

EVALUATING TACTICAL COMBAT CASUALTY CARE TRAINING TREATMENTS  
EFFECTS ON COMBAT MEDIC TRAINEES IN LIGHT OF SELECT HUMAN  
DESCRIPTIVE CHARACTERISTICS

by

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## **ABSTRACT**

The use of military forces in urban operations has increased considerably over the past years. As illustrated by the current conflict in Iraq, the Army finds itself fighting its toughest battles in urban areas facing unconventional forces. Soldiers face many threats in hostile fire environments, whether conducting large-scale mechanized warfare, low-intensity conflicts, or operations other than war. Through 1970, there has been no demonstrable reduction in battlefield mortality rate as a percentage of all casualties since data was kept since before the Civil War. For that period of time, nearly all the reduction in overall mortality rate occurred through reduced mortality in Hospital Chain. As of 1970, about 90 percent of all combat deaths occur before a casualty reaches a definitive care facility.

Tactical Combat Casualty Care (TCCC), also known as TC3, is the pre-hospital care rendered to a casualty in a combat environment. The application of TCCC principles during a tactical combat environment has proven highly effective and is a major reason why combat deaths in latest conflicts (Operation Iraqi Freedom and Operation Enduring Freedom) are lower than in any other conflict in the history of the United States.

The Army continues to emphasize reducing battlefield mortality rate. Current tools and methods used for initial skills and sustainment training of combat medics throughout the Army are insufficient. New technologies are needed to provide medics with greater opportunities to develop and test their decision making and technical medical skills in multiple, COE-relevant, training scenarios.

In order to address some of these requirements, the U.S. Army Research Development and Engineering Command, Simulation and Training Technology Center (RDECOM-STTC) is

developing the 68W – Tactical Combat Casualty Care Simulation (TC3 Sim) for the US Army Medical Department (AMEDD) Center & School at Fort Sam Houston. The Army is considering the use of the TC3 Sim game as a tool to improve the training of individual Soldiers as well as improve the readiness of combat medics.

It is the intent of this research to evaluate the effectiveness of instructional games in general and the use of the TC3 game in particular for teaching the concepts of tactical combat casualty care. Experiments will be conducted to evaluate the training effectiveness of this tool in supporting the 68W10 Healthcare Specialist Course program of instruction (POI). The goal of this research is to address important questions such as: Is this game an effective tool to train Soldiers the aspects of TC3? Can knowledge gain through the use of the simulation be transferred into task related situations? How can this tool be incorporated in the current POI in order to increase training effectiveness?

To mom and dad: Thanks for your example, support, and unconditional love.

To Harry, Francisco Javier and Cristina Elena: Every day you inspire me and give me strength to  
continue my journey.

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## CHAPTER ONE: INTRODUCTION

The use of military forces in urban operations has increased considerably over the past years. As illustrated by the current conflict in Iraq, the Army finds itself fighting its toughest battles in urban areas facing unconventional forces. Soldiers face many threats in hostile fire environments, whether conducting large-scale mechanized warfare, low-intensity conflicts, or operations other than war. Through 1970, there has been no demonstrable reduction in mortality rate as a percentage of casualties on the battlefield since before the Civil War as depicted in Figure 1. As seen in Figure 2, as of 1970 about 90 percent of all combat deaths occur before a casualty reaches a definitive care facility (Parsons 2006). Figure 3 provides statistics regarding the top ten causes of death in Operation Iraqi Freedom (Parsons 2006, Training Materials). In Iraq, the use of Improvised Explosive Devices (IEDs) by enemy forces has become a challenge and has worsened the situation. IEDs are designed to kill or incapacitate personnel and mostly are victim-activated (Global Information 2006). The amount of casualties due to these devices is increasing. Recent statistics show, that in the past, 40 to 60 percent of the attacks began with an IED with direct fire attacks immediately following the detonation of the device. Figure 4 shows IED fatalities by month from July 2003 until June 2006 (ICCC 2006). This is the situation our Soldiers are facing constantly and the Army needs to be able to train in these urban scenarios as well as conduct realistic mission planning and mission rehearsal. Modeling and simulation plays a big role in the development and refinement of Army tactics, techniques and procedures (DoD Modeling and Simulation Master Plan, 1995). One group that can greatly benefit from this kind of training is the military medical personnel. The primary mission of all military medical personnel in the combat field is to treat the wounded and save lives.



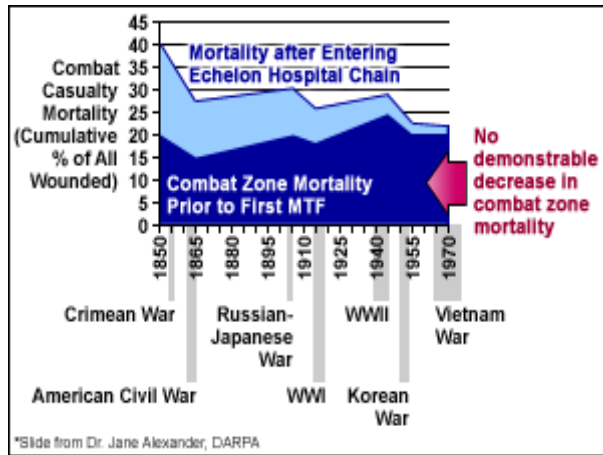


Figure 1: Demonstrable Reduction in Mortality Rate (retrieved from ATTAPS website on June 30, 2006)

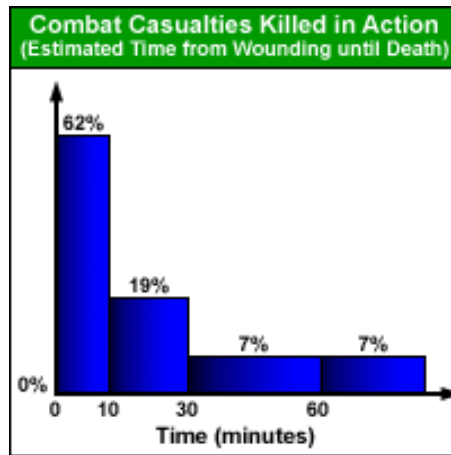


Figure 2: Combat Casualties Killed in Action (KIA)

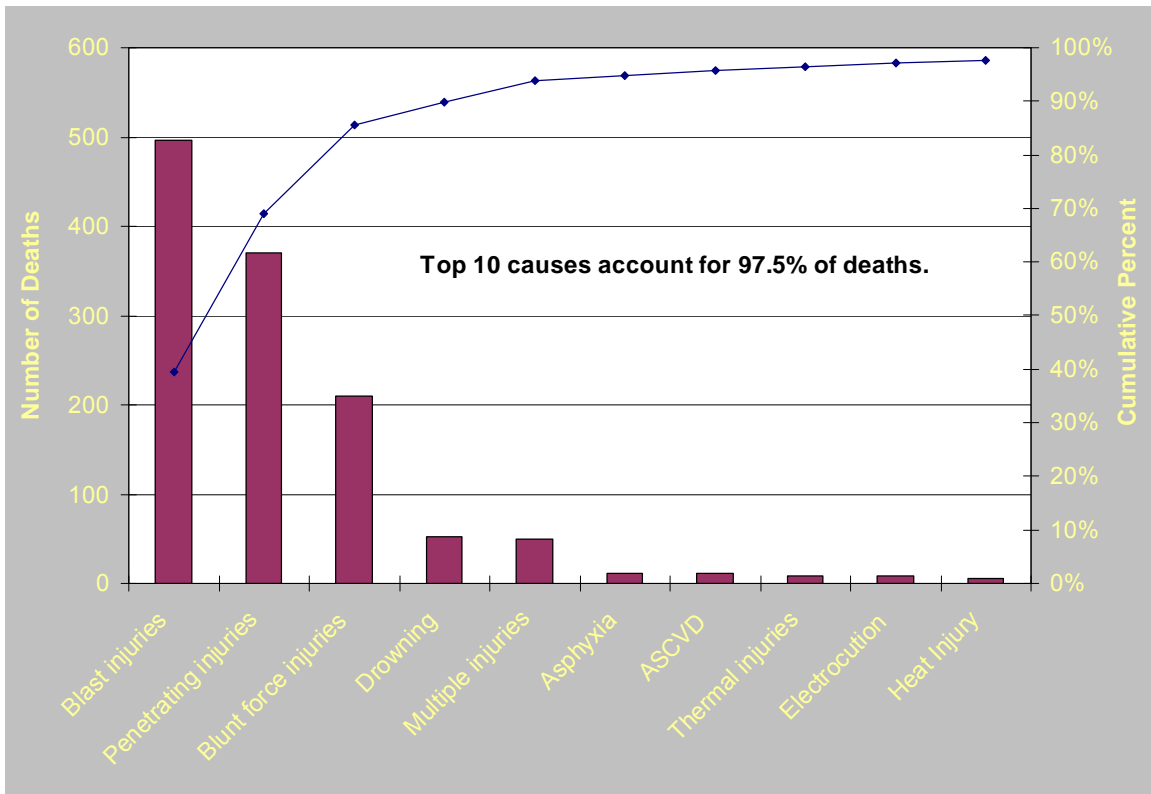


Figure 3: Top Ten Causes of Death in Operation Iraqi Freedom

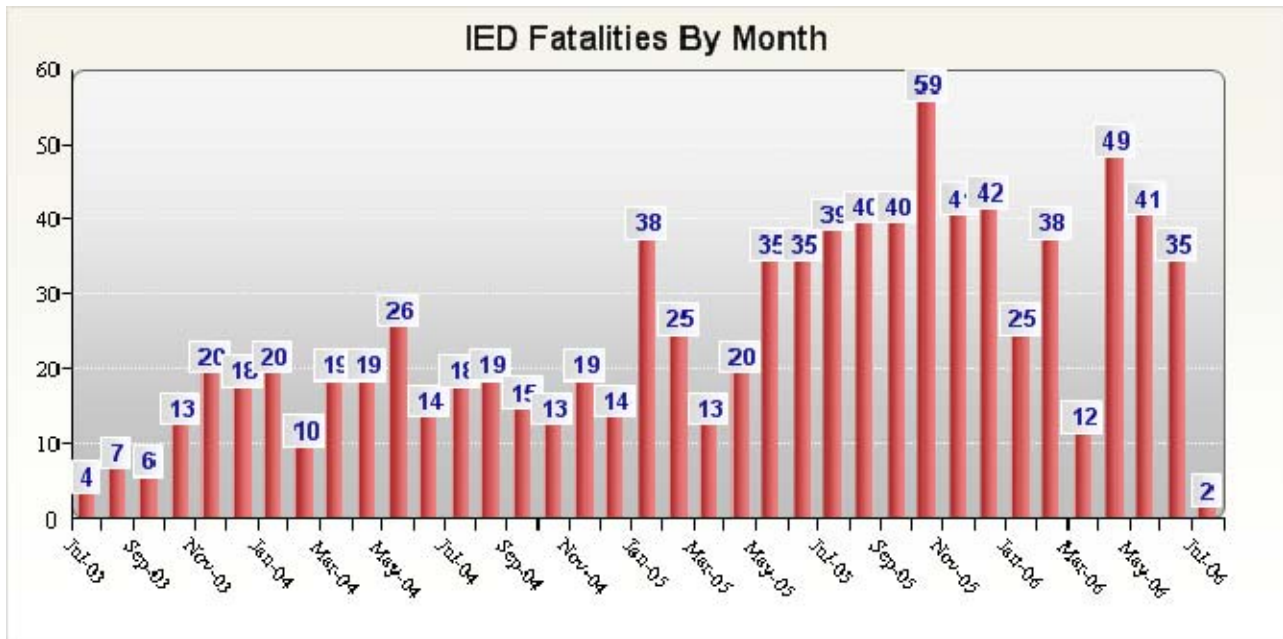


Figure 4: Monthly Statistics of Fatalities Caused by IEDs

## **Modeling, Simulation, and Games in Training**

Modeling is a generic term meaning the generation of an abstract representation of some real world entity. A model is a physical, mathematical, or logical representation of a system, entity, phenomenon, or process. A simulation is a method for implementing a model over time. It is a software framework that executes a model in the proper order, provides timing and coordination between them, and controls the inputs and outputs. Modeling and simulation is the use of models, including emulators, prototypes, simulators, and stimulators, either statically or over time, to develop data as a basis for making managerial or technical decisions (Wikipedia 2006).

