td>
<td>80.89</td>
<td>66.00</td>
<td>97.00</td>
<td>75.75</td>
<td>81.50</td>
<td>88.75</td>
</tr>
</tbody>
</table>

From the above histogram and the Anderson-Darling normality test ($p$-value = 0.811) we cannot reject the hypothesis that the locus of control scores are normally distributed. However, they are somewhat negatively skewed.
It should be noted that it is possible there are actually two overlapping distributions. One distribution at the low end which appears to be somewhat of a normal distribution (between 65 and 75) and another positively skewed distribution (between 80 and 95+). As previously mentioned in this chapter; this is important for modelers interested in building probability density functions for variables that could accurately represent a system under examination. However, with the limited sample size ($N = 20$) there are not enough data to make conclusive statements as to the distribution of the participants’ locus of control independent variable.

### 4.2.3 Participant’s Immersion Tendencies

Participants’ responses from their training immersion tendencies instrument were recorded then a point value ranging from 1-7 was assigned to each of their responses. The data set was complete except in two instances. First participant number 1 omitted a response to question number 18 and secondly where participant number 2 omitted a response to question number 4. To complete the data set for these individuals the mean of their other responses (3.4 and 3.48, respectively) were substituted for the null responses.

A total score for each participant was calculated by summing each participant’s response on the 31 individual items; thereby yielding an overall training immersion tendency score.

The first row in Table 10 lists the 20 participants and the second row lists their overall IMT score (sum of their 31 instrument items).

### Table 10: Participants’ Overall IMT Score

<table>
<thead>
<tr>
<th>Participant</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMT Score</td>
<td>110</td>
<td>117</td>
<td>81</td>
<td>113</td>
<td>139</td>
<td>103</td>
<td>97</td>
<td>91</td>
<td>107</td>
<td>76</td>
<td>156</td>
<td>104</td>
<td>102</td>
<td>115</td>
<td>110</td>
<td>122</td>
<td>109</td>
<td>92</td>
<td>79</td>
<td>98</td>
</tr>
</tbody>
</table>
Figure 5 presents box plots for the 20 participants’ overall immersion tendencies scores on the instrument.

![Figure 5: Box Plot of Participant’s IMT Scores](image)

The mean of the participants’ LOC scores was 106.09 with a standard deviation of 19.20.

Table 11 and Figure 6 present the descriptive statistics for the participants’ overall training immersion tendencies scores.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SE Mean</th>
<th>StDev</th>
<th>Variance</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>106.09</td>
<td>4.29</td>
<td>19.20</td>
<td>368.47</td>
<td>76.00</td>
<td>156.00</td>
<td>93.25</td>
<td>105.50</td>
<td>114.50</td>
</tr>
</tbody>
</table>
From the above histogram and the Anderson-Darling normality test ($p$-value = 0.350) we cannot reject the hypothesis that the locus of control scores are normally distributed. However, they are somewhat positively skewed.

It should be noted that it is possible there are actually two overlapping distributions; one distribution at the low end which appears to be somewhat normally distributed (between 80 and 120) and another distribution (between 140 and 160). Again; this is important for modelers interested in building probability density functions for variables that could accurately represent a system under examination. Similarly, with the limited sample size ($N = 20$) there are not enough data to make conclusive statements as to the distribution of the participants’ immersion tendencies independent variable.
4.2.4 Self-reported Live Simulation Performance

A participants’ learning style that makes them open to accepting the credibility of using live simulation for learning and rehearsal, and open to integrating it into their task schema, is key to the value of live simulation in training. Participants that feel live simulation is just a ‘game’ (e.g., James Kirk in Chapter 1) and unimportant will not internalize the training; they must feel they should practice and can apply what they learn in the simulation. Therefore, immediately following the live simulation, participants completed a questionnaire designed to capture their perceptions as to their performance in the live simulation. This instrument measured their perceived value of the exercise and their desire to transfer what they learned in the simulation to real world situations.

This 27-item training exercise questionnaire (APPENDIX C: PARTICIPANT’S SIMULATION PERFORMANCE) contained eight questions (3, 7, 19, 22, 23, 25, 26, and 27) that had to be reverse scored in order to convert the score so that six points was always assigned to the response indicating the highest level of performance in the live simulation. The data set was complete except where participant number 2 failed to respond to question number one and participant number 12 failed to respond to question number nine. To complete the data set the mean of these two participants other 26 responses was used for these two questions. Table 12 displays the self-reported scores for participants. The participant ID is in the first (top) row and their overall score on the questionnaire is in the second (bottom) row.

Table 12: Participants’ Score for Self-reported Performance

<table>
<thead>
<tr>
<th>Participant</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>144</td>
<td>127</td>
<td>102</td>
<td>134</td>
<td>107</td>
<td>135</td>
<td>120</td>
<td>118</td>
<td>128</td>
<td>133</td>
<td>132</td>
<td>137</td>
<td>101</td>
<td>133</td>
<td>112</td>
<td>131</td>
<td>132</td>
<td>135</td>
<td>121</td>
<td>135</td>
</tr>
</tbody>
</table>
The mean of the participants’ scores was 125.87 with a standard deviation of 12.22. Table 13 displays descriptive statistics for the self-reported performance.

<table>
<thead>
<tr>
<th>N</th>
<th>Mean</th>
<th>SE Mean</th>
<th>StDev</th>
<th>Variance</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>125.87</td>
<td>2.73</td>
<td>12.22</td>
<td>149.31</td>
<td>101.00</td>
<td>144.00</td>
<td>118.50</td>
<td>131.50</td>
<td>134.75</td>
</tr>
</tbody>
</table>

Figure 7 summarizes the self-report data; presenting a graph of the distribution and a description of the data.

Figure 7: Descriptive Statistics for Self-assessment Scores
From the above histogram and the Anderson-Darling normality test ($p$-value = 0.010) we should reject the hypothesis that the participant’s locus of control scores are normally distributed. Instead the data are negatively skewed (-0.885).

It should be noted that this negative skewed distribution of participants’ simulation performance is consistent with the senior rater’s (Table 6) experiences training students using live simulation. However, it is also possible the distribution is actually a composite distribution that represents two or more separate underlying distributions. As previously mentioned in this Chapter this is important for modelers interested in building probability distribution functions for variables that could accurately represent a system under examination. Again, with the limited sample size ($N = 20$) there are not enough data to make conclusive statements as to the actual distribution of the participants’ self-reported performance dependent variable.

4.2.5 Self-reported Live Simulation Qualitative Data

Of the 20 participants only nine responded to the open-ended item on the post-simulation exercise questionnaire: “What specific aspects of the exercise, if any, differed with the real world?” (APPENDIX C: PARTICIPANT’S SIMULATION PERFORMANCE). Of those six were non-responsive to the question (e.g., responding “None” or commenting on how much they they liked the training). Only three offered limited insight into improving the exercise and none of them helped with the interpretation of the quantitative data and therefore they are not included in the data analysis. The responsive comments were:

- “I felt that more time should have been given to prepare for this exercise.”
- “The level of understanding for the simulated students was much greater. More questions are expected from a true training environment.”
• “I will be dealing with at least 7 or 8 groups at a time.”

4.2.6 Expert-reported Live Simulation Performance

In addition to self-reported performance in the live simulation, expert raters also documented each participant’s performance in the simulation using a checklist designed to record the participants’ behavioral indicators (APPENDIX D: LIVE SIMULATION OBSERVER’S CHECKLIST) in five major factor areas. The expert raters observed each participant’s behaviors in the live simulation and during the simulation recorded a score for each of the five checklist factors.

Following the live simulation and observations on all participants the three expert raters’ (Table 6: Expert Rater Qualifications) data were examined for completeness and inter-rater reliability. An examination of the data revealed Raters A and B had complete data sets for all 20 participants; however, Rater C failed to record data on four participants (see Table 14).

<table>
<thead>
<tr>
<th>Expert Rater</th>
<th>Missing Participant Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rater A</td>
<td>All 20 participants rated</td>
</tr>
<tr>
<td>Rater B</td>
<td>All 20 participants rated</td>
</tr>
<tr>
<td>Rater C</td>
<td>All data missing on four participants</td>
</tr>
</tbody>
</table>

An examination of the correlation between the raters and a distribution of their scores (see histograms in Figure 8) reveals a lack of inter-rater reliability between Rater C and Raters A and B.
Due to the lack of agreement between Rater C and Raters A and B, and Rater C’s incomplete data set, Rater C’s responses were not included in calculating scores for the expert-reported simulation performance.