Training simulations typically come in one of three categories:

1. Live Simulation: involves real people operating real systems. Military training events using real equipment are live simulations. They are considered simulations because these events are not conducted against a live enemy. In general, live simulations may:
  - Involve individuals or groups
  - Use actual equipment
  - Involve sensors/instrumentation that track location, time of weapon fire, time of weapon impact/casualties, and other important information
  - Provide an area of operations similar to that used in combat and not fully replicate actual combat operations
2. Virtual Simulation: A simulation involving real people operating simulated systems in a simulated world or “virtual environment”. The virtual environment is the effect created by generating an environment that does not exist in the real world. The environment is interactive, allowing the participant to look and navigate about the environment,

enhancing the immersion effect. Virtual simulations inject human-in-the-loop in a central role by exercising motor control skills, decision skills, or communication skills.

3. Constructive Model or Simulation: Models and simulations that involve simulated people operating simulated systems. Real people stimulate (make inputs) to such simulations, but are not involved in determining the outcomes. Constructive simulation is often referred to as "wargaming" since it bears some resemblance to table-top war games in which players command armies of Soldiers and equipment which move around a board.

The categorization of simulation into live, virtual, and constructive is problematic (Wikipedia 2006), because there is no clear division between these categories. The degree of human participation in the simulation is infinitely variable, as is the degree of equipment realism. This categorization of simulations also suffers by excluding a category for simulated people working real equipment, for example smart vehicles. Even though live training has been the preferred method of military preparedness, it involves large amounts of time, people, money, and resources. Simulation and virtual training can be used to augment live training. In addition, when live training is limited due to monetary, time or operational constraints, simulation systems can help fill the training gap.

The Army, in an effort to improve effectiveness and efficiency of training at all levels is looking to make use of simulation to train its units and leaders. In fact, the Department of Defense (DoD) has identified the need to restructure the entire process of training as stated in the DoD Training Transformation Plan (Department of Defense, 2004 page 2), "The dramatic transformation of America's strategic environment continues its significant impact on our military forces and its demand for an equally dramatic transformation in how we prepare forces for combat and non combat operations... we need to transform the way we train."

The US Army faces budget and time constraints, therefore, new ways need to be identified in an effort to provide effective and relevant training taking into account limited resources. One area that the Army is looking into is the use of PC based training as well as gaming technology. Desktop simulations and digital game-based technologies have earned much attention for their potential as training tools. Hays (2005) provided the following definition of a game: “A game is an artificially constructed, competitive activity with a specific goal, a set of rules and constraints that is located in a specific context. A game is not reality. It is a constructed activity that resembles portions of reality. It provides a competitive environment for a player by challenging him or her to reach a goal. The purpose of the game (e.g., enjoyment, information, instruction, etc) helps define the goals, rules, and context of the game.” The physical realism and interactivity of the emerging gaming technologies could be utilized to develop cognitive skills. Prior research indicates that higher levels of learning motivation are associated with digital game-based technologies (Baxter, Ross, Phillips, Shafer, & Fowlkes, 2004).

### **Training the Army Combat Medics**

As a nation at war, the initial skills medical training for Army combat medics has shift focus from textbook procedures to realistic, battlefield-centric missions as outlined in the Operational Needs Statement (ONS) for Medical Simulation Training Centers for Combat Lifesavers (CLS) and Tactical Combat Casualty Care (TC3) Training. The Department of Combat Medic Training (DCMT) at the U.S. Army Medical Department Center and School serves as the proponent for the 68W Health Care Specialist and the Army Emergency Medical Service (EMS). The Army combat medics, also known as 68W, provide in many cases the first

line of medical support and assistant to injured Soldiers in the battlefield. DCMT provides the Army with highly motivated and disciplined 68W, Health Care Specialists (Combat Medics) who are National Registry Emergency Medical Technician-Basic (EMT-B) certified. These Soldier medics possess the additional necessary medical skills to sustain the force, survive the battlefield and accomplish the mission to *"Conserve the Fighting Strength."* (AMMED, 2006).

Pre-hospital care continues to be the most important aspect of battlefield medicine. Newly assigned combat medics attend the 16-week, 68W10 Healthcare Specialist Course at Fort Sam Houston, TX. The course supports both active Army and reserve component Soldiers. The instructors use a variety of instructional development strategies to effectively prepare Soldier medics for administering care and saving lives on the battlefield.

The course is designed to train junior enlisted Soldiers to perform emergency medical treatment and routine patient care duties in the field as well as in military treatment facilities. The major training components include combat trauma, invasive procedures, Force Health protection, evacuation, CBRNE (chemical, biological, radiological/nuclear and explosive), and support of care which encompasses some basic nursing skills. The course is taught as part of a 16-week, residence training program and requires 440 hours of classroom training, 192 hours of situational training exercises and 128 hours of field training exercises. The course also prepares students to pass the test requirements of the National Registry of Emergency Medical Technicians – Basic (EMT-B) as a foundation for the Health Care Specialist (Fowler, Smith & Litteral, 2005).

Soldier medics are preparing for these missions by participating in more field exercises with an emphasis on mass casualties and patient evacuation. Classroom instruction provides Soldiers with the basic knowledge and skills; however, current classroom and field instruction

lack the ability to provide all Soldiers with an opportunity to test their skills in multiple, COE (Current Operating Environment) relevant, training scenarios.

Even though the current Died-of-Wounds rate for Operation Iraqi Freedom is at a historically low rate, Soldiers continue to die from the three main causes: Hemorrhage, Airway Compromise, and Tension Pneumothorax. Operations in Afghanistan and Iraq have identified gaps in the training of combat medics. Improvements in the way medics are trained in Tactical Combat Casualty Care, particularly in regards to the three main causes of death, can further reduce the number of battlefield deaths and therefore have a direct impact on mission accomplishment. The goal is to improve medical care at the point of the wounding. If a casualty survives long enough to reach a care facility, his chance of survival increases.

### **Tactical Combat Casualty Care**

Tactical Combat Casualty Care, also known as TC3, is the pre-hospital care rendered to a casualty in a combat environment (CALL, 2006). The application of TC3 principles during a tactical combat environment has proven highly effective and is a major reason why combat deaths in latest conflicts (Operation Iraqi Freedom and Operation Enduring Freedom) are lower than in any other conflict in the history of the United States.

Most medical providers and medics train in a traditional civilian trauma care setting. Trauma care training for military corpsmen and medics has been based primarily on the principles taught in the Advanced Trauma Life Support (ATLS) course (Mosby 2003). ATLS provides a standardized approach to the management of trauma that has proved very successful when used in the setting of a hospital emergency department.

The challenge is that the principles of TC3 are fundamentally different from those of traditional civilian trauma care. These differences are based on the unique patterns and types of wounds that are suffered in combat and the tactical conditions medical personnel encounters during combat. Several factors that affect casualty care during combat and differentiate that from a civilian hospital setting include the following:

- Hostile fire may be present which prevents the treatment of the casualty.
- Medical equipment is limited to that carried by mission personnel.
- Tactical considerations may dictate that mission completion take precedence over casualty care.
- Time until casualty evacuation is highly variable (from minutes to hours or days).
- Casualty evacuation may not be possible based on the tactical situation.

To be successful, medical providers must have skills and training oriented to combat trauma care, as opposed to civilian trauma care and unfortunately, many military medical providers and medics lack this type of experience. In a combat environment, the pre-hospital period is the most critical time to care for any casualty. According to the Center for Army Lessons Learned, up to 90 percent of combats deaths occur before a casualty can reach a medical treatment facility. This is the main reason why it becomes critical to treat a combat casualty at the point of injury, prior to evacuation and arrival at a medical facility.

In a combat environment, casualties will generally fall into three categories:

- Casualties who will die regardless of receiving any medical intervention.
- Casualties who will live regardless of receiving any medical intervention.
- Casualties who will die if they do not receive timely and appropriate medical intervention.



In addition, it has been determined that combat deaths result from the following:

- 31 % of the fatalities are due to a penetrating head trauma
- 25 % of the fatalities are due to a surgically uncorrectable torso trauma
- 10 % of the fatalities are due to potentially correctable surgical trauma
- 9 % of the fatalities are due to exsanguinations
- 7 % of the fatalities are due to a mutilating blast trauma
- 5 % of the fatalities are due to Tension Pneumothorax (PTX)
- 1 % of the fatalities are due to airway obstruction/injury
- 12 % of the fatalities are due problems with the wounds, mainly infection and shock

Deaths associated with exsanguinations, Tension Pneumothorax (PTX), and airway obstruction/injury account for 15 % of the fatalities. These deaths could be avoided with timely intervention at the point of injury. Specifically, it has been estimated that of all preventable deaths, 90 % can be avoided with the application of a tourniquet, in the case of an extremity hemorrhage, the immediate treatment of a PTX, and the establishment of a stable airway.

TC3 addresses the Casualties who will die if they do not receive timely and appropriate medical intervention, particularly injuries associated with exsanguinations, Tension Pneumothorax (PTX), and airway obstruction/injury. TC3 is structured so that correct intervention is performed at the correct time in order to meet the three important goals of field care: treat the casualty, prevent additional casualties and complete the mission.

There are three distinct phases of care in combat casualty management. Each phase has its own characteristics and limitations and the care provided under each phase depends directly on those limitations. The following is a description of each phase:

- Care Under Fire – this phase is characterized by the care rendered at the point of injury when both the medic and the casualty are subjected to effective hostile fire. There is extremely high risk of additional injuries from hostile fire for both the medic and the casualty. Available medical equipment is limited to that carried by the medic and the casualty. The major considerations during this phase of care are suppression of hostile fire, moving the casualty to a safe position and treatment of immediate life-threatening hemorrhage. Casualty care during this phase is complicated since the medical equipment available for care is limited and unit’s personnel will be directly engaged with hostile fire preventing them from assisting the casualty with treatment and evacuation. Also, the tactical situation prevents the medic or medical provider from performing a detailed examination or definite treatment of casualties. If the situation occurs at night time, which frequently occurs, the medical provider has to deal with severe visual limitations while treating the casualty.
- Tactical Field Care – this phase is characterized by the care rendered by the medic once both the medic and the casualty are no longer under effective hostile fire. It also applies to those situations in which an injury has occurred on a mission, but there has been no hostile fire. Available medical equipment is still limited to that carried into the field by mission personnel. Time to evacuation may vary from minutes to hours. During this phase care is directed toward more in-depth evaluation and treatment of the casualty focusing on those conditions not addressed during the care under fire phase. The risk of hostile fire has been reduced but still exists; therefore in some cases tactical field care will consist of rapid treatment of wounds with the expectation of reengagement with hostile forces at any time. The need to avoid undertaking nonessential evaluation and

treatment is critical in such situations. The medical equipment available is still limited to what has been brought into the field by mission personnel. The time available for treatment is highly variable and the time prior to evacuation, or possible engagement with hostile forces, can range from a few minutes to hours. Medics must take care to partition supplies and equipment in the event of prolonged evacuation wait times.

- Combat CASEVAC Care- CASEVAC is the evacuation of combat casualties from the battlefield. This phase is characterized by the care rendered once the casualty has been evacuated and picked up by an aircraft, vehicle or boat for transportation to a higher echelon of care. Additional equipment and medical personnel that has been pre-staged should be available. This phase is a continuation of care rendered during the tactical field care, but with the addition of medical personnel and equipment that may be brought with the evacuation asset. The arrival of additional personnel is important for several reasons: the medic can be one of the casualties, there may be multiple casualties exceeding medic's capability to care simultaneously, and additional medical personnel, such as physicians and other specialists, provide greater expertise. The additional medical equipment brought by the evacuation assets serves several purposes: medical re-supply may be accomplished and more advanced medical equipment (blood products, fluids, electronic monitoring devices, oxygen, etc.) may be used.