To calculate a participant’s overall score; the mean of the expert raters score for each question or item on the observation checklist (Q-1 through Q-5) were recorded. These five individual checklist item scores were then summed for each participant (first column in Table 15) in order to derive an overall score (second column in Table 15) for each of the participants.
Table 15: Expert Raters’ Live Simulation Scores

<table>
<thead>
<tr>
<th>Participant</th>
<th>Overall Score</th>
<th>Q 1</th>
<th>Q 2</th>
<th>Q 3</th>
<th>Q 4</th>
<th>Q 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-1</td>
<td>28.00</td>
<td>6.00</td>
<td>6.00</td>
<td>5.00</td>
<td>5.50</td>
<td>5.50</td>
</tr>
<tr>
<td>P-2</td>
<td>25.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>P-3</td>
<td>25.50</td>
<td>5.50</td>
<td>6.00</td>
<td>4.50</td>
<td>5.00</td>
<td>4.50</td>
</tr>
<tr>
<td>P-4</td>
<td>10.50</td>
<td>2.00</td>
<td>2.50</td>
<td>1.00</td>
<td>2.50</td>
<td>2.50</td>
</tr>
<tr>
<td>P-5</td>
<td>24.00</td>
<td>4.50</td>
<td>5.00</td>
<td>4.50</td>
<td>5.50</td>
<td>4.50</td>
</tr>
<tr>
<td>P-6</td>
<td>25.00</td>
<td>5.50</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>4.50</td>
</tr>
<tr>
<td>P-7</td>
<td>12.00</td>
<td>2.00</td>
<td>2.50</td>
<td>2.00</td>
<td>3.00</td>
<td>2.50</td>
</tr>
<tr>
<td>P-8</td>
<td>11.00</td>
<td>2.00</td>
<td>2.50</td>
<td>2.50</td>
<td>2.50</td>
<td>1.50</td>
</tr>
<tr>
<td>P-9</td>
<td>25.00</td>
<td>5.00</td>
<td>5.50</td>
<td>4.50</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>P-10</td>
<td>10.50</td>
<td>1.50</td>
<td>1.50</td>
<td>2.00</td>
<td>2.50</td>
<td>3.00</td>
</tr>
<tr>
<td>P-11</td>
<td>9.50</td>
<td>2.00</td>
<td>1.50</td>
<td>2.00</td>
<td>2.50</td>
<td>1.50</td>
</tr>
<tr>
<td>P-12</td>
<td>23.00</td>
<td>5.00</td>
<td>4.50</td>
<td>4.00</td>
<td>5.00</td>
<td>4.50</td>
</tr>
<tr>
<td>P-13</td>
<td>20.50</td>
<td>4.00</td>
<td>4.00</td>
<td>3.50</td>
<td>4.50</td>
<td>4.50</td>
</tr>
<tr>
<td>P-14</td>
<td>19.50</td>
<td>4.00</td>
<td>4.00</td>
<td>3.50</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>P-15</td>
<td>20.50</td>
<td>4.00</td>
<td>4.50</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>P-16</td>
<td>26.50</td>
<td>5.50</td>
<td>5.50</td>
<td>4.50</td>
<td>5.50</td>
<td>5.50</td>
</tr>
<tr>
<td>P-17</td>
<td>24.00</td>
<td>4.50</td>
<td>5.00</td>
<td>4.50</td>
<td>4.50</td>
<td>5.50</td>
</tr>
<tr>
<td>P-18</td>
<td>22.00</td>
<td>4.50</td>
<td>5.00</td>
<td>4.00</td>
<td>4.50</td>
<td>4.00</td>
</tr>
<tr>
<td>P-19</td>
<td>17.50</td>
<td>3.00</td>
<td>4.50</td>
<td>3.00</td>
<td>3.50</td>
<td>3.50</td>
</tr>
<tr>
<td>P-20</td>
<td>25.50</td>
<td>5.00</td>
<td>5.50</td>
<td>4.50</td>
<td>5.00</td>
<td>5.50</td>
</tr>
<tr>
<td>Mean</td>
<td>20.25</td>
<td>4.03</td>
<td>4.28</td>
<td>3.68</td>
<td>4.23</td>
<td>4.05</td>
</tr>
</tbody>
</table>

The mean of the experts’ scores was 20.25 with a standard deviation of 6.191. Table 16 displays descriptive statistics for the participants’ live simulation performance as reported by the expert raters.

Table 16: Descriptive Statistics for Participants’ Expert Rater Scores

<table>
<thead>
<tr>
<th>N</th>
<th>Mean</th>
<th>SE Mean</th>
<th>StDev</th>
<th>Variance</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Q1</th>
<th>Median</th>
<th>Q3</th>
</tr>
</thead>
</table>

Figure 9 presents a distribution histogram and descriptive statistics that characterize these expert observer dependent variable data.
Figure 9: Descriptive Statistics for Expert Raters Scores

From the above histogram and the Anderson-Darling normality test ($p$-value = 0.005) we should reject the hypothesis that the expert raters scores are normally distributed. Instead the data are negatively skewed (-0.744).

It should be noted that this negative skewed distribution of expert raters’ data of participants’ simulation performance is consistent with the senior rater’s (Table 6) experiences training students using live simulation. However it is also possible the distribution is actually a composite distribution that represents two or more separate underlying distributions (e.g., one with a mean of approximately 11, another with a mean of approximately 20, and another with a mean of approximately 26). As previously mentioned in this chapter this is important for modelers interested in building density distribution functions for variables that could accurately
represent a system under examination. However, with the limited sample size \( N = 20 \) there are not enough data to make conclusive statements as to the actual distribution of the participant performance dependent variable as reported by expert raters.

4.3 Hypothesis #1

4.3.1 Introduction

To evaluate hypothesis # 1 \((H_1)\), whether a learner’s internal locus of control is correlated with their performance in a live simulation, a regression analysis was conducted to determine the strength of the correlations between each participant’s previously collected LOC data and both their self-reported performance in the live simulation and their performance in the live simulation as reported by the observers who were expert raters.

4.3.2 Correlation of LOC with Self-reported Live Simulation Performance

To test this hypothesis, first the participants’ overall locus of control scores and their self-reported performance in the live simulation were analyzed. Table 17 displays the results of the regression analysis of the participants’ LOC scores and their self-reported performance in the live simulation.
Table 17: Regression Analysis: Self-report Score vs. LOC Score

The regression equation is
Self-report Score = 71.5 + 0.663 LOC Score

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>71.46</td>
<td>23.06</td>
<td>3.10</td>
<td>0.006</td>
</tr>
<tr>
<td>LOC Score</td>
<td>0.6631</td>
<td>0.2794</td>
<td>2.37</td>
<td>0.029</td>
</tr>
</tbody>
</table>

S = 10.9567  R-Sq = 23.8%  R-Sq(adj) = 19.62%

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>676.0</td>
<td>676.0</td>
<td>5.63</td>
<td>0.029</td>
</tr>
<tr>
<td>Residual Error</td>
<td>18</td>
<td>2160.9</td>
<td>120.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>2836.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 10 presents residual plots for the participant’s LOC score versus the self-assessment of their performance in the live simulation. An examination of the residuals indicates that errors between the predicted values and their actual values are relatively stable, and that a variance-stabilizing transformation to the model is not warranted. Additionally, from the residual probability plot and histogram it appears the residuals are moderately robust with respect to normality.
Figure 10: Residual Plots for Participant’s LOC Score vs. Self-assessment of Performance

Figure 11 displays the regression analysis scatter plot and model for the correlation between the participants’ scores for locus of control and self-reported performance in the simulation. Figure 12 presents a summary report for these two variables under examination. Of particular interest is the Pearson correlation value of 0.029 and an adjusted coefficient of determination equal to 19.62%.
**Regression for Self Report Score vs LOC Scores**

**Model Selection Report**

**Fitted Line Plot for Linear Model**

\[ Y = 71.43 + 0.6635 \times \]

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Selected Model</th>
<th>Alternative Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared (adjusted)</td>
<td>19.62%</td>
<td>18.00%</td>
</tr>
<tr>
<td>p-value, model</td>
<td>0.029*</td>
<td>0.072</td>
</tr>
<tr>
<td>p-value, linear term</td>
<td>0.029*</td>
<td>0.365</td>
</tr>
<tr>
<td>p-value, quadratic term</td>
<td>-</td>
<td>0.433</td>
</tr>
<tr>
<td>p-value, cubic term</td>
<td>-</td>
<td>0.227</td>
</tr>
<tr>
<td>Residual standard deviation</td>
<td>10.955</td>
<td>11.065</td>
</tr>
</tbody>
</table>

* Statistically significant (p < 0.05)

---

**Figure 11: Regression Model of LOC Score vs. Self-assessment of Performance**
Figure 12: Summary Report Participant LOC vs. Self-assessment of Performance

The Pearson correlation for internal locus of control scores and the participants’ self-reported live simulation performance score at 0.029 provide statistically significant evidence of a positive correlation between the two variables.