The tools and methods currently used for initial skills and sustainment training are insufficient for training combat medics throughout the Army. New technologies are needed to provide medics with greater opportunities to develop and test their decision making and technical medical skills in multiple, COE-relevant, training scenarios.

In order to address some of these requirements, the U.S. Army Research Development and Engineering Command, Simulation and Training Technology Center (RDECOM-STTC) executed a three-year (FY04-06), joint Army Technology Objective (ATO) with the US Army Medical Research and Materiel Command (MRMC), entitled Advanced Medic Training Technologies. The goal of the research was to produce enhanced tools, techniques, and procedures enabling the Army to field and maintain better trained medics, reduce the costs of training, and improve the ability to save lives on the battlefield.

In fulfilling this ATO, the US Army RDECOM-STTC forged a partnership with the US Army Medical Department (AMEDD) Center & School, the Department of Combat Medic Training (DCMT) at Fort Sam Houston, TX, and the Army Research Institute (ARI) to develop and implement new technologies to support simulation-based training environments for Army combat medics. The TC3 Game-Based Simulation is a prototype application that was developed through this partnership. This game-based simulation leverages technology developed through previous research sponsored by the RDECOM-STTC, the Joint ADL Co-Laboratory's prototype program, and other associated research for the National Guard Bureau Civil Support Team Trainer (CSTT). It combines advanced interactive training techniques, Advanced Distributed Learning technologies, and immersive 3D/Virtual simulations to provide the required knowledge and skills to significantly improve the training of Army combat medics.

### **The Tactical Combat Casualty Care Simulation (TC3 Sim)**

Military trainers are becoming increasingly interested in using games to train their units. One of these games is the 68W-Tactical Combat Casualty Care Simulation (TC3 Sim). TC3 Sim is comprised of a Desktop Simulation and Courseware for Individual training of the Tactics,

Techniques and Procedures (TTPs) associated with Tactical Combat Casualty Care. TC3 Sim provides a deliberate focus on training objectives by simulating realistic casualties within a tactical combat environment set up to provide cues and conditions to support the principles of TC3. The TC3 simulation merges Advanced Distributed Learning technologies and commercial gaming technologies to provide individual and collective training in an immersive 3D environment. The main purpose of this courseware is to provide the knowledge, skills, and practice necessary to students to help them understand the differences between trauma management in the United States and trauma management in a foreign country during wartime.

The 68W – TC3 Sim was developed for the US Army Medical Department (AMEDD) Center & School at Fort Sam Houston in partnership with the US Army Research, Development and Engineering Command's Simulation & Training Technology Center (RDECOM-STTC). The courseware is based on the same systematic approach for Basic and Advanced Trauma Life Support (BTLS, ATLS) that is used for Emergency Medical Technicians (EMTs). However, it will incorporate tactical situations that will require departures from these established principles as dictated by the principles of Tactical Combat Casualty Care (TC3).

### **Capabilities of TC3 Sim**

- “Learn by doing” – Combat Medics and Combat Lifesavers may practice and train together in the same 3D environment from geographically different locations.
- A Standards-Based Architecture allows tracking and assessment of student performance through any SCORM (Shareable Content Object Reference Model) conformant Learning Management System.

- Standardized Curriculum - conforms to Basic and Advanced Trauma Life Support courses (BTLS, ATLS) and the Emergency Medical Technician Basic Course (EMT-B)
- Cost Effective – All assets used to develop the 68W-TC3 Simulation are tagged with meta-data so that they can be reused and repurposed for other training applications.
- Modular Development - Deliver complex information to a diverse, geographically dispersed audience in a short period of time
- Simulation Subsystem – Accurate casualty models within tactical combat scenarios drive the interactions between the student, the simulated environment and other entities.
- Individual and Collective Training – Provide practical feedback and hands-on experience in situations that cannot easily be practiced using live scenarios.
- After Action Review – Feedback in the form of an “after action review” will be supported by the ability to replay the entire simulation in varying levels of detail
- Portability – Simulations may be accessed online or may be installed on an existing network for use in the classroom. Also the students have the capability to run the software from their PCs.
- Human Performance Assessment Modeling to allow both skill-based and knowledge-based assessments.

The TC3 simulation provides the opportunity of improving the training of Army combat medics through the use of virtual Field Training Exercises in which each Soldier will play the role of a combat medic in a variety of contextual situations. The training is centered on TC3 tasks such, as accessing casualties, prioritizing treatment (triage), treating casualties and preparing casualties for evacuation. The use of this relatively low-cost training tool is expected

to improve the training of the Soldiers and improve the readiness of combat medics throughout the Army.

The TC3 simulation is being designed for use in the following capacities for initial and sustainment training (Fowler, Smith & Litteral, 2005):

1. When used in a classroom environment at the AMEDD Center & School, the TC3 simulation will provide an opportunity for student medics to assume key positions and perform their duties under the guidance of an instructor. This approach also allows instructors to pause the simulation to discuss key points within the context of a lecture.
2. The AMEDD Center & School may install the TC3 simulation in one of their Learning Resource Centers. It is expected that this will foster independent learning by encouraging students to learn for themselves based on their understanding of how and why new knowledge and skills learned in the 68W10 Healthcare Specialist course are related to their own experiences in the TC3 simulation.
3. The TC3 simulation may eventually be deployed as a distance-learning tool for sustainment training. Programs such as this are numerous in the civilian sector of emergency medicine. However, very few of them meet the needs of the Army or meet the stringent requirements of the Continuing Education Coordinating Board of Emergency Medical Services (CECBEMS).

### **Description of the GAP**

The linear battlefield limits the number of trained medical personnel attached to maneuver elements. There is a need to fill the gap with some type of medical capability at the individual Soldier level in order to improve the survivability of the Soldier in combat. As sited

by retired Lieutenant Colonel Donald L. Parsons (Parsons, 2006), “improving care at the point of wounding is the best medicine. The process has to start long before Soldiers ever see the battlefield and the first step is training and then more training.”

There is a growing advocacy for the use of instructional games as a tool to provide cognitive skills. However, the decision to use these kinds of games is often made on the basis of “leaps of faith” instead of empirical data that could measure the effectiveness of instructional games. Although previous research has demonstrated that some games can indeed provide effective learning for a variety of learners, this does not guarantee that the use of a particular game on a specific instructional task could be effective (Hays 2005).

The Army is currently pursuing the use of instructional games in an effort to improve effectiveness in training. There are some advantages to this concept when compared to live, virtual and constructive simulations. If developed to be run on a PC, games provide a low cost alternative to training. They can be distributed easily, and so there is potential to minimize time and logistics. If the Soldier has access to a PC, he or she could play the game any time, anywhere.

The Army is considering the use of the TC3 Sim game as a tool to improve training of individual Soldiers and improve the readiness of combat medics. It is the intent of this research to evaluate the effectiveness of this instructional game in teaching the concepts of tactical combat casualty care. Experiments will be conducted to evaluate the training effectiveness of this tool in supporting the 68W10 Healthcare Specialist Course program of instruction (POI). The goal of this research is to address an important question: Can instructional games encourage learning? i.e., is this game an effective tool to train Soldiers the aspects of TC3?



## **CHAPTER TWO: LITERATURE REVIEW**

The literature review below takes on an interdisciplinary focus in the quest to identify limitations of current research in training effectiveness analysis of instructional games used for training. The potential of using games to encourage learning has been the focus of much literature recently published in the areas of education, learning and training. Many have tried to answer the question: Can instructional games encourage learning? An overview of the terminology used in the field regarding instructional games, today's learning community and current research done in the area of training effectiveness evaluations using instructional games will be presented. Several Technical Reports as well as a thesis are discussed. A summary of the review will tie all interdisciplinary subjects together and a discussion on the research gap will be presented.

### **Simulations, Games, and Instructional Games**

In literature on instructional games, the terms simulations, games, simulation-games, digital game-based, and computer games are used interchangeably (Greenblat & Duke, 1981; Dorn, 1989; Prensky, 2001; Mitchell & Savill-Smith, 2004; Hays, 2005). It is important to understand the difference between terminology and the characteristics and categories of instructional games for the purposes of this research.

According to Hays (Hays, 2005) "all simulations are based on models of reality". A model is "a physical, mathematical, or logical representation of a system, entity, phenomenon, or process" (Department of Defense, 1997, pg. 138). A simulation is "a method for implementing a model over time" (Department of Defense, 1997, pg. 160). It is a software framework that

executes a model in the proper order, provides timing and coordination between them, and controls the inputs and outputs.

Cunningham (1984) defined simulation as “a device for replacing some aspect of reality for purposes of experimentation, prediction, evaluation, or learning.” (pg. 215)

After an extensive literature review, Dorn (1989) provided definitions of game, simulation and simulation games. He defined game as “any contest or play among adversaries or players operating under constraints or rules for an objective or goal” (pg. 2); simulation as “an operating representation of central features of reality” (pg. 2); simulation game as “activities undertaken by players whose actions are constrained by a set of explicit rules particular to that game and by a predetermined end point. The elements of the game constitute a more or less accurate representation or model of some external reality with which players interact by playing roles in much the same way as they would interact with reality itself”(pg. 3).

Games are a powerful information technology different to previous technologies such as television (Carsten & Beck, 2005). Games are interactive (Birnbaum, 1982). Game’s powerful interactivity reinforces particular behaviors: individual control, trial- and- error, and constant change. In fact Costikyan (2002, pg. 11) stressed the fact that every game is interactive and the phrase “interactive game” is a redundancy. In fact his definition of a game was stated as “an interactive structure of endogenous meaning that requires players to struggle towards a goal” (2002, pg. 22). He explains that he uses the phrase “endogenous meaning” to highlight the fact that the meaning of a game is internal to the structure of the game and does not have any meaning outside the game itself. Costikyan (2002, pg. 26) discussed Mark Leblanc’s Taxonomy of game pleasures to look at what it is about games that people find compelling. According to Leblanc there are eight categories of pleasure in a game:

- Sensation – good visuals (graphics), good audio and sometimes tactile elements (game controls) provide sensory pleasure.
- Fantasy – an environment that fosters dispensation of disbelieve.
- Narrative – games should support a sense of drama.
- Challenge – the amount of struggle that will captivate the players desire to engage with the game.
- Fellowship – shared intense experiences breed a sense of fellowship.
- Discovery – revealing hidden information.
- Expression – games provides a player with a way to express themselves and also allow them to choose how they present themselves in the context of the game.
- Masochism – submission to a game’s structure.

According to Leemkuil et al (2000) a simulation is a type of system that is very close to games. They reiterate that simulations resemble games in that both contain a model of some kind of system and they provide opportunities to the learners to input information/actions and observe the consequences of their actions.

According to Garris, et al (2002), some of the key features of simulations are “that they represent real-world systems; they contain rules and strategies that allow flexible and variable simulation activity to evolve; and the cost of error for participants is low, protecting them from the more severe consequences of mistakes.”

Garris, et al, (2002) identified six key dimensions that characterize games in contrast to simulations. They argue that simulations that incorporate these features become game-like simulations:

- Fantasy – “Games represent an activity that is separate from real life in that there is no activity outside the game that literally corresponds. Games involve imaginary worlds; activity inside these worlds has no impact on the real world; and when involved in a game, nothing outside the game is relevant.”(pg. 447)
- Rules/goals – “Although game activity takes place apart from the real world, it occurs in a fixed space and time period with precise rules governing game play.”(pg. 448)
- Sensory stimuli – “Games imply the temporary acceptance of another type of reality. This imaginary world disrupts the stability of normal sensations and perceptions and allows the user to experience a distortion of perception that is not readily experienced in the real world.”(pg. 449) User’s attention can be captivated by sound effects, dynamic graphics, and other sensory stimuli.
- Challenge – “Goals should be clearly specified, yet the possibility of obtaining that goal should be uncertain. Games should employ progressive difficulty levels, multiple goals, and a certain amount of informational ambiguity to ensure an uncertain outcome. Performance feedback and score keeping allows the individual to track progress toward desired goals. Finally, goals must be meaningful to the individual. Linking activities to valued personal competencies, embedding activities within absorbing fantasy scenarios, or engaging competitive or cooperative motivations can serve to make goals meaningful.” (pg. 450)
- Mystery - “mystery evokes curiosity in the individual” (pg. 450) and previous research has indicated that curiosity is one of the primary factors that drive learning.
- Control – “Control refers to the exercise of authority or the ability to regulate, direct, or command something.” (pg.451)

In discussing the advantages of simulations over real-life tasks, Tomlinson and Masuhara (2000) found that simulations are more economical, they make certain kinds of interactions more accessible for observation and measurement, they help with the introduction of complex subjects, and they allow the participants to be exposed to situations that they had never previously encountered in their working environment.

Dempsey, et al, (1996, p. 3) defined a game as “a set of activities involving one or more players. It has goals, constraints, payoffs, and consequences. A game is rule-guided and artificial in some respects. Finally a game involves some aspects of competition, even if competition is with oneself.”

Later on Hays (2006) defined the term game as “an artificially constructed, competitive activity with a specific goal, a set of rules and constraints that is located in a specific context.”

He stated that there are four parts to this definition:

1. “Artificially constructed” – a game is a representation of reality, i.e. it is not real. A game is a simulation and when a game is used for instructional purposes it is important that the user understand the context of use.
2. “Competitive activity” – a simulation can be regarded as a game only if it includes competition.
3. “Specific goal” – which is established by both rules and constraints.
4. “Located in a specific context” – a game for instructional purpose must meet specific training goals.

Squire (2005) in describing a game noted that “they provide situated experiences in which players are immerse in complex, problem solving tasks. Good games teach players more than just facts; they provide ways of seeing and understanding problems and, critically, supply

opportunities to “become” different kinds of people”. According to his research, digital games are routinely listed as the most influential medium by people under the age of 35. He stresses the fact that games are a powerful socializing force and that those who play computer and video games have different attitudes about work, play and their co-workers than do their peers.

Roger Caillois (1957) in his book “Games and Men” identified several characteristics that define a game (Wikipedia, 2007):

- Fun
- Separate: enclosed in time and space
- Uncertain : outcome is unforeseeable
- Non-productive
- Governed by rules: specific to the activity and different from everyday life
- Fictitious: it takes the setting in a different reality

Csikszentmihalyi as noted by Hays (2005) discussed how Roger Caillois classified games into four classes depending on the experience that they provide:

- Agnostic Games- games involving competition (i.e. sports/athletic events)
- Aleatory Games - games involving element of chance (i.e. dice, cards)
- Vertigo or Illinx Games – games that alter the person’s consciousness by scrambling ordinary perception (i.e. riding the merry-go-round)
- Mimicry Games – games that allow the creation of alternative realities (i.e. arts in general – theater, dance)

A game can include a combination of these experiences and can be played in a variety of mediums but it is important to note that it is the characteristics not the medium in which it is

played that define a game. Even though most games are intended for enjoyment they can be designed for instruction as long as they support specific instructional objectives (Hays 2005).

Hays (2007) provided definition for different types of games and reiterated the fact that a game could be a combination of several different game types:

- Simulation-based Games – a simulation that incorporate game like activities (i.e. role-playing games, computer and video games)
- Individual or Group Games – games where the individual or a group of people compete against a skill standard.
- Games of Skill – games requiring certain skills ( i.e. board games, word games, games of physical skills, and instructional games)
- Games of Chance – games based on chance (i.e. dice games, card games, and lottery type games)
- Tailored Games – games that have been modified to include specific task characteristics and constraints.
- Hybrid Games – a game that is a combination of different types of games. Simulation Game is the most often encountered hybrid.

Björk and Holopainen (2003) developed a conceptual model to identify the elements commonly found in games. Their intent was to create a model that could describe games as an activity. They identified four different categories that describe different aspects of the activity:

- Holistic Components – those that describe the overall activity of the game:
  - Game Instance – every time a game is played it is different to other instances in terms of the constitution of the players, the place where it is played (location), external requirements and limitation, or the experience of the players.

- Game Session – is the activity defined by the time spent on playing a game instance.
- Play Session - distinct periods of game play activity that when combined constitute a game session.
- Bounding components – those that describe the meaning of the activity and what is allowed within the activity:
  - Rules – that dictates the flow of the game. Rules can be endogenous (explicitly stated as being part of the game) or exogenous (not formally inscribed or enforceable within the game).
  - Modes of play – constructs to define boundaries between activities within the larger activity of playing a game.
  - Goals and Sub-goals – plans and actions of players during a game play or session are geared towards achieving a goal. In complex games goals are often split into smaller sub-goals.
- Temporal components - those that describe the unfolding of the activity:
  - Actions – the state of the game can only be changed by the player’s actions. Actions can be continuous (being temporally defined by measure game time) or discrete (being temporally defined by its relation to other actions).
  - Events – discrete points in the game play where the state of the game changes.
  - Closures- a change of game state triggered by the completion of a goal or sub-goal.
  - End Conditions - specify the game state of when a closure occurs.
  - Evaluation Functions – determines the outcome of an event.



- Objective components – physical and logical objects that maintain the game state or provide functionality such as randomizing, score keeping or time keeping:
  - Players – logical components that perform actions can be interpreted as having strategies and goals, and can enter or leave the game.
  - Interface – means of accessing the game.
  - Games Components – physical and logical components of games that help maintain and inform players about the current state of the game.

Leemkuil, et al. (2000) provided a definition of game and a list of characteristics based on a literature study. Their definition states that “Games are competitive, situated (learning environments) based on a set of rules and/or an underlying model, in which, under certain constraints, some goal state must be reached. Games are situated in a specific context that makes them (more or less) realistic, appealing and motivating for the players. Important elements that are related to the situatedness of games are validity/fidelity, complexity, risk, uncertainty, surprise, unexpected events, role play, access to information, and the representation form of the game”. They defined the following characteristics of games:

- Reaching Goal States - an important feature of a game is that some kind of goal has to be reached. The goals could be: reaching a certain level of proficiency/efficiency, solving problems, or becoming the best amongst other players or competitors.
- Constraints, rules, and incentives – each game consists of rules that define actions that could be taken and goals of the game.
- Competition – games require a sense of accomplishment in terms of “winning” or “losing”. This is accomplished by either beating players/teams/system or outperforming players/teams/yourself.

- Situatedness of Games – games are situated in a specific context that determines how realistic, appealing and motivating it is for the players. Amongst the criteria used to determine the correspondence between “reality” and the game situation are the complexity, risk/uncertainty, roles, and type of interactions.

Prensky (2001, p. 118-119) identified six key structural elements in computer games that when combined strongly engages the gamer: rules, goals and objectives, outcomes and feedback, conflict/competition/challenge/opposition, interaction, representation or story. He provided the following insights on why games engage:

- “Games are a form of fun” – They provide the player with “enjoyment and pleasure”.
- “Games are a form of play” – They provide the player with “intense and passionate involvement”.
- “Games have rules” – They provide the player with “structure.”
- “Games have goals” – They provide the player with “motivation.”
- “Games are interactive” – They provide a sense of “doing.”
- “Games have outcomes and feedback” – They provide a “learning” experience.
- “Games are adaptive” – They provide “flow.”
- “Games have win states” – They provide the learner with “ego gratification.”
- “Games have conflict/competition/challenge/opposition” – They provide “adrenaline.”
- “Games have problem solving” – That sparks people’s “creativity.”
- “Games have interaction” – They encourage participation in “social groups.”
- “Games have representation and story” – They provide “emotion.”

Garris et al (2002) describe the motivational process in the context of a game cycle. According to the authors, the game play triggers repeated cycles of user judgments, behavior, and feedback. They provide the following description of each step within the cycle as follows:

- User judgments – “As users initiate game play, they make subjective judgments regarding whether the game is fun, interesting, and engaging. These judgments are typically represented by self-reports of interest and engagement, enjoyment, and feelings of mastery.” (pg. 452)
- User behavior – “The affective judgments that are formed from initial and ongoing game play determine the direction, intensity, and quality of further behavior. Motivated learners more readily choose to engage in target activities, they pursue those activities more vigorously, and they persist longer at those activities than do less motivated learners.” (pg. 453)
- System feedback – “Feedback is a critical component of the judgment-behavior-feedback cycle. Individual judgments and behavior are regulated by comparisons of feedback to standards or goals.” (pg. 454)

In explaining the role of gaming in education and training Becker (1980) expressed that “Education and training are specific kinds of communication. Educational research has shown that inductive approaches are superior, although only slightly, to deductive approaches. Gaming is excellently suited for inductive teaching and training, allowing for a deductive input in later stages of the communication process.”

According to Hays (2007) “an instructional game is specifically designed or modified to meet training objectives. It meets these objectives by including rules, constraints, and activities that closely replicate the constraints of the real- world task that is being trained. An instructional

game must be incorporated into a training program in a manner that ensures that trainees understand the training objectives of the game, and receive detailed feedback about their performance in the game and how their performance supported their training objectives”. He noted that instructional games should be considered a training aid tool rather than a stand-alone training method. If used as a stand-alone training tool, the game must be designed such that all instructional capabilities provided by the trainer are incorporated.

When considering instructional games Hays (2007) further classify games by the type of task to be trained:

- Skills and Procedures Training Games – games geared towards helping individuals learn specific skills and procedures.
- Action Games – games that require the trainee to react to specific situations and engage in real-time actions.
- Role-playing Games – game that allows the trainee to practice specific activities that are required for a certain task.
- Strategy Games – games where the trainee is required to practice strategy skills.

Rice (2007) in his article “Assessing Higher Order Thinking in Video Games” defined the characteristics comprising advanced gaming products that could be used for educational purposes by identifying those elements that would lead to higher cognitive processing. Bloom’s Taxonomy (1956) in the cognitive domain defines order thinking levels to be, from lower to higher: Knowledge, comprehension, application, analysis, synthesis, and evaluation. Rice (2007) defined Cognitive Virtual Interactive Environment (VIE) as software products designed to encourage higher order thinking by users. Virtual requires the use of complex three-dimensional graphics to create a meaningful virtual reality experience, Interactive requires extensive user

interaction while playing the game, and Environment indicates the context within which the game takes place. According to Rice the difference between simple computer games (those promoting only knowledge and comprehension) and cognitive VIEs is that the former provide sufficient complex interactions that would promote higher order thinking to take place.

According to Dorn (1989), in order for simulation games to meet instructional goals, they should be designed and used properly to meet specific instructional purposes. Instructional games should be selected such that they accomplish specific training requirements goals and they should be accompanied with discussions, lectures and other methods of instruction. They should be incorporated in the program of instruction to support specific instructional event, not at random. Finally, feedback should be incorporated as a structured and guided activity such that learning can be fostered and the experience can be meaningful to training.

According to Garris et al (2002), debriefing is the most critical aspect of experiential learning using simulation/gaming since the debriefing process allows the user to transform game events into learning experiences: “Debriefing is the review and analysis of events that occurred in the game itself.” (pg. 454), further, “Debriefing provides a link between what is represented in the simulation/gaming experience and the real world. It allows the participant to draw parallels between game events and real-world events” (pg. 454).

de Freitas and Jarvis (2006) presented a framework that highlights the importance of four main aspects of “game-based learning” to be considered when developing games for instruction or training. According to the authors, “game-based learning” is to be considered synonymous with “serious games,” that is, a digital game with a specified educational or training purpose. The four main aspects of a “serious game” in their framework are the following:

- Context – context of the game and usage is essential to the effectiveness of the game in the training environment. Contextual factors include: where a game will be used and technical support availability.
- Learner Specification – user profile needs to be developed to understand the characteristics, learning preferences and cognitive styles of the targeted group of learners.
- Representation – this relates to how levels of immersion, fidelity, and interactivity are integrated into the game application such that it is effective and provides the required level of engagement.
- Pedagogical model or approach used – Need to consider the learning theory and approaches behind the application (i.e. associative, cognitive, and situative perspectives) in order to ensure that the game is used effectively to support specified learning outcomes.