4.3.3 Correlation of LOC with Expert Observed Live Simulation Performance

An analysis of the participants’ LOC scores and their reported performance in the live simulation as recorded by expert observers of the self-report and expert observer data was conducted next. Table 18 displays the results of this regression analysis.
**Table 18: Regression Analysis Expert Report Score vs. LOC score**

The regression equation is

\[
\text{Expert Observer Score} = -6.7 + 0.329 \text{ LOC Scores}
\]

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-6.72</td>
<td>11.76</td>
<td>-0.57</td>
<td>0.575</td>
</tr>
<tr>
<td>LOC Score</td>
<td>0.3287</td>
<td>0.1425</td>
<td>2.31</td>
<td>0.033</td>
</tr>
</tbody>
</table>

\[S = 5.58846\quad \text{R-Sq} = 22.8\%\quad \text{R-Sq(adj) = 18.5\%}\]

**Analysis of Variance**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>166.09</td>
<td>166.09</td>
<td>5.32</td>
<td>0.033</td>
</tr>
<tr>
<td>Residual Error</td>
<td>18</td>
<td>562.16</td>
<td>31.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>728.25</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 13 displays a linear model and scatter plot depicting the regression analysis results for the participants’ internal training LOC scores versus their performance in the live simulation as reported by expert raters. With a Pearson correlation value of 0.033 and an adjusted \(R^2\) of 18.52%; this provides statistically significant evidence of a positive correlation between these two variables.
Figure 13: Scatter Plot of Participant’s LOC Score vs. Expert Score

Figure 14 presents residual plots for the participants’ LOC score and the expert raters’ assessment of their performance in the live simulation. An examination of the residuals indicates that errors between the predicted values and their actual values are relatively stable, and that a variance-stabilizing transformation to the model is not warranted. Additionally, from the residual probability plot and histogram the residuals are moderately robust with respect to normality.
4.3.4 Findings for Correlation of LOC and Live Simulation Performance

Analysis of the data reveal there is a statistically significant coloration between the participants’ internal locus of control and both:

- self-reported performance, and
- expert observed performance.

In other words the greater their internal locus of control the better they performed in the live simulation. With respect to hypothesis $H_1$ (a learner’s internal LOC is correlated with their performance in a live simulation); there is not enough data to reject alternate hypothesis $H_1$. In light of the data hypothesis #1 is accepted.
A participant’s internal locus of control is positively correlated with their performance in this instructor training live simulation.

4.4 Hypothesis #2

4.4.1 Introduction

To evaluate hypothesis #2 ($H_2$), whether a learner’s immersion tendencies is correlated with their performance in a live simulation, a regression analysis was conducted to determine the strength of the correlations between each participant’s previously collected IMT data and both their self-reported performance in the live simulation and their performance in the live simulation as reported by the observers who were expert raters.

4.4.2 Correlation of IMT with Self-reported Live Simulation Performance

To test this hypothesis, first the participants’ overall immersion tendencies and their self-reported performance in the live simulation was analyzed. Table 19 displays the results of the regression analysis of the participants’ LOC scores and their self-reported performance in the live simulation.

Table 19: Regression Analysis Self-report Score vs. IMT Score

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>118.57</td>
<td>16.07</td>
<td>7.38</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>IMT Score</td>
<td>0.0688</td>
<td>0.1492</td>
<td>0.46</td>
<td>0.650</td>
</tr>
</tbody>
</table>

S = 12.4805 R-Sq = 1.2% R-Sq(adj) = 0.0%

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>33.1</td>
<td>33.1</td>
<td>0.21</td>
<td>0.650</td>
</tr>
<tr>
<td>Residual Error</td>
<td>18</td>
<td>2803.7</td>
<td>155.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>2836.9</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 15 depicts a scatter plot and the regression model for the participant’s immersion tendencies scores versus their self-reported performance in the live simulation. The Pearson correlation is not statistically significant ($p=0.650$); however, it appears there is some minor positive correlation. Conclusive statements about the correlation would require a larger sample size.

Figure 15: Regression Model: Self-report of Performance vs. IMT Score

Figure 16 presents residual plots for the participant’s IMT score versus the self-report of their performance in the live simulation. An examination of the residuals indicates that errors between the predicted values and their actual values are relatively stable, and that a variance-
stabilizing transformation to the model is not warranted. Additionally, from the residual probability plot and histogram the residuals are moderately robust with respect to normality.

![Residual Plots for Self-report Score](image)

**Figure 16: Residual Plots for Self-report vs. IMT Scores**

### 4.4.3 Correlation of IMT with Expert Reported Live Simulation Performance

An analysis of the correlation between the participants’ immersive tendency score and their reported performance in the live simulation, as recorded by expert observers, was conducted next.
Table 20 displays the results of this regression analysis.

**Table 20: Regression Analysis: Expert Report Score vs. IMT Score**

The regression equation is

\[
\text{Expert Observer Score} = 5.63 + 0.147 \times \text{IMT Scores}
\]

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>5.627</td>
<td>8.674</td>
<td>0.65</td>
<td>0.525</td>
</tr>
<tr>
<td>IMT Score</td>
<td>0.14679</td>
<td>0.08295</td>
<td>1.77</td>
<td>0.095</td>
</tr>
</tbody>
</table>

\[ S = 5.48923 \]

R-Sq = 15.6%  
R-Sq(adj) = 10.6%

**Analysis of Variance**

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>94.37</td>
<td>94.37</td>
<td>3.13</td>
<td>0.095</td>
</tr>
<tr>
<td>Residual Error</td>
<td>17</td>
<td>512.24</td>
<td>30.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>606.61</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The data for participant number 11 were not included in this analysis due to their unusually high IMT score (156) and corresponding low simulation performance (9.5). Due to their unusually large \( x \)-value, when their results were included it significantly changed the regression model for this analysis. It was determined that their data should be omitted for one of the following two reasons:

- First, this participant could have inflated their self-reported their data in order to satisfy social pressures or provide ‘answers’ the participant believes the instructors want to see. Or they could have in inflated sense of their true immersive tendency. In this case the participant is a true outlier and their data should be excluded from the analysis.

- Secondly, assuming this single participant accurately reported their immersive tendency then they are not an outlier; instead they must represent a small sub-population that when included in the analysis exerts a disproportionate effect on the regression model. If this distinct sub-population exists then it should be modeled
separately so as to improve the predictive accuracy of the model(s) and further research needs to be conducted in order to fully understand this sub-population.

Figure 17 depicts a scatter plot and the regression model for the participant’s immersion tendencies scores and the expert raters’ assessment of their performance in the live simulation. The Pearson correlation is not statistically significant ($p=0.095$); however, it appears there is some practical positive correlation. The results reveal an interesting pattern; however, conclusive statements about the correlation would require additional investigation and a larger sample size.

![Figure 17: Regression Analysis for EO vs. IMT Scores](image)

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Selected Model</th>
<th>Alternative Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared (adjusted)</td>
<td>10.59%</td>
<td>6.35%</td>
</tr>
<tr>
<td>p-value, model</td>
<td>0.095</td>
<td>0.231</td>
</tr>
<tr>
<td>p-value, linear term</td>
<td>0.095</td>
<td>0.522</td>
</tr>
<tr>
<td>p-value, quadratic term</td>
<td>-</td>
<td>0.637</td>
</tr>
<tr>
<td>p-value, cubic term</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Residual standard deviation</td>
<td>5.489</td>
<td>5.618</td>
</tr>
</tbody>
</table>

Figure 17: Regression Analysis for EO vs. IMT Scores
Figure 18 presents residual plots for the participant’s IMT score versus the expert raters’ assessment of their performance in the live simulation. An examination of the residuals indicates that errors between the predicted values and their actual values are relatively stable, and that a variance-stabilizing transformation to the model is not warranted. Additionally, from the residual probability plot and histogram the residuals are weak with respect to normality.

![Residual Plots for Expert Observer Scores](image)

**Figure 18: Residual Plots for EO vs. IMT Scores**
4.4.4 Findings for Correlation of IMT and Live Simulation Performance

Analysis of the data reveal there is not a statistically significant coloration between the participants’ immersion tendencies and their:

• self-reported performance, or

• expert observed performance.

With respect to hypothesis $H_2$ (a learner’s immersion tendencies (IMT) is correlated with their performance in a live simulation); there is enough data to reject hypothesis $H_2$. The participants’ immersion tendencies do not predict performance in this live simulation.

While the participant’s immersion tendencies and their performance in this live simulation were not statistically significant, there was possibly some practical correlation with their performance in this instructor training live simulation.

4.5 Validity Concerns

Potential limitations to validity for this study, along with mitigation strategies include:

1. Participants may tend to be overly optimistic in their self-reporting.

   *In addition to collecting participants’ self-reported performance, expert raters also provided performance data on each participant. The opinion of the expert raters was used to validate the results of the participants’ self-reporting.*

2. Participants may feel they cannot be candid if they believe their responses will impact their grades or class standing.

   *Participants were informed that their responses would be entirely confidential and their forms and data was administered and collected by non-organizational personnel.*
3. Expert raters may have different levels of evaluating live simulation and/or their experience may not be in an area that allows them to adequately assess participants’ performance in a live simulation thereby impacting their ratings. **Expert raters attended inter-rater reliability (IRR) training and their ratings were examined for reliability. An expert whose data was determined to be an outlier was discarded.**

4. Participants may think there is a desired or optimum response for various surveys or scales that were administered. Or their responses on the training questionnaires may influence their Participant’s Simulation Performance Questionnaire responses. **Administration of the questionnaires and surveys was temporally separated in order to minimize any perception of a relationship between the various instruments.**

**4.6 Conclusions**

The data demonstrate that affective variables do have a positive correlation with performance in this live simulation. It also demonstrates that specific affective variables are better or worse predictors of a participant’s performance in this live simulation. An area for future research should be to find the most ‘sensitive’ variable to use as a predictor of performance in a simulation. Additionally, larger sample sizes will allow researchers to draw more conclusive results and determine if the variables are part of a larger normal distribution or if they are composed of two or more underlying distributions.

As previously mentioned in Chapter 2, Ruggeroni (2001) concluded that: “A general high level of immersion does not mean that a person will be effectively immersed in any situation but in one that is of interest to them.” It is possible that the lower correlations for immersion
tendencies may in part be explained by the participant’s level of interest in facilitating training. Most of the participants are experienced classroom instructors who have been delivering traditional stand-up platform instruction. The live simulation used in this research required them to shift to a facilitator style of instruction. Their interest in this type of instruction was not measured during this research; therefore, conclusions regarding their level of interest in this type of live simulation and their immersion tendencies are unknown.

Further analysis of this data will allow the instructor training ISD live simulation development team to better determine whether learning style predicts live simulation activity outcomes by relating learning style with observer and self-reported assessments. By measuring student learning styles, gathering student impressions of live simulation activities, and observing student live simulation performance, conclusions may be drawn that suggest future directions for the organization’s use of live simulation.
CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

As previously discussed findings from this study include:

1. There was statistically significant correlation between specific affective variables and the participant’s performance in a live simulation. However, what causes the improved performance is not completely understood. With an adjusted coefficient of determination equal to 19.6% for internal locus of control and performance in a live simulation; an incomplete mathematical model for describing live simulation performance still exists.

2. Correlations between the independent and dependent variables selected for this research varied significantly. Due to these variations it suggests that there may be independent variables that are even more sensitive measures of predicting performance in live simulations.

3. Affective variables of the participants varied significantly and these variations need to be considered in the design of live simulations.

4. There may be sub-populations within the independent variable under consideration in this study.

5. Collecting performance data on the participants is important and should be well thought out. This is especially true where the expert observer(s) are not subject matter experts (SMEs) in the technical area being trained or rehearsed through the live simulation.
6. Consideration must be given to the roles being rated or evaluated in the simulation. In other words evaluating the participant in a supporting role rather than the primary role may be a better indicator of performance in the live simulation.

5.2 Correlation versus Causation

The results of this study indicate a statistically strong correlation between a participant’s internal locus of control and their performance in the live simulation. However, correlation does not necessarily indicate causation. One explanation of the cause for better performance is that those with higher internal locus of control were more motivated to practice the training and integrate the KSAs into their schema. In this study locus of control may have been an indicator of the participant’s level of internal motivation. Other cognitive psychological variables (e.g., memory, cognition, and meta-cognition) which were not studied may also influence performance in a live simulation. Additionally, in other domain-specific live simulations (e.g., mass-casualty exercises, live fire exercises, etc.) other factors such as physical strength are probably predictors of performance.

There are a number of psychological variables that contribute to an individual’s performance in a live simulation, locus of control being one of them. The other ones are not well understood and additional research should be conducted in order to better understand them and develop a more complete model for describing them.

5.3 Sensitivity of Independent Variables

The ability to use locus of control or immersion tendencies as a predictor of performance in live simulation varied greatly in this research, as one would expect since they mapped to different constructs. This provides very strong evidence that not all affective variables are equal
in their ability to predict performance in the simulation and there may be variables that are even stronger predictors of performance. In this study an individual’s internal locus of control was a stronger predictor of their future success in the live simulation and it may be suitable for many applications. However, future research should focus on expanding our knowledge of the impact affective variables have in training transfer and the learner’s performance in live simulation. Additionally, research should also be conducted into the optimum instrument for measuring those independent variable(s).

The ideal instrument would be brief yet also be reliable and have a high level of predictive validity. A short yet sensitive instrument would ensure it would be easier and less intrusive to administer it, would also be easier for individuals conducting live simulation to interpret the results.

One such short validated instrument that is often used for training is the *Gregorc Style Delineator* (Gregorc, 1995). This scale is specifically designed to focus on learning styles, is relatively brief, and easy to score. Additionally, this instrument has four sub-scales that may further aid in understanding or ‘defining’ the participants. However, it was not used in this study for two primary reasons. First, the sub-scales (Concrete/Sequential, Abstract/Sequential, Abstract/Random, and Concrete/Random) would have complicated the findings. Secondly, and more important, the organization conducting the live simulation in this study did not have access to the instrument. Future research into selecting an instrument that allows trainers to predict performance in live simulation may want to consider conducting research with this learning style delineator to determine its predictive validity with respect to performance in a live simulation.

It may also be possible, and it would certainly be desirable, to develop a short series of questions that could be administered through normal conversations with the participant that
would allow the instructor to confidently determine a participant’s learning style (at a level needed for the purposes of the simulation) without the need for administering and scoring a written instrument. In other words, over the course of the normal training activities (e.g., classroom training, coffee breaks, etc.) the instructor would ask the participant a few questions that would allow the instructor to assess the learning style of the participant. The instructor could then assign the participant to an appropriate role in the simulation or to spend more time properly preparing them for the simulation.

5.4 Distribution of the Independent Variables

An examination of the distribution of the independent variables under consideration in this study suggested there may be sub-populations within the data. In this study the sample size was not large enough to determine if there were underlying distributions to the data. This would be especially true if the outliers represent a very small sub-group. In other words, is the pilot (see CHAPTER 1: INTRODUCTION) who continued to fly into bad weather an anomaly or does he represent a small sub-group? If he represents a frequently unseen small sub-group that is resistant to live simulation then it may be more important to identify members of the sub-group and provide them with alternatives to live simulation or additional preparation.

Accurate distribution of the affective variables is also very important to instructional and simulation developers who wish to model high fidelity agents within virtual simulations or build constructive simulations that mimic or predict ‘real life’ events. Without accurate stochastic distributions, the fidelity of the model(s) would be greatly decreased (Law, 2007).
5.5 Live Simulation Lessons Learned

It is not only desired, but hoped, that recommendations from this research will provide organizations, and instructional and simulation designers the quantitative and qualitative data needed to design and deliver more effective live simulations. This section presents several ‘lessons learned’ during the course of this research.

5.5.1 Transfer to Other Types of Live Simulations

There are many types of live simulations; they include:

- Participant role playing exercises using real training equipment (such as the instructor training simulation used in this research).
- Live-fire exercises using real or simulated ammunition.
- Mass-casualty exercises such as the ones used by first responders. These often include a large number of participants practicing many different roles (e.g., security personnel, doctors, EMTs, fire department personnel, etc.).
- Hybrid live simulations such as those:
  - Used in pilot flight training which, due to safety and cost considerations, utilize an aircraft simulator to fly a ‘real-life’ mission.
  - That require participants to utilize data obtained from a constructive simulation.

Although live simulations differ the affective variables of the participants should, in varying degrees, apply to all populations. Therefore, while not tested in this research, it seems safe to assume that the findings of this study should in some measure have broader applications and be able to be generalized to these other types of live simulations. In other words the variables
that predict success in this instructor training live simulation may also correlate with success in a call center or customer service live simulation.

5.5.2 Role Assignment within the Simulation

This study’s data and the anecdotal evidence from the expert observers suggest that some participants benefited more than others from this live simulation. The expert observers noted that some participants took the simulation more seriously and did not “break character” while in the simulation. This may suggest that some participants would benefit more than others by being active participants in the simulation while, for others, the training is seen more as an activity that must be tolerated. For example, while some participants kept in character throughout the simulation, others broke character and joked that “if this were real I would have” done something differently.

Due to time constraints and the number of roles available in a given live simulation frequently not all trainees are able to play an active role. For example, a large mass casualty or live-fire exercise may require some of the trainees to perform in the role of:

- an accident victim,
- an umpire or score keeper, or
- a more passive observer.

Being able to identify those who will gain the most from the simulation, so live simulation can be developed for them or so they can serve in an active learning role would maximize the value of the simulation and provide the highest return-on-investment for an organization. It may be that assigning them a less active role (e.g., that of an umpire or safety
observer) will help them to master the objectives of the live simulation in ways that being an active participant are unable to do.