Greenblat (1973) noted that simulation games “represent modes of getting students to learn by provoking inquiry rather than by “feeding” information”. She discussed that the beliefs in the potency of games as tools for pedagogical use stem from several sources to include the following statements:

- “the view that the mind is an instrument to be developed rather than a receptacle to be filled”
- “modes of teaching are needed which will help to develop people who are excited about learning”
- “the desire to develop modes of promoting engagement and curiosity”
- “the idea that students learn not because learning is a goal in and of itself, but because learning leads to a goal achievement”

- “the belief that learners learn to act by acting” in an interactive way.
- “students must learn to examine the social world, picking out relevant variables and examining their nature and consequences”

In discussing why computer games should be used for learning, Mitchell and Savill-Smith (2004, p.17) presented the following reasons:

- With visual and spatial aesthetics games are seductive and provide excitement.
- Games motivate via entertainment.
- Games provide an interactive environment.
- Games provide an immersive experience.

Hays and Singer (1989) discussed potential ways of using games as instructional tools. They observed that games could be used to provide instructional information on specific knowledge and skills and could be used to transmit facts, teach skills, and provide insights.

de Freitas and Oliver (2006) stressed the importance of identifying learners specification when considering using games as a tool. Questions such as: who is the learner? What is their background and learning history? What are the learning styles and preferences? Who is the learner group? How can the learner group be best supported? need to be asked to support the use of gaming tools. The following section will try to address some of these questions in an effort to understand the characteristics of today’s learning community.

### **Today’s Learning Community**

According to Prensky (Prensky 2001, p. 1-19) learners have changed in some fundamentally important ways. The majority of the people who are learning today grew up in an era full of radical changes and innovations in technology. Today’s generation was raised

surrounded by an incredible array of new technologies (internet, cellular phones, video games, laptops ...). He believes that one of the reasons educators are not more successful in educating and training the young workforce is due the fact that “we are working hard to educate a new generation in old ways.” Statistics show (Rideout et al., 2005) that children between the ages of 8 through 18 spend more than an hour a day using the computer for recreational use with video games being the top activity. This tremendous amount of time spent playing computer games during their formative years have led them to be “hard wired” in a different way compared to previous generations.

According to Abell (2000) trainers need to consider that within the adult learner population there are nested generational subgroups such as Generation X (born between 1965 and 1976) and Generation Y (born between 1977 and 1995). Learners within those generations tend to have high expectations for the quality of technology-based instruction they receive. Their needs include the inclination for independent learning experiences that incorporate fast-paced and visually intensive instruction, frequent interactions with corresponding feedback, and strong desire to experience a sense of accomplishment. Sacks’s (1998) research found that nearly half of the college students in his sample valued entertainment as their number one trait in an instructor. He reiterates that this is due to the fact that Generation X has been engulfed in entertainment since birth. According to Cohen (as cited by Abell 2000) Generation X prefer fast paced presentation full of information and with a combination of entertainment. In addition Generation X wants to receive frequent feedback and a daily sense of accomplishments. They prefer experiential assignments therefore trainers must use tools that will expose them to grabbing/sustaining situations allowing learners to react and reflect upon their experiences. In his research Cohen noted that Generation X prefer visual images in comparison to written word.



According to statistics presented, 41 percent of 18-24 year olds did not read a book that was not required for school. Cohen predicted that Generation Y would present the same characteristics as Generation X but more intense.

According to Prensky (2001), education can be improved by creating new ways of learning that will fit with the new generation's world, style and capabilities. Game based learning is an alternative that is being used to enhance the learning process that appeals to people from the "games generation."

Sixty nine percent of American heads of households play computer and video games (ESA, 2007). The average game player age is 33 and adult's gamers have been playing an average of 12 years and fifty-three percent of game players expect to be playing as much or more ten years from now than they do today (ESA, 2007).

According to Greenfield as cited by Prensky (2001, p. 20-42) skills developed as a result of playing video games go far beyond hand-eye coordination skills. Among Greenfield's findings:

- Playing video games enhances players' skills at divided attention tasks, such as monitoring multiple locations simultaneously. Therefore, players get faster at responding to both expected and unexpected stimuli.
- Playing video games augments skills of "rule discovery" through observation, trial and error, and hypothesis testing, i.e., the thought process behind scientific thinking.

Prensky also alluded to the fact that today's trainers (mostly in the late 30s, 40s and 50s) raised in a pre-digital era have a different dynamic when compared to the trainees (20s and early 30s) who have been influenced by interactive technologies such as video and computer games and the internet. For this generation traditional training and schooling does not engage them.

Among his observations, the following are the ten main cognitive style changes that he has observed in the Games Generation compared to earlier generations:

1. Twitch speed vs. Conventional speed – The Games Generation has more experience processing information quickly. Trainers should create training experiences that exploits the ability of twitch speed but at the same time incorporates content that is important and useful.
2. Parallel processing vs. linear processing – The Game Generation feels more comfortable doing more than one thing at the same time. Trainers should identify ways to enhance parallel processing in their training allowing exposure to more information at once.
3. Graphics first vs. text first – The Game Generation has been exposed to high-quality and highly expressive graphics with little or no accompanying text since childhood. This has acutely sharpened their visual sensitivity. They find it more natural to begin with visuals and to mix text and graphics in a richly meaningful way.
4. Random access vs. step-by-step – The ability to hypertext has encourage a less sequential information structure. This new form of information structure has allowed the Game Generation to be aware and able to make connections in order to follow infinite paths instead of restricting them to a single path.
5. Connected vs. standalone – The Games Generation has been raised in an era were internet connectivity is available anytime, anywhere, at almost no cost. As a result, Games Generation people are not constraint by their physical location and tend to think differently about how to get information and solve problems.
6. Active vs. passive – The Game Generation are more fearless when interacting with software. They are not afraid to explore the capabilities of software in contrast with the

previous generation which are more reluctant to interact. Being exposed at an early age to games, they are used to play with software, hitting every key if necessary, until they figure out the available features of the software.

7. Play vs. work – The Game Generation has been exposed to many types of logic, spatial relationships, and other complex thinking tasks that have been embedded in the games they are used to play since childhood. They are very much an intellectual-problem-solving oriented generation. Trainers should support the development of new game interfaces to help the new generation learn in their own cognitive style.
8. Payoff vs. patience – The Game Generation has been exposed to interactions that excel at giving feedback and the payoff for any action taken is typically extremely clear. This has led to a huge intolerance on their part for things that don't pay off at the level expected.
9. Fantasy vs. reality – The Game Generation has been exposed to more realistic graphics. Current computer capabilities have made possible bringing fantasy to life. Fantasy elements from the past as well as from the future pervades in their lives. Digital Game-based learning that incorporate fantasy trades should be incorporated by trainers to enhance the learning experience.
10. Technology-as-friend vs. technology-as-foe – To the Game Generation computer is a necessary tool. They grew up using computers to play, relax and have fun. Trainers should continually seek ways to communicate, transfer information and build necessary skills via the media (computer and games) this generation willingly engage in.

To succeed in training the Game Generation (Carsten & Beck, 2005), the training curriculum should be created such that:

- Leans heavily on trial and error
- Includes the opportunity of learning from peers
- Allows for people to take risks in a safe environment
- Allows for players to achieve a skill that is meaningful and perceived as having value.

Carsten and Beck (2005) reached these conclusions based on the results of a study of 2,500 Americans, mainly business professionals. The group included a wide range of ages, women as well as men, with all levels of gaming experience. They used questions to explore how gamers (defined as those who had grown up playing video games) think and feel about their work compared to non-gamers.

Kirkley, Tomblin and Kirkley (2005) in citing Beck and Wade, the authors of *Got Game*, state that there are clear distinction between those who grew up playing video games and those who did not. According to the authors, the gamers use more open communication methods, creative problem solving strategies, and take more risk.

For training to be effective, organizations need to adapt their training programs to give gamers new ways of learning to harvest their potential (Carstens & Beck, 2005) by introducing more interactive tools.

It has been argued that young Soldiers, those belonging to the “digital” generation, might respond positively to the introduction of video games in a training environment. Belanich et al conducted a series of research efforts to investigate this claim. US Army Soldiers across various ranks were surveyed. They found that “contrary to popular belief” most Soldiers do not engage in video game play regularly. The authors recommend assessing training audience’s prior experience with video games before introducing an instructional game in the training

environment. In addition Soldiers without experience should be given ample preparatory practice time before engaging in training that incorporates video games.

### **Training Effectiveness of Games**

For several decades, the benefits of games have been debated (Clark (1983), Kozma (1994)). Claims that games can increase the motivation and interest of trainees, improvement of learning and improvement of attitudes towards a particular subject matter are amongst them. Several authors (Greenblat (1973), Bredemeier and Greenblat (1981), Dorn (1989), Whiteley and Faria (1989), Leemkuil, Jong, and Ootes (2000), Randel, Morris, Wetzel and Whitehill (1992), and Mitchell and Savill-Smith (2004)) have presented extensive reviews of the literature on simulation games for teaching and learning trying to provide a better understanding of those claims in terms of available empirical data. Recently Hays (2005; 2006) updated those findings with more recent data.

Greenblat (1973) provided a comprehensive review of claims and evidence for teaching with simulation games. The two interrelated problems discussed are the following:

- Empirical evidence to systematically test claims of favorable outcomes is very limited.
- Even though the empirical evidence concerning the consequence of teaching with simulations is still limited, utilization is spreading rapidly.

In order to research the claims and evidence of games as instructional tools she reviewed books, published and unpublished articles, newsletters, and advertisements from games' publishers. She organized the numerous propositions found in her research in six distinct categories: (a) Motivation and interest, (b) Cognitive learning, (c) Changes in the character of

later course work, (d) Affective learning re subject matter, (e) General affective learning, and (f) Changes in classroom structure and relations.

She found that most of the evidence is largely anecdotal. Few of the reports had followed systematic testing of the hypotheses hence a lack of empirical evidence. Even though she indicated that simulation games could deliver effective cognitive and conceptual learning, the greatest amount of discussion centered in the claim about the increase of motivation and interest, but still a great deal anecdotal information was provided. In fact she indicated that the cognitive learning that takes place is “learning of principles and procedural sequences and the acquisition of referents for concepts rather than factual information” (Greenblat, 1973) She attributed the lack of support that the data collected provide due to methodological shortcomings of the studies. Many of the research studies suffered from poor research design:

- Lack of pre-test precluded measurement of change
- Lack of control groups
- Failure to consider Hawthorne effects
- Poor criteria for accepting or rejecting hypothesis
- Poor sampling techniques – unrepresentative subjects and heterogeneous nature of some samples (people of differing ages and academic backgrounds)
- Lack of control for relevant student characteristics (gamers vs non-gamers)

Wiebenga (2005) expressed that little attempt is being made to conduct empirical research regarding the effectiveness of games in training resulting in a critical gap between theory and practice that needs to be addressed.

In his discussion on what are simulation games designed to do and teach, Dorn (1989) identified the following claims that appeared repeatedly in literature:

- The use of simulation games will increase student's motivation to learn and their interest in learning.
- Simulation games can be used to change and improve student's attitudes toward self, environment, and classroom learning.
- Simulation games will deliver effective cognitive and conceptual learning.
- Simulation games can enhance cooperation, interaction, and communication between students.
- Simulation games will change classroom structures by promoting a more relaxed, friendly, and warm climate

He concluded that after 25 years of evaluation of simulation games, still opinions regarding its effectiveness varies considerably. According to Dorn, the evidence was considered to be ambiguous, enthusiastic, impressionistic, and subjective. He agreed with Greenblat's (1973) assessment that many reasons for the contradictory and inconclusive results of these studies is due to methodological flaws in the research evaluation. Dorn alluded to the fact that cognitive learning takes place in simulation games but it seems to be difficult to specify or articulate. His assessment of the evaluation research literature can be summarized as "A substantial amount of consistent research shows that simulation games do increase students' interest and motivation, that they can be effective in changing some attitudes, and that they are at least as effective as more conventional pedagogy in teaching cognitive learning" (Dorn 1989).

Dorn believes that simulations are based on the model of experiential learning rather than on the model of information processing. According to this model, learners first act on a particular instance of the application, then they attempt to understand the effects of their behaviors and decisions in that particular instance, then seek to understand the general principles that apply,

and finally apply those principles to new circumstances such that the learning is useful in future context.