On the other hand some research suggests that individuals whose learning style is not as ‘open’ to the live simulation may need more coaching or need instruction as to the benefits of the simulation. In other words, it may be that individuals with a high internal locus of control are more hesitant to just accept the activity at face value. These individuals may need to ‘see’ the relevance of the simulation or they may need to have ‘proof’ that the live simulation is a worthwhile activity before they are motivated to perform (Spector, 1982). Finally, participants may need to understand what ‘winning’ in the context of the simulation means.

A re-examination of the original correlation plot for participants who exhibited this ‘lack of motivation’ reveals that some very high internals did indeed perform below that which was predicted by the model \( P_{LS} = 71.43 + 0.6635 \, LOC_s \); where \( P_{LS} \) is the participant’s performance in the live simulation and \( LOC_s \) is the participant’s training locus of control score. Again, a numerically high score represented a high internal training locus of control. The two data points surrounded by the red oval in Figure 19 represent two participants who had very high internal training locus of control yet their performance in the simulation was lower than predicted. Their lower than expected performance results in the simulation may be explained by Spector’s (1982) assertion that, while internals learn better and should demonstrate better on the job task performance, they will only exert effort if they can see that it will reward them.
Figure 20 displays the results of a revised linear model and scatter plot which depicts the regression analysis for training LOC scores versus self-reported performance in the live simulation after removing the two potential outliers who had lower than predicted performance in the data set (noted in Figure 19). The results are statistically significant $p = 0.004$ and the adjusted $R^2 = 38.36$ percent.
Figure 20: Scatter Plot of Participant’s TLOC Score vs. Performance

Table 21 displays the Pearson correlation values and the adjusted $R^2$ values for the original population of the study and the revised population. Removing the two potential outliers, subjects who displayed lower than expected performance, substantially improved the level of statistical significance, more than doubling the adjusted $R^2$ value. This provides a practical significance which might imply that during the development of large scale simulations the identification and role allocation for these individuals should be carefully accounted for.
Instruments were not administered which could have determined if these two individual’s lack of performance was due to motivational (not ‘seeing’ the what’s in it for me’), a capacity issue, or if the two participants removed from the revised population represent the James Kirk-type individual (see Chapter 1). In order to determine this and appropriate strategies would be for preparing them for live simulation would require additional research.

5.5.3 Too Much Internal Locus of Control

This study found evidence to support the conclusion that training locus of control was positively correlated with performance in a live simulation. However, if a little internal locus of control is good; can there be such a thing as too much internal locus of control. In light of Spector’s research findings that internals need appropriate “performance-reward contingencies in order to perform at their potential (Spector, 1982) the original LOC versus self-reported simulation data was reexamined. This reexamination reveals a potentially interesting pattern. It appears that up to a certain limit a participant’s performance increases in relation to their internal locus of control; however, above this limit their performance may actually begin to decrease. Figure 21 depicts this ‘curve’ in the performance with a red arc.
Figure 21: Potential Limit to Internal Locus of Control

This potential trend in the data should be investigated through additional research and a larger sample size

5.5.4 Use as an Instructional/Evaluation Strategy

A recent study suggested that a positive correlation between specific Myers-Briggs personality types and performance in a constructive simulation could be due to the simulations being designed by the same personality types (Patz, 1992). Could success in a live simulation favor participants with the same affective variables that the designer of the simulation possesses? Would it have made a difference in the outcome of the Kobayashi Maru simulation (see Chapter 1) if a Captain Kirk-type personality had been on the team that designed this simulation? Can any of the correlations uncovered in this investigation be attributed to the affective variables of the simulation designers? These are interesting questions and since the backgrounds of the developers of this live simulation are unknown it would require additional research to answer.
However, until further research is conducted into this area instructional systems and simulation design teams may want to bear in mind their biases and the composition of the design team.

5.5.5 Use with Homogeneous Populations

Complete demographics for the participants in this live simulation research are unknown. However, the expert observes believe there was somewhat limited homogeneity within the population of participants. They all self-selected to become instructors, were mature adults, had been with the organization for a number of years; however, they were evenly split between male and female, and they came from a diverse range of backgrounds and experience. This is in contrast to occupations where there is an extremely high level of homogeneity within the population (where the individuals have very similar experiences, education, gender, beliefs, etc.). For example, soldiers who go to boot camp as young adults and are acculturated into the military, a call center which hires a specific type of person, or an organization which utilizes a psychological screening inventory for employee hiring.

An understanding of the match between the optimum ‘user profile’ for a live simulation (or multiple specific roles within a live simulation) and the population that will be utilizing the simulation would be of great value to instructional and simulation developers. It could help them determine:

- When it would be most advantageous to prescribe live simulation as an instructional intervention and/or evaluation strategy, or when another form of training may be more appropriate.
• Which, if any, homogeneous population (e.g., military pilots) will benefit most from live simulation. For example, are the typical employees in a specific call center or the scientists in a research facility more or less open to live simulation training?

• If there is a need to administer an instrument to assess the participant’s affective variables. This is especially true where the variable used to predict performance in the live simulation is unknown for the population to be trained. On the other hand, if the population is homogenous and their predisposition to live simulation is known it may not be necessary to administer an instrument.

5.5.6 Collection of Performance Data

In order to be able to correlate the participants’ affective variable with their performance in the live simulation a data collection instrument needed to be developed (APPENDIX D: LIVE SIMULATION OBSERVER’S CHECKLIST). During practice trials with prototype checklists and during the inter-rater reliability (IRR) training it became apparent that in order to ensure the accuracy of the performance data and to support the observers a sound instrument was critical.

The tools and process used for collecting performance data during the simulation is important and should be well thought out. This is especially true where the expert observer(s) is not a subject matters expert (SME) in the technical area of the simulation.

The final data collection instrument used in this study contains three basic parts. These parts include:

1. The checklist items in part one collect generic live simulation data. During the development of the live simulation observer’s checklist it became apparent that there are some core behaviors that would be common to all live simulations. This part of
the checklist is generic in that the expert observers felt that it could be used to
measure participants in any live simulation. For example, one of the items asks the
observers to rate whether the participant “takes the simulation seriously”. This would
apply to participants in a live-fire exercise as well as in this instructor training live
simulation.

2. The checklist items in part two are designed to collect data specific to the simulation.
During the development of this part it was important to focus on the specific training
outcomes (learning objectives) and behavioral markers that would indicate the
participants were applying what they learned in training. This part of the checklist
should be specific to the simulation for which it is intended. While any live
simulation developed for instructor training might share some common items, this
section of the checklist for a mass-casualty live simulation might be completely
different. For example, since this training taught the participants how to
observe/monitor their students and this was a goal of the simulation; “Observes and
Monitors” was an item on the checklist where as “response time” might be a marker
on a mass-casualty exercise checklist.

3. Part three was a built in job aid and this was key to the success of the checklist. This
job aid was developed specifically to support rating the items in part two and would
be unique to the items developed for that part of the checklist. In order to develop part
three, SMEs translated esoteric and somewhat ill defined behaviors statements from
the objectives (such as “Observes and Monitors”) into more concrete and specific
sub-behavioral markers for the expert observers to rate. For example, “Observes and
Monitors” was decomposed further into five sub-behavioral markers (e.g., ensured
the group of students stayed on track) for the job aid. Developing the job aid and its related sub-behavioral markers was time consuming, but provided a necessary mechanism for standardizing rating across observers and provided a means for non-SME observers to more accurately rate technical performance.

It is recommended that those wishing to develop a data collection instrument for a live simulation invest the time working with SMEs and the simulations training objectives to develop the technical behavioral markers specific for their simulation.

5.6 Limitations to Expert-reported Live Simulation Performance

One of the important dependent variables in this study was the participant’s level of performance in the live simulation as reported by expert raters. In order to document their performance, a checklist for the expert raters was developed (APPENDIX D: LIVE SIMULATION OBSERVER’S CHECKLIST). Since the simulation was designed to provide participants with the opportunity to practice the facilitation skills they learned during the classroom portion of the training; the checklist focused on capturing this aspect of their performance. This led to the development of IRR training and a checklist that constrained the raters to only record the performance of the participants as they practiced the KSAs from their classroom training on becoming a facilitator.

This constraint or bias aspect to the checklist can probably be attributed to the checklist designer’s familiarity with live simulation in an aviation context. For example, during a check ride (live simulation) when the pilot fills the role of pilot in command (PIC) they are required to successfully pass the check ride on their own merit. This was the mental model for the participant in the simulation: that of the instructor facilitating the training to a group of students.
Whereas a better model for rating participants may be the one that is used in aviation training to evaluate performance during a line oriented flight training (LOFT) sessions. During a LOFT session the performance of the entire crew (all team roles) is evaluated rather than just the participant acting in the role of pilot-in-command.

As participants who finished playing the role of the instructor rotated to the role of student, and vice versa, it became clear that many items on the expert observer’s checklist (APPENDIX D: LIVE SIMULATION OBSERVER’S CHECKLIST) also applied to their role as a student. For example, the checklist item: “Treats other performers in the live simulation as appropriate for the simulation,” also applied to the participants when they performed in the role of a student. Collecting data on the participant in both roles would have possibly been more informative and allowed the raters to more accurately assess some items on the checklist.

In general this bias was noticed by the expert observers early in their rating performance in the live simulation. However, their perception was that participant who treated the live simulation with ‘respect’ did so in both in their student and instructor roles. Although there may have been some differences, without further data it is impossible to quantify this aspect of their performance. It is also possible that the expert observers’ data would have been more sensitive if they had collected the participants’ data when they were in the role of the student rather than the instructor.

While this is not a limitation to the study in the classical sense, it is one aspect of the study where additional data collection would have been interesting and it should be something to consider in future studies of this nature and/or in evaluating individual performance in live simulations.
5.7 Implication for Instructional and Simulation Developers

A short time ago during a presentation entitled *Adding Simulation to your Human Performance Toolkit* (Westerlund, Kincaid, & Westerlund, 2010) an attendee who agreed that simulation could be a powerful tool for instructional designers asked: ‘What are some tips I can use to develop live simulation for my customer support staff?’ At that time I was hard pressed to provide her with a prescriptive list of do’s and don’ts for developing live simulation since the vast majority of live simulation developers are guided by heuristics, developed over a number of years of trial-and-error and practice, rather than reference to a seminal text on live simulation.

This study has shed light on a number of potential ‘tips’ and implications for instructional and simulation designers and the design of live simulations. If I were asked the above question today I would tell the above mentioned conference attendee that the epistemological implications from this research for instructional and simulation developers include the following:

1. Students need to know what ‘winning,’ in the context of the simulation, means. If participants view ‘winning’ differently than the simulation designers then they cannot be expected to perform in ways hoped for or predicted.

2. A well thought out and designed performance data collection instrument is critical to standardizing the reporting of performance data. This is especially true if the data is intended for grading or remediation purposes. The expert observer’s checklist needs to capture behavioral indicators that provide insight into the performer’s internal affective state.

3. An understanding of the participant’s or population’s affective variables may assist instructional and simulation designers to better assign learners to various team roles within the simulation. Additionally, learner characteristics may also provide guidance
to developers as they make decisions about the design of the simulation and whether
live simulation is the best learning strategy for a given population or instructional
outcome. Learners who are more resistant to the effects of live simulation may need
additional support before or during the simulation, or may need to be placed in roles
that are more suitable for them. For example, *internals* may need more complex roles.

4. It is important to note that this research focused on individual performance in a live
simulation such as an instructor facilitating training or a phone operator in a call
center; therefore, without further research, it is unknown how much can be
generalized to simulations involving teams. In designing live simulations and data
collection instruments for team performance additional factors need to be considered.
These factors center around the research on team performance and were outside the
scope of this research. According to Salas et al. “The science of team performance
has produced a wealth of knowledge on how to compose, manage, structure, measure
and promote team performance (Salas, Cooke, & Rosen, 2008).”

5. Managers of instructional and simulation design teams may need to bear in mind the
teams biases and the composition of the team to ensure that live simulations do not
favor participants with the same internal preferences as the design team.

6. Existing research on increasing presence, involvement, and immersion should be
incorporated into the development of live simulations (Witmer & Singer, 1998).
While there is no empirical research yet connecting this to live simulation it is in line
with (and in ways extends) existing research on adult learning such as the work on
andragogy by (Knowles, 1996). It is also consistent with the few qualitative responses
(Section 4.2.5 Self-reported Live Simulation Qualitative Data) from the participants pertaining to making the simulation more realistic.

5.8 Future Research

Live simulations are expensive to develop and conduct therefore measures to improve them should provide a significant return-on-investment. As previously discussed, findings from this study and areas for future research include:

1. Determining the most sensitive affective variable useful for predicting performance in live simulation.
2. Developing an elegant and simple instrument for predicting a participant’s performance in a live simulation and predicting transfer to ‘real life’ situations.
3. Conducting research with larger sample sizes in order to make stronger statements with regards to the distribution of affective variables in the population.
4. Determining to what extent the findings from this research can be generalized to other types of live simulation.
5. Determining if other forms of live simulation (e.g., mass-casualty exercises, live fire exercises, customer support exercises, etc.) depend on different affective variables.
6. Investigating the most suitable roles for a participant in a live simulation for a given learning style or affective variable preference.
7. Investigating whether a questionnaire that would be analogous to Witmer and Singer’s presence questionnaire (PQ) could be developed for live simulation. The PQ is designed to measure to what degree an individual experiences presence in a virtual environment. The goal of the Westerlund Live Simulation Presence Questionnaire
(WLSPQ) would be to develop an instrument for measuring presence in a live simulation.

8. Investigating the link between Spector’s hypothesis that workplace performance may be degraded for high internals that do not find relevance in a task, and their performance in live simulation.

9. Determine if too much internal locus of control is correlated with a decrease in participant’s performance.
APPENDIX A: TRAINING LOCUS OF CONTROL SCALE
**TRAINING QUESTIONNAIRE #1**

Name: ________________________________________________

The following questions concern your GENERAL beliefs and feelings.

1. **USE PEN OR PENCIL TO MAKE DARK MARKS LIKE THIS ● NOT LIKE THIS ☒ ☐**

2. **MARK ONLY ONE OPTION PER QUESTION AND ANSWER ALL THE QUESTIONS.**

REMEMBER THAT YOUR ANSWERS ARE CONFIDENTIAL AND WILL ONLY BE USED TO IMPROVE TRAINING.

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree Moderately</th>
<th>Disagree Slightly</th>
<th>Agree Slightly</th>
<th>Agree Moderately</th>
<th>Agree Very Much</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Life is what you make of it.</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>2. For most of life, people can pretty much accomplish whatever they set out to accomplish</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>3. If you know what you want out of life, you can achieve it</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>4. If people are unhappy with a decision made by the person in charge, they should do something about it</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>5. Getting what you want out of life is mostly a matter of luck</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>6. Making money is primarily a matter of good fortune</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>7. Most people are capable of doing well if they make the effort</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>8. In order to do well in life, you need to have family members or friends in high places</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>9. Doing well is usually a matter of good fortune</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>10. When it comes to really doing well, who you know is more important than what you know</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>11. Achieving success in life is a result of hard work and performing well</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>12. To make a lot of money you have to know the right people</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>13. It takes a lot of luck to be an outstanding employee on most jobs</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>14. People who perform well generally get rewarded</td>
<td>○ ○ ○ ○ ○ ○</td>
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<tr>
<td>15. Most employees have more influence on the person in</td>
<td>○ ○ ○ ○ ○ ○</td>
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</table>
charge than they think they do

16. The main difference between people who make a lot of money and people who make a little money is luck

17. Practice is the key to performing well
APPENDIX B: TRAINING IMMERSION TENDENCIES SCALE
<p>| | | | | | | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Do you easily become deeply involved in movies or TV dramas?</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
<tr>
<td>2. Do you ever become so involved in a television program or book that people have problems getting your attention?</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
<tr>
<td>3. Do you ever become so involved in a movie that you are not aware of things happening around you?</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
<tr>
<td>4. How frequently do you find yourself closely identifying with the characters in a story line?</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
<tr>
<td>5. Do you ever become so involved in a video game that it is as if you are inside the game rather than moving a joystick and watching the screen?</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
<tr>
<td>6. How good are you at blocking out external distractions when you are involved in something?</td>
<td>Not Very Good</td>
<td></td>
<td>Somewhat Good</td>
<td></td>
<td></td>
<td>Very Good</td>
</tr>
<tr>
<td>7. When watching sports, do you ever become so involved in the game that you react as if you were one of the players?</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
<tr>
<td>8. Do you ever become so involved in a daydream that you are not aware of things happening around you?</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
<tr>
<td>9. Do you ever have dreams that are so real that you feel disoriented when you awake?</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
<tr>
<td>10. When playing sports, do you become so involved in the game that you lose track of time?</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
<tr>
<td>11. How well do you concentrate on enjoyable activities?</td>
<td>Not At All</td>
<td></td>
<td>Moderately Well</td>
<td></td>
<td></td>
<td>Very Well</td>
</tr>
<tr>
<td>12. How often do you play arcade or video games? (OFTEN should be taken to mean every day or every two days, on average.)</td>
<td>Never</td>
<td></td>
<td>Occasionally</td>
<td></td>
<td></td>
<td>Often</td>
</tr>
</tbody>
</table>
13. Have you ever gotten excited during a chase or fight scene on TV or in the movies?  
   - Never  - Occasionally  - Often