Prenski (2001, p. 14) believes that the two factors that make game-based learning a success are the motivation of the game combined with a learning methodology that “ is fast, effective, and definitely un-school like”.

Randel, Morris, Wetzel and Whitehill (1992) provided a review of literature comparing the instructional effectiveness of games to conventional classroom instruction over a period of 28 years. They focused on empirical data instead of teachers judgments. Among the conclusions they reached based on their research:

- Out of the subject areas that they examined (social sciences, math, language arts, logic physics, biology, retention over time, and interest), math was the one that showed the greatest percentage of results favoring games as an instructional tool.
- Games rated as more interesting compared to conventional instruction.
- When trying to demonstrate the effects of games, careful consideration must be given to the selection of measurements. The test for effectiveness should match what the game is teaching.
- When evaluating games, the experimental designs used must be more rigorous. Experimental designs should reduce confounding variables such as Hawthorne effects, teacher biases, different times for treatments, etc.
- Subject matter areas where very specific content can be targeted are more likely to show beneficial effects for gaming.



Leemkuil, Jong, and Ootes (2000) conducted a study to examine the theoretical analyses and empirical results in the area of instructional use of games and simulations. They reviewed 66 studies. A summary of their findings is as follows:

- The areas that show beneficial effects for gaming are those where the subject matter has very specific content that can be targeted and objectives precisely defined.
- Simulation/games show greater retention over time than conventional classroom instruction.
- Students reported more interest in simulation and game activities than in more conventional activities.

They noted that “ The educational goals of games depend on the setting in which they are used and can be very diverse like: development of consciousness and motivation, training skills, development of knowledge and insight, training in communication and co-operation, integration of learning experiences, and assessment. Much of the work on the evaluation of games has been anecdotal, descriptive or judgmental, but there are some indications that they are effective and are superior to case-studies in producing knowledge gains. However, there is general consensus that learning with interactive environments such as games, simulations, and adventures is not effective when no instructional measures or support is added.”

Mitchell and Savill-Smith (2004) conducted a review of literature on the use of computer and video games for learning. Among the questions that guided their research the two that are relevant to this research are:

- Why use computer games for learning?
- How have computer games been used?

On citing Randel, who provided a review of studies done up to 1991 in terms of effectiveness of games and conventional classroom instruction, he found that there are differences observed depending on the educational areas where the games were used with best results found in the areas of math, physics and language arts. According to Randel, simulation games require active participation which affords opportunities for the learning material to be integrated into cognitive structures.

Among the conclusions drawn from their research, the beneficial effects of gaming are most likely to be found when specific content is targeted and the objectives of the training are specifically defined. In addition, it was also noted that in many studies performed, the students reported more interest in the game activities than in traditional classroom instruction.

Mitchell and Savill-Smith (2004) concluded that the literature base that addresses the use of computer games for learning remains small and further research is needed that particularly focuses on the potential use of computer games for learning by young adults.

de Freitas (2004) found that games and simulations can significantly support differentiated learning assisting learner groups with diverse learning abilities and approaches. Her research also found that games and simulations can support learners with skills-based needs.

Spelman (2002) conducted a study to gather empirical evidence on the effectiveness of simulations in ESL writing instruction. The results showed that the use of simulations proved to work as well as the traditional method of instruction in increasing the writing competency of English as Second Language (ESL) composition students and proved superior to the traditional method in the evaluation of writing samples. Also, the use of simulations proved superior in lowering anxiety and in increasing the students' perception of the usefulness of the class.

Baxter, Ross, Phillips, Shafer and Fowlkes (2004) conducted a pilot study to examine the training utility of a game-based tactical decision-making simulation when compared to the traditional paper-based Tactical Decision Games used in the USMC Infantry Platoon Sergeant Course. In evaluating the strengths and weaknesses of both approaches, they found that the approaches were complementary to one another. The game-based instructional tool was superior on the timing of operations and team coordination while the paper-based intervention enhanced mental stimulation, planning, and command level decision making. Both trainees and instructors emphasized the utility of combining both approaches. The game-based intervention was deemed to have motivational properties when compared to the paper-based intervention, but it was noted that care must be taken when designing game interfaces such that they are intuitive and require little learning as possible. They stressed the need for instructor support when using game-based tools for both exercise control and feedback on student performance.

Hays (2005) conducted a review of literature on instructional games with a focus on the empirical research on the instructional effectiveness of games. One hundred and five articles were documented in the report. Of those, 48 articles provided empirical data on the effectiveness of instructional games. After reviewing the empirical research on the value of games on instructional effectiveness he concluded that:

- Empirical research that has been conducted on instructional games is fragmented since it includes a gamma of different factors such as different tasks, age groups, and different types of games. Also the research contains ill-defined terms and methodological flaws.
- No evidence was found to indicate that games are the preferred instructional method in all situations.

- An instructional game will only be effective if it is design to meet specific instructional objectives and used as it was intended.
- If a game is to be incorporated in a program of instruction, it should include debriefing and feedback so the learners understand what happened during the game and how the events and activities of the game support the instructional objectives.
- The use of a game should be accompanied with instructional support on how to use the game. This will allow the learners to focus on the instructional information instead of focusing on the interfaces and requirements of the game.
- Caution should be used when generalizing the results of a study conducted with one age group to another age group.
- Some of the research is biased by the evaluator's interest in "proving" the effectiveness of the game specifically if the evaluator is who developed the game.
- A lot of the research failed to use control groups that would allow comparison of the results to other instructional methods.
- No clear and detailed description of the instructional game was provided specifically on characteristics that made it a "game."

Additionally, Hays stated that "the control of the learning experience is an essential feature of instruction. Without this control, we cannot be sure that the student learned what is required from a given instructional product". He states that instruction as a minimum should include the following elements:

- Specific instructional objectives – these objectives are defined by task requirements.
- Meaningful interaction – the learner should have the opportunity to interact with the instructional content in a meaningful way.

- Performance Assessment – learner’s performance needs to be assessed to determine if learning of the intended content occurred.
- Feedback – the results of the assessment needs to be presented to the learner in a timely manner to ensure that correct actions are reinforced and incorrect actions are remediated.

In his summary regarding use of games for health care education (Hays 2005) most of the studies reviewed did not provide information regarding the instructional effectiveness of the games. In studies that attempted to collect empirical data failed to include control groups that would allow comparison of the results to other instructional methods.

Westbrook and Braithwaite (2001) evaluated a web-based educational game on health care system designed to promote information-seeking skills and collaborative interaction among students. They conducted the evaluation using pre and post game questionnaires and focus group discussions. The results demonstrated the effectiveness of the game in improving learning outcomes. The evaluation only addressed the usability of the game and student achievements of specific learning outcomes. Transfer of the knowledge was not addressed in the study.

In his master’s thesis Litteral (2005) wanted to explore if computer based learning could provide deeper synthesis of information than conventional stand and deliver lecture when considering students from the X Generation. In addition, he hypothesized the following:

- Computer game base learning can facilitate more learning styles than traditional lecture instruction alone.
- Computer game based learning motivates students to learn more, with a competitive game approach to learning.

The initial game based system targeted for the study was the TC3 Simulation. Due to project delay, the game was not at a maturity level required to perform the evaluation. An

alternative simulation system was used to conduct the experiment. Even though the participants came from the targeted population, bias introduced by the instructors and the lack of time available for the students to interact with the game did not allowed for conclusive results. In addition, most of the data was qualitative in nature since it was based on a pass fail criteria that was based on instructor observation and evaluation of a hands on task. In his summary, Litteral emphasized the need to conduct more experimentation with special emphasis on quantitative data.

According to Bae (2002) descriptive characteristics of trainees (personality level, motivation level, goal level, general aptitude, age, education, and experience level) can influence training process. He emphasizes the fact that examination of trainee characteristics has great potential for enhancing the understanding of why training is effective. According to the author, few studies on trainee characteristics have reviewed variables such as age, educational qualifications and experience.

Ferdig (2007) identifies the fact that there are still a need for more research in the area of educational gaming and areas such as students gender, age and race should be looked at as well as game genres (first person shooter, role-playing, action, adventure, etc.).

Mishra and Foster (2007) reiterate that the claims about games for learning lack substantial research. They conducted a literature review and found that research should focus on content, game genre and appropriate populations. They stressed the fact that empirical studies in authentic settings should be conducted to validate earlier claims. They also emphasized the fact that content and genre cannot be overlooked in the research. According to the authors, research should separate game genres and examine what can be learned in them. Large volumes of media comparison studies indicate that in general no significant difference exists between distance

learning and traditional classroom learning (Liu and Schwen, 2006). The authors go to indicate that those studies lack quality and have inconclusive results. Even though learning preferences do exist, how much influence they actually have when it comes to learning is unanswered (Santos 2006).

Amr (2007) argues that educational games can be an effective tool for educational purpose as long as the game incorporates certain features such as immediate feedback, interactivity, and sufficient challenge. According to Amr, if the game incorporates too many multimedia components (for example, adding irrelevant sounds and music) allowing for distractions will impact negatively the learning outcome. He stressed the need for more research in the areas of the student's attitudes towards game, gender, and game skillfulness.

Egenfeldt-Nielsen (2007) conducted research regarding the use of computer games in education. Of the 20 studies reviewed, even though there was an overwhelming support that students can learn from games, none of the studies actually compared computer games to other teaching methods or activities.

According to Rice (2007) computer video games are an emerging instructional medium that offer strong degree of cognitive efficiencies for experiential learning. Rice (2007) and Egenfeldt-Nielsen (2007) both agree that even though educational games have shown promise in an educational setting, research needs to address pedagogical considerations such as: what would a well-designed educational game look like? In addition since assessment is generally text-based there is a need to explore questions such as: Can engagement in computer game action lead to higher text-based achievement?

Concerns that games used for training not necessarily increase knowledge was identified by Wiebenga (2005). According to the author, the people who play the games are more

interested in winning and beating the game than they are to learn and apply new skills. When trying to evaluate the effectiveness of a game, it is important to understand the target audience.

Participants need to be assessed in terms of:

- Attitudes towards the content being taught and the use of games
- Knowledge
- Motivation

Brown, et al (2005) examined direct and interaction effects of learner's characteristics (cognitive ability, prior knowledge, prior experience, and motivation) and classroom characteristics on learning. They compared traditional classroom instruction with instruction via videoconferencing. Results suggest that students with low motivation benefited from small and from non-videoconference classes. Learners with high levels of motivation to learn did not perform differently across any of the instructional environments. According to the authors (Brown, et al, 2005), most models of training effectiveness suggest that both situational and individual factors have effects on training outcomes.

Lessons learned from additional literature in training effectiveness evaluations regarding methodological inadequacies can be summarized as follows:

- Many researchers have underutilized the techniques of randomization, control groups and control of the treatment variable. (Butler et al, 1988)
- When designing test questions for performance evaluation, they need to be phrased similar to the context presented to the trainer. (Wash, et al, 2006)
- When designing an experiment, need to control a block of time that will allow the trainee to complete both context and game time. (Wash, et al, 2006)



- One of the variables that should be controlled is the level of entry knowledge. (Wash, et al, 2006)
- Treatment time for both control group and treatment should be the same. (Batchelder and Rachal, 2000)
- When designing the experiment, introduce the game in the same way it is expected to be used in the program of instruction.(Batchelder and Rachal, 2000)
- Hidden variables such as the attitude of trainers towards the game and attitudes of the trainees towards the instruments used to measure performance can impact the results of the experiment.(Batchelder and Rachal, 2000)

### **Summary of Literature Review**

The potential of using games to encourage learning has been the focus of many literature research recently published. Many have tried to answer the question: Can instructional games encourage learning?

In a quest to find the answer, it was clear that a better understanding of the characteristics of games used for instructional purposes was needed. A great deal of research has concluded that games motivate and interest individuals. Many claim that motivation and interest are key elements in learning. Some of the characteristics that support that motivation and interest include: interactive, goal oriented, entertainment, competition, immersive, and adaptive.