14. Have you ever gotten scared by something happening on a TV show or in a movie?  
   - Never  - Occasionally  - Often

15. Have you ever remained apprehensive or fearful long after watching a scary movie?  
   - Never  - Occasionally  - Often

16. Do you ever become so involved in doing something that you lose all track of time?  
   - Never  - Occasionally  - Often

17. On average, how many books do you read for enjoyment in a month?  
   - None  - One  - Two  - Three  - Four  - Five  - Six or More

18. Do you ever get involved in projects or tasks, to the exclusion of other activities?  
   - Never  - Occasionally  - Often

19. How easily can you switch attention from the activity in which you are currently involved to a new and completely different activity?  
   - Not Easily  - Fairly Easily  - Very Easily

20. How often do you try new restaurants or new foods when presented with the opportunity?  
   - Never  - Occasionally  - Often

21. How frequently do you volunteer to serve on committees, planning groups, or other civic or social groups?  
   - Never  - Sometimes  - Frequently

22. How often do you try new things or seek out new experiences?  
   - Never  - Occasionally  - Often

23. Given the opportunity, would you travel to a country with a different culture and a different language?  
   - Never  - Sometimes  - Maybe  - Absolutely

24. Do you go on carnival rides or participate in other leisure activities (horseback riding, bungee jumping, snow skiing, water sports) for the excitement of thrills that they provide?  
   - Never  - Occasionally  - Often

25. How well do you concentrate on disagreeable tasks?  
   - Not At All  - Reasonably Well  - Very Well

26. How often do you play games on computers?  
   - Never  - Occasionally  - Often
27. How many different video, computer, or arcade games have you become reasonably good at playing?  
- None  - One  - Two  - Three  - Four  - Five  - Six or More

28. Have you ever felt completely caught up in an experience, aware of everything going on and completely open to all of it?  
- Never  - Occasionally  - Frequently

29. Have you ever felt completely focused on something, so wrapped up in that one activity that nothing could distract you?  
- Not at all  - Occasionally  - Frequently

30. How frequently do you get emotionally involved (angry, sad, or happy) in news stories that you see, read, or hear?  
- Never  - Occasionally  - Often

31. Are you easily distracted when involved in an activity or working on a task?  
- Never  - Occasionally  - Often
APPENDIX C: PARTICIPANT’S SIMULATION PERFORMANCE QUESTIONNAIRE
Name: __________________________________________

**DIRECTIONS:**

1. **USE PEN OR PENCIL TO MAKE DARK MARKS LIKE THIS ● NOT LIKE THIS ✗ ☑
2. **MARK ONLY ONE OPTION PER QUESTION AND ANSWER ALL THE QUESTIONS ON THE FRONT AND THE BACK**
3. **REMEMBER THAT YOUR ANSWERS ARE COMPLETELY CONFIDENTIAL. NO INSTRUCTOR OR ACADEMY PERSONNEL WILL SEE YOUR INDIVIDUAL SURVEY RESULTS.**

| Please read each pair of statements. Indicate which of the two most closely matches your opinion about the exercise you just completed. The more the statement matches your opinion, the closer your mark should be to it. |
| --- | --- | --- | --- | --- | --- | --- |
| I DID NOT like the exercise. ☐ ☐ ☐ ☐ ☐ | I LIKED the exercise. ☑ ☑ ☑ ☑ ☑ |
| This exercise covered TOO LITTLE material. ☐ ☐ ☐ ☐ ☐ | This exercise covered TOO MUCH material. ☑ ☑ ☑ ☑ ☑ |
| I will RETAIN what I learned from this exercise. ☐ ☐ ☐ ☐ ☐ | I will SOON FORGET what I learned from this exercise. ☑ ☑ ☑ ☑ ☑ |
| I EXPECTED to complete exercises like this as part of my training. ☐ ☐ ☐ ☐ ☐ | I DID NOT EXPECT to complete exercises like this as part of my training. ☑ ☑ ☑ ☑ ☑ |
| I have completed MANY exercises similar to this one. ☐ ☐ ☐ ☐ ☐ | I have completed FEW exercises similar to this one. ☑ ☑ ☑ ☑ ☑ |
| I found the exercise to be DIFFICULT. ☐ ☐ ☐ ☐ ☐ | I found this experience to be EASY. ☑ ☑ ☑ ☑ ☑ |
| The task for which I am training WILL BE MUCH EASIER because I completed this exercise. ☐ ☐ ☐ ☐ ☐ | The task for which I am training WILL NOT BE ANY EASIER because I completed this exercise. ☑ ☑ ☑ ☑ ☑ |
| The setting for this task felt ARTIFICIAL. ☐ ☐ ☐ ☐ ☐ | The setting for this task felt REALISTIC. ☑ ☑ ☑ ☑ ☑ |
| The responses of others to my performance felt ARTIFICIAL. ☐ ☐ ☐ ☐ ☐ | The responses of others to my performance felt REALISTIC. ☑ ☑ ☑ ☑ ☑ |
| The experience was of LITTLE VALUE to me. ☐ ☐ ☐ ☐ ☐ | The experience was of GREAT VALUE to me. ☑ ☑ ☑ ☑ ☑ |
| I WILL NOT be able to apply this experience to my job. ☐ ☐ ☐ ☐ ☐ | I WILL be able to apply this experience to my job. ☑ ☑ ☑ ☑ ☑ |
| I learned LITTLE from doing the exercise myself. ☐ ☐ ☐ ☐ ☐ | I learned A GREAT DEAL from doing the exercise myself. ☑ ☑ ☑ ☑ ☑ |
| I learned LITTLE from watching others do the exercise. ☐ ☐ ☐ ☐ ☐ | I learned A GREAT DEAL from watching others do the exercise. ☑ ☑ ☑ ☑ ☑ |
| The exercise was an INEFFECTIVE way to practice my skills. ☐ ☐ ☐ ☐ ☐ | The exercise was an EFFECTIVE way to practice my skills. ☑ ☑ ☑ ☑ ☑ |
| I took the exercise LIGHTLY. ☐ ☐ ☐ ☐ ☐ | I took the exercise SERIOUSLY. ☑ ☑ ☑ ☑ ☑ |
| Other students in my class took the exercise LIGHTLY. ☐ ☐ ☐ ☐ ☐ | Others students in my class took the exercise SERIOUSLY. ☑ ☑ ☑ ☑ ☑ |
| I did a **POOR** job with the exercise. | I did an **EXCELLENT** job with the exercise. |
| Others in my class did a **POOR** job with the exercise. | Others in my class did an **EXCELLENT** job with the exercise. |
| I WILL use the knowledge and skills I developed in this exercise. | I WILL NOT use the knowledge and skills I developed in this exercise. |
| This exercise was a **GOOD MATCH** for my learning style. | This exercise was a **POOR MATCH** for my learning style. |
| I FEEL READY to try what I learned in this exercise. | I DO NOT FEEL READY to try what I learned in this exercise. |
| I would like **MORE** activities like this as part of my training. | I would like **FEWER** activities like this as part of my training. |
| This exercise was **GOOD PRACTICE**. | This exercise was **NOT GOOD PRACTICE**. |
| I am **SKEPTICAL** that this exercise is a good way to practice what I learned. | I am **NOT SKEPTICAL** that this exercise is a good way to practice what I learned. |
| After this exercise I felt it was a **GOOD USE** of my time. | After this exercise I felt it was **NOT A GOOD USE** of my time. |
| This exercise was **APPROPRIATE** for someone with my level of expertise. | This exercise was **INAPPROPRIATE** for someone with my level of expertise. |
| I would **RECOMMEND** this activity as a good way to develop experience. | I would **NOT RECOMMEND** this activity as a good way to develop experience. |

**What specific aspects of the exercise, if any, differed with the real world?**

**Thank you for your time.**
<table>
<thead>
<tr>
<th>Performer’s Technical Behaviors (as appropriate for the simulation)</th>
<th>Disagree very much</th>
<th>Disagree moderately</th>
<th>Disagree slightly</th>
<th>Agree slightly</th>
<th>Agree moderately</th>
<th>Agree very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintains eye contact with audience.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Uses appropriate body language.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Uses appropriate inflection while delivering lesson.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Manages learner interactions to facilitate learning.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Takes steps to involve the learner.</td>
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<tr>
<td>Makes appropriate use of media in delivering lesson.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Demonstrates mastery of questioning skills.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Appropriate language for lesson.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Prepares lesson plan appropriate for the adult learner.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Demonstrates consideration of linkages between learning objectives and evaluation methods</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Overall, the performer presents the lesson well.</td>
<td>1 2 3 4 5 6</td>
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</table>

<table>
<thead>
<tr>
<th>Performer’s Simulation Behaviors</th>
<th>Disagree very much</th>
<th>Disagree moderately</th>
<th>Disagree slightly</th>
<th>Agree slightly</th>
<th>Agree moderately</th>
<th>Agree very much</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does not “break character” while in the simulation.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Demonstrates he/she takes the simulation seriously.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Uses tools or equipment necessary for the simulation appropriately.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Monitors his/her behaviors and improves over the course of the simulation.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Treats other performers in the live simulation as appropriate for the simulation.</td>
<td>1 2 3 4 5 6</td>
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<tr>
<td>Items</td>
<td>Markers</td>
<td></td>
<td>Notes</td>
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<tr>
<td><strong>Briefs Trainees</strong></td>
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<tr>
<td></td>
<td>Introduced self and online training modules</td>
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<tr>
<td></td>
<td>Provided motivating statement (e.g., “What’s in it for me?”)</td>
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<tr>
<td></td>
<td>Covered administrative details</td>
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<tr>
<td></td>
<td>Reviewed module and lesson objectives/expectations</td>
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<tr>
<td></td>
<td>*Explained why cooperative learning is important, including 2 responsibilities</td>
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<tr>
<td></td>
<td>*Explained group accountability in lesson post-test process, if applicable</td>
<td></td>
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<tr>
<td></td>
<td>*Emphasized importance of reading and following directions, especially during cooperative exercises</td>
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<tr>
<td></td>
<td>Explained why you are observing and how you will be observing (e.g. you’ll be in and out of the room)</td>
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<td></td>
<td>Explained everything trainees need to complete the training is accessible on the computer (including cases, scenarios, objectives, cooperative exercises)</td>
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<tr>
<td></td>
<td>Provided tips for progressing through course</td>
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<tr>
<td></td>
<td>*Checked for understanding</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Observes/ Monitors</strong></td>
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<tr>
<td></td>
<td>*Used unobtrusive observation techniques that did not interfere with group’s ability to meet objectives</td>
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<tr>
<td></td>
<td>*Ensured group stayed on track</td>
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<tr>
<td></td>
<td>*Ensured everyone actively participated</td>
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### Work Locus of Control Scale

*Copyright Paul E. Spector, All rights reserved, 1988*

The following questions concern your beliefs about jobs in general. They do not refer only to your present job.

|   | 1. A job is what you make of it. | 2. On most jobs, people can pretty much accomplish whatever they set out to accomplish | 3. If you know what you want out of a job, you can find a job that gives it to you | 4. If employees are unhappy with a decision made by their boss, they should do something about it | 5. Getting the job you want is mostly a matter of luck | 6. Making money is primarily a matter of good fortune | 7. Most people are capable of doing their jobs well if they make the effort | 8. In order to get a really good job, you need to have family members or friends in high places | 9. Promotions are usually a matter of good fortune | 10. When it comes to landing a really good job, who you know is more important than what you know | 11. Promotions are given to employees who perform well on the job | 12. To make a lot of money you have to know the right people | 13. It takes a lot of luck to be an outstanding employee on most jobs | 14. People who perform their jobs well generally get rewarded | 15. Most employees have more influence on their supervisors than they think they do | 16. The main difference between people who make a lot of money and people who make a little money is luck |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|   | Disagree very much | Disagree moderately | Disagree slightly | Agree slightly | Agree moderately | Agree very much |
| 1. | 1 | 2 | 3 | 4 | 5 | 6 |
| 2. | 1 | 2 | 3 | 4 | 5 | 6 |
| 3. | 1 | 2 | 3 | 4 | 5 | 6 |
| 4. | 1 | 2 | 3 | 4 | 5 | 6 |
| 5. | 1 | 2 | 3 | 4 | 5 | 6 |
| 6. | 1 | 2 | 3 | 4 | 5 | 6 |
| 7. | 1 | 2 | 3 | 4 | 5 | 6 |
| 8. | 1 | 2 | 3 | 4 | 5 | 6 |
| 9. | 1 | 2 | 3 | 4 | 5 | 6 |
| 10. | 1 | 2 | 3 | 4 | 5 | 6 |
| 11. | 1 | 2 | 3 | 4 | 5 | 6 |
| 12. | 1 | 2 | 3 | 4 | 5 | 6 |
| 13. | 1 | 2 | 3 | 4 | 5 | 6 |
| 14. | 1 | 2 | 3 | 4 | 5 | 6 |
| 15. | 1 | 2 | 3 | 4 | 5 | 6 |
| 16. | 1 | 2 | 3 | 4 | 5 | 6 |
APPENDIX F: IMMERSIVE TENDENCY QUESTIONS
(Witmer & Singer, 1998)

1. Do you easily become deeply involved in movies or TV dramas?
2. Do you ever become so involved in a television program or book that people have problems getting your attention?
3. How mentally alert do you feel at the present time?
4. Do you ever become so involved in a movie that you are not aware of things happening around you?
5. How frequently do you find yourself closely identifying with the characters in a story line?
6. Do you ever become so involved in a video game that it is as if you are inside the game rather than moving a joystick and watching the screen?
8. How physically fit do you feel today?
9. How good are you at blocking out external distractions when you are involved in something?
10. When watching sports, do you ever become so involved in the game that you react as if you were one of the players?
11. Do you ever become so involved in a daydream that you are not aware of things happening around you?
12. Do you ever have dreams that are so real that you feel disoriented when you awake?
13. When playing sports, do you become so involved in the game that you lose track of time?
14. How well do you concentrate on enjoyable activities?
15. How often do you play arcade or video games? (OFTEN should be taken to mean every day or every two days, on average.)
16. Have you ever gotten excited during a chase or fight scene on TV or in the movies?
17. Have you ever gotten scared by something happening on a TV show or in a movie?
18. Have you ever remained apprehensive or fearful long after watching a scary movie?
19. Do you ever become so involved in doing something that you lose all track of time?
20. On average, how many books do you read for enjoyment in a month?
21. Do you ever get involved in projects or tasks, to the exclusion of other activities?
22. How easily can you switch attention from the activity in which you are currently involved to a new and completely different activity?
23. How often do you try new restaurants or new foods when presented with the opportunity?
24. How frequently do you volunteer to serve on committees, planning groups, or other civic or social groups?
25. How often do you try new things or seek out new experiences?
26. Given the opportunity, would you travel to a country with a different culture and a different language?

27. Do you go on carnival rides or participate in other leisure activities (horseback riding, bungee jumping, snow skiing, water sports) for the excitement of thrills that they provide?

28. How well do you concentrate on disagreeable tasks?

29. How often do you play games on computers?

30. How many different video, computer, or arcade games have you become reasonably good at playing?

31. Have you ever felt completely caught up in an experience, aware of everything going on and completely open to all of it?

32. Have you ever felt completely focused on something, so wrapped up in that one activity that nothing could distract you?

33. How frequently do you get emotionally involved (angry, sad, or happy) in news stories that you see, read, or hear?

34. Are you easily distracted when involved in an activity or working on a task?
APPENDIX G: ADDITIONAL LOCUS OF CONTROL DATA
This appendix contains additional LOC data for future evaluation and analysis.

Figure 22: Histograms of Participant's LOC Responses
Figure 23: Histogram of LOC Item Responses
Figure 24: Box Plots of LOC Survey Items
Figure 25: Box Plots of Participants' LOC Survey Responses
Figure 26: Individual Value Plot of LOC Scale Items
This appendix contains additional IMT data for future evaluation and analysis.

Figure 27: Regression for Senior Rater vs. IMT Scores
Analysis of Variance for Two Observers

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R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
Residual Plots for Senior Observer

Figure 28: Residual Plots for Senior Observer
Regression Analysis: Senior Observer (SO) vs. IMT Scores

The regression equation is
SO = 16.2 + 0.0239 IMT Scores

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S = 6.53937  R-Sq = 0.5%  R-Sq(adj) = 0.0%

Analysis of Variance

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R denotes an observation with a large standardized residual.
X denotes an observation whose X value gives it large leverage.
APPENDIX I: IRB APPROVAL
NOT HUMAN RESEARCH DETERMINATION

From : UCF Institutional Review Board #1  
FWA00000351, IRB00001138  
To : Ken K. Westerlund  
Date : March 06, 2013

Dear Researcher:

On 3/6/2013 the IRB determined that the following proposed activity is not human research as defined by DHHS regulations at 45 CFR 46 or FDA regulations at 21 CFR 50/56:

Type of Review: Not Human Research Determination  
Project Title: Affective variable impacting the efficacy of live simulation.  
Investigator: Ken K. Westerlund  
IRB ID: SBE-13-09105  
Funding Agency:  
Grant Title:  
Research ID: N/A

University of Central Florida IRB review and approval is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are to be made and there are questions about whether these activities are research involving human subjects, please contact the IRB office to discuss the proposed changes.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Patricia Davis on 03/06/2013 01:22:33 PM EST

IRB Coordinator
LIST OF REFERENCES


Ruggeroni, C. (2001). Ethical education with virtual reality: Inmersiveness and the knowledge transfer process. In G. Riva, & F. Davide (Eds.), *Communications through virtual*