Another area that needed to be researched was the characteristics of the new generation of trainees. Several authors identified the need to understand the characteristics, learning preferences and cognitive styles of the targeted group of learners. It is clear that the generation of students that has been exposed to innovative technology since their early years tend to have

high expectations for the quality of technology-based instruction they receive. Their needs include the inclination for independent learning experiences that incorporate fast-paced and visually intensive instruction, frequent interactions with corresponding feedback, and strong desire to experience a sense of accomplishment.

Finally a review of research done in the area of training effectiveness evaluations using instructional games was conducted in order to understand the current state of claims and evidence of games as instructional tools. Most of the evidence presented is anecdotal and subjective. Data collected to support empirical evidence is flawed due to methodological shortcomings of the studies.

### **Research Gap**

One statement is prevalent in most of the literature reviewed, that is, that in terms of the claim that games can improve learning, there is very weak empirical support. Many of the studies performed in an effort to collect empirical data suffered from poor experimental design.

Some of the shortcomings are the following:

- Lack of pre-test precluded measurement of change
- Lack of control groups
- Failure to consider Hawthorne effects
- Poor criteria for accepting or rejecting hypothesis
- Poor sampling techniques – unrepresentative subjects and heterogeneous nature of some samples (people of differing ages and academic backgrounds)
- Lack of control for relevant student characteristics (gamers vs. non-gamers)
- Lack of instructor support and performance feedback

- Evaluations performed by developers who are biased towards proving the effectiveness of the game.
- No clear and detailed description of the instructional game used in the evaluation

There is a great deal of emphasis in literature regarding the need to conduct more experimentation with special emphasis on quantitative data. In particular, further research is needed that particularly focuses on the potential use of computer games for learning by young adults. Several authors identified a need for more research in the areas of the student's attitudes towards game, gender, age, educational qualifications, experience, student's attitudes and race, as well as, game genres. In addition, special focus should be placed on methodology used when designing the experiment to prevent shortcomings presented in the literature review. It is the intent of this research to look at the relationships that exist between student's age, educational qualifications, experience, and attitudes towards computer games and their performance using a game based simulation. In addition, the extent to which changes in trainee knowledge, skills and attitudes transfer back to task related situations will be evaluated. In an effort to draw empirical results, effectiveness of the simulation will be compared to traditional modes of instruction.

## **CHAPTER THREE: METHODOLOGY**

As indicated above, the particular gap in the literature that this research focuses on is the potential use of computer games as experiential tools for learning by Soldiers who for the most part are essentially young adults. This includes game genres and student attitudes towards game, gender, age, educational qualifications, experience, and race. Further this research methodology is being designed to prevent shortcomings in past research identified in the literature review above.

Limitations on methodology arise primarily from scope. Limitations result in terms of evaluation, subjects, and games considered. Each topic is discussed in turn below concluding with proposed methodology and evaluation approach and protocols.

### **Training Effectiveness Evaluation Approach**

The main purpose of a training program is to impart the acquisition of knowledge, skills, and competencies. Evaluating a particular training program is a challenging task. In 1959, Kirkpatrick presented what is today one of the most well known models for training effectiveness evaluation (Kirkpatrick, 1959). In his model, summarized in Table 1, Kirkpatrick proposes to evaluate the effectiveness of a training program at multiple levels. Level I, Reaction Criteria, evaluates the participant's reaction to the training program, Level II, Learning Criteria, evaluates if there has been any increase in knowledge or capability as a consequence of completing the training program, Level III, Behavioral Criteria, evaluates any changes in behavior on the job as a result of the training program, and Level IV, Results Criteria, evaluates the effect on the organization resulting from the training program.

Table 1: Kirkpatrick (1959) Training Effectiveness Evaluation Model

<p><b>Level I</b> <b>Reaction</b> <b>Criteria</b></p>	<p>Reaction: Evaluates user affective and attitudinal response to the training program.</p> <p>Focuses on self-report measures.</p> <p>Instruments: Surveys, questionnaires, focus groups, etc.</p>
<p><b>Level II</b> <b>Learning</b> <b>Criteria</b></p>	<p>Knowledge Acquisition: Evaluates user's increase in knowledge and capability as a result of the training program.</p> <p>Focuses on learning outcomes.</p> <p>Instruments: pre-/post Knowledge Test, Interview or on-the-job assessments, etc.</p>
<p><b>Level III</b> <b>Behavior</b> <b>Criteria</b></p>	<p>Skill Transfer: Evaluates changes in behavior on the job as a result of the training program.</p> <p>Focuses on the job performance measures.</p> <p>Instruments: self-assessments, on-the-job performance ratings, etc.</p>
<p><b>Level IV</b> <b>Results</b> <b>Criteria</b></p>	<p>Benefits: Evaluates the effect on the organization resulting from the training program.</p> <p>Focuses on long-term productivity performance measures.</p> <p>Instruments: Utility Analysis Instruments, Organizational performance reports, Quality Assurance reports, etc.</p>

According to Casey and Doverspike (2005) usually the most common evaluation method utilized is level 1 which represents the affective and attitudinal responses of the trainees towards the training program. A meta-analysis was conducted (Arthur, et al, 2003) to look at designs and evaluation features used in the evaluation of training effectiveness in organizations. The article cited statistics published by the American Society for Training and Development's 2002 regarding the types of Training Effectiveness Evaluations conducted by surveyed organizations. According to this report, 78% of the organizations utilized the reaction criteria (Level I) for their

evaluation, 32% of the organizations used learning criteria measures (Level II), 9% used behavioral criteria measures (Level III), and 7% used results criteria measures (Level IV). Klein (2002) expanded Kirkpatrick's (1959) four level model of evaluation to include a fifth level: Societal Consequences. Societal Consequences is the extent to which the intervention impacts the larger environmental and social systems (Kaufman & Keller, 1994). It is the objective of this research to evaluate the training effectiveness using a game-based simulation developed to train combat medics the principles of TC3 tasks following Kirkpatrick's (1959) four level model comparing it to multimedia and interactive modes of instruction. The first three levels will be evaluated: Reaction, Knowledge Acquisition, and Skill Transfer. Once the Soldiers leave medic training and are assigned to their new duty stations, due to scattering of these medics to various units around the world, it is extremely difficult to evaluate the impact of organization performance by the TC3 training program.

Peterson and Arnn (2005) presented a model of human performance that incorporated self-efficacy and motivation as factors that contributes to Human Performance. The model presented is the following:

Human Performance = f (self-efficacy X ability X motivation) + situational factors

Where:

- Self-efficacy – refers to people's judgments of their own competence to complete a specific task. It is the individual's conviction about his/her ability to successfully execute a specific task within a given context.
- Ability – the capacity to perform some task or cognition. It is a combination of a person's talent, learning, and experience. People with lesser talent can still learn a specific ability through training and practice.

- Motivation – is the willingness to perform. It could be intrinsic in nature were the individual is seeking for emotional reward (praise or recognition) or extrinsic in nature were the individual is seeking a tangible reward (monetary, promotion).
- Situational factors –among some of the Situational factors that have a powerful influence on people’s motivation and their ability to perform and complete a specific task we have: task-related information, tools and equipment, materials and supplies, task training, support from others, time availability, and environment.

This model indicates that self-efficacy, ability, and motivation are critical components of human performance and situational factors also impact performance. In addition to evaluating training effectiveness up to level III, it is the intent of this research to look at the roles self-efficacy and motivation play in a game-based environment. It is not within the scope of this research to validate the model of Human Performance cited above.

Self-efficacy affects the goals people set for themselves, their actions and emotions, their persistence through difficult tasks and challenges, and their choices and decisions. Self Efficacy has proven to be an important factor in the area of academic achievement in traditional learning settings, but its role in e-learning environments is still in its infancy (Hodges 2008). Research has suggested that people with high self efficacy typically manifest higher confidence levels. Lanigan’s (2008) research found low correlation between self efficacy and actual skills but stresses the need to examine self efficacy and skills tests in order to explore more in depth the relationship between the two. Training quality may affect efficacy since mastery is more likely to be achieved if the training provides thorough instruction, opportunities to practice to meet stated standards, with feedback focused on skills learned and goals achieved. Research in various fields of study has validated the concept of self-efficacy as the foundation for human actions. Further

research in this area can provide resources and self-efficacy measures to enhance task performance (Peterson and Arnn, 2005).

Motivation has been defined as the desire or willingness to engage in a task. Motivation refers to an individual's choice to engage in an activity and the intensity of effort or persistence in that activity. The motivated learners are enthusiastic, focused and engaged. They are interested in and enjoy what they are doing, they try hard, and they persist over time (Garris, Ahlers, and Driskell, 2002). Behaviors can be intrinsically or extrinsically motivated and both play a role in determining how motivated a person in doing a specific task is. However, students that are intrinsically motivated are more likely to show a higher conceptual understanding of the material and use more problem solving skills (Green and Sulbaran, 2006). The ultimate goal is to motivate people not just because an activity is interesting in itself but also because they value the activity as important.

### **User Profile**

According to Bae (2002) descriptive characteristics of trainees (personality level, motivation level, goal level, general aptitude, age, education, and experience level) can influence training process. He emphasizes the fact that examination of trainee characteristics has great potential for enhancing the understanding of why training is effective. According to the author, few studies on trainee characteristics have reviewed variables such as age, educational qualifications and experience. The audience available for this research involves Soldiers participating in the 68 W Tactical Combat Casualty Care (TC3) Program of Instruction (POI). This audience typically consists of young, new recruits between the ages of 18 and 21 years of age and older more experienced medics who have not received TC3 training in their the formal



POI. The TC3 POI training is also of value for reservists and National Guard serviceman called to active duty. Before attending the TC3 training, an individual must have completed the initial 68 W training that consists of nine and a half weeks of the civilian focused Emergency Management Training (EMT) model. In addition, participants must have passed the National Registry EMT exam. Table 2 summarizes the TC3 target audience profile (Sotomayor, et al, 2007).

Table 2: TC3 Target Audience Profile

<b>Educational background</b>	New recruits: high school Reserves and older medics: some college
<b>Prior level of medical training</b>	New recruits: Passed the National Registry EMT exam Reserves and older medics: some prior EMT and combat medical training
<b>Computer literacy level</b>	Recruits: intermediate level computer literacy Reservists: basic computer literacy
<b>Male/female ratio</b>	5 to 1 male to female
<b>Age range</b>	18 to 50
<b>Reading level</b>	9 <sup>th</sup> grade
<b>Learning style</b>	Visual and Kinesthetic
<b>Background</b>	Various backgrounds from throughout the United States. Some foreign students
<b>Motivation for completing the training</b>	Job requirement, advancement, job knowledge, personal pride

### Participants

Feedback from subject matter experts at DCMT suggests that the TC3 Game-Based Simulation is appropriate for training principles of TC3. Therefore, participants will include Soldiers that have completed EMT-Basic training but have not begun the TC3 portion of the POI. The experiment will be conducted at Fort Sam Houston, Texas. Typically TC3 classes

begin every 2 to 3 weeks. Each class consists of approximately 400 students. Voluntary participation will be requested and participants will be recruited after completing EMT-B. The current 68 W MOS male to female ratio is approximately 5:1. Similar ratio is expected to be observed during the experiment. An identification number will be assigned to each participant in order to protect their privacy. This number will be utilized through the experiment.

As part of the evaluation the participants will be asked to complete a demographics survey included in Appendix A. Data regarding educational level, age, gender and experience will be collected to be analyzed.

### **Instructional Media**

TC3 training has three defined media sets available for instruction: (1) Multimedia: Self-paced, Power Point with Video Clips (2) Interactive: Self-served, computer-based courseware, and (3) Experiential: Self-served, computer-based, interactive courseware with simulation game. These media sets can be mixed and matched to supplement one another. Each media set is discussed in turn below.

#### **Multimedia: TC3 Traditional Power Point Training**

The traditional TC3 training consists of power point based training on three subjects of tactical combat casualty care: Hemorrhage Control, Airway Management, and Breathing. The material presented in the power point training was adapted from current training materials obtained from instructors at Fort Sam Houston. Video Clips are embedded in the PowerPoint to demonstrate procedures and provide additional content related information. In the current program of instruction at DCMT an instructor utilizes the PowerPoint slides to facilitate delivery

of TC3 principles. Normally the slides are not available to the students for their individual use. They are used by the instructor as a tool to deliver instruction.

### **Interactive: TC3 Courseware**

The TC3 interactive courseware provides knowledge, skills, and practice of TC3 principles. It was developed as distant learning tool to support sustainment training. Soldiers have the capability to download the courseware from the Joint Knowledge Online (JKO) website. JKO is a portal system sponsored by the United States Joint Forces Command that utilizes advanced distributed learning technology to deliver courseware and learning tools to support training of individual warfighters. Each module discusses in detail the Tactical Field Care principles and operations in the areas of tactical field care and care under fire. A variety of interactive presentation methods and screen layouts have been incorporated in the TC3 Courseware in order to simulate a classroom setting with effective immediate feedback from the instructor.

The basic interface consists of video player-like function keys at the bottom of the screen. The user can move forward by clicking the “forward” arrow on the extreme right. To move to the previous screen, the user must click the “back” arrow located on the extreme left. The user has the capability to pause and return to play using the “play/pause” button or can replay using the “replay” button. The user can also go to a specific screen by specifying the screen number. See Figure 5 for the interface buttons.

Hyperlinks are used to present more in depth information regarding a specific topic. Special ‘explore-it’ screens allow the user to click an image or roll over text to display additional information in the form of images, video, or text. Figure 6 shows the yellow text box that pops

up when the mouse pointer is rolled over “endotracheal intubation” as an example of the interactivity built within the courseware.

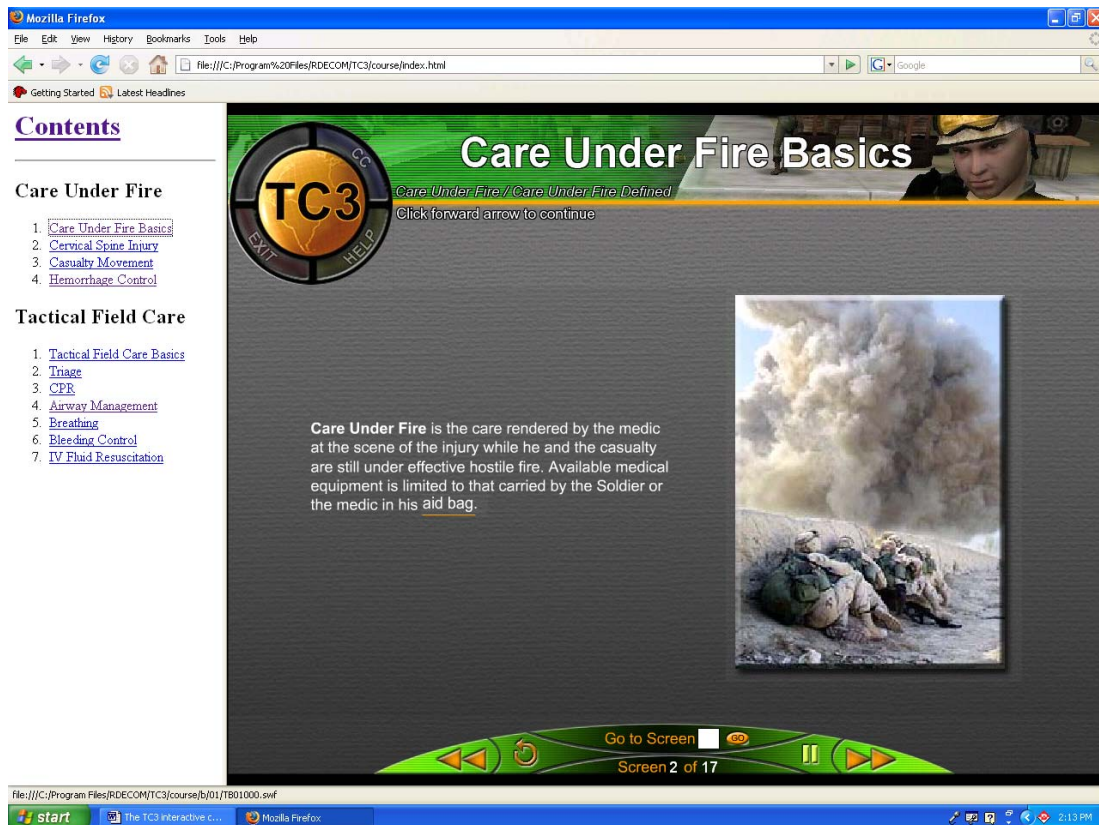


Figure 5: Interface Buttons

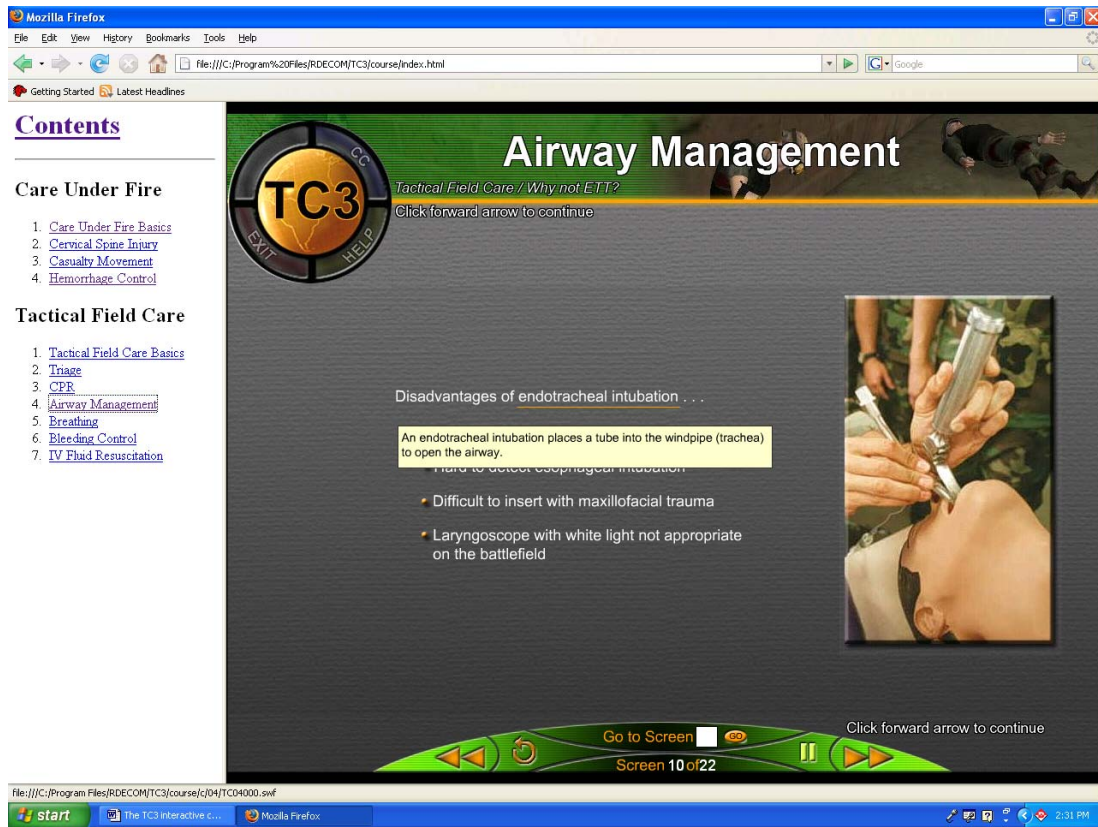


Figure 6: Text Box Pop-up

A “Your Thoughts” screen was integrated into the courseware. This feature provides the ability to enter the user’s thoughts on a particular issue and then compare it to TC3 doctrine. Figure 7 demonstrates a Short Answer question: The slide shown is actually the one right after the question was answered. Notice that the user’s answer from the previous slide can be recalled to compare it with the correct answer. Multiple choice activities provide the user with situations or questions where he or she must use acquired knowledge or previous experience to select from a set of choices. The user must select the answer by left click on the answer and click on the submit button. See Figure 8 for an example of a Multiple Choice question. Every question is provided with a response immediately after it is answered. If questions are answered incorrectly,

the program will automatically skip to the previous relevant few slides to explain the correct answer.

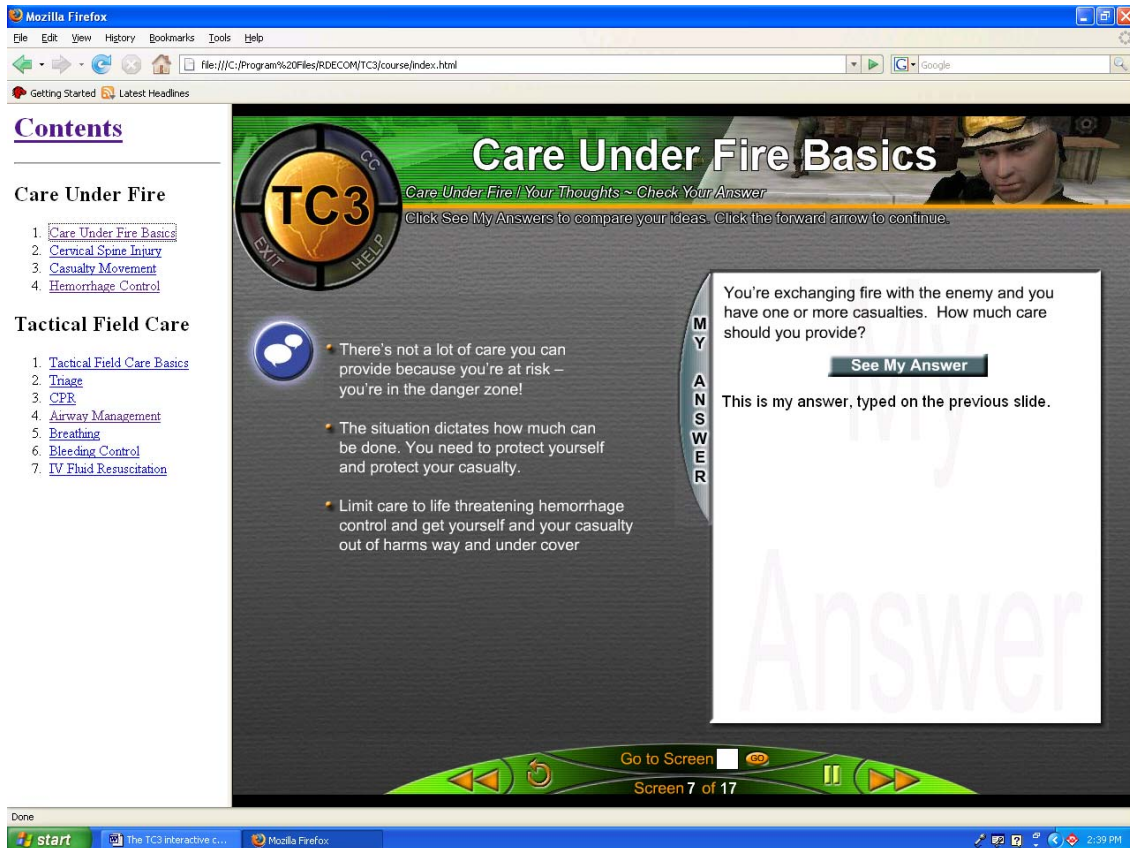


Figure 7: Short Answer Question

The screenshot shows a web browser window with the following content:

- Browser Title:** Mozilla Firefox
- Address Bar:** file:///C:/Program%20Files/RDECOM/TC3/course/index.html
- Page Title:** Airway Management
- Course Logo:** TC3 Tactical Field Care / Your Opinion
- Navigation:** EXIT, HELP, CC
- Section Headers:**
  - Care Under Fire
    - Care Under Fire Basics
    - Cervical Spine Injury
    - Casualty Movement
    - Hemorrhage Control
  - Tactical Field Care
    - Tactical Field Care Basics
    - Thage
    - CPR
    - Airway Management
    - Breathing
    - Bleeding Control
    - IV Fluid Resuscitation
- Question Text:** "If you want a more definitive airway than the nasopharyngeal, you can use the Combitube. The Combitube, shown here, uses two ventilation tubes and two inflation balloons. Which tube should you ventilate first and how many cc's of air go into each inflation balloon? **Select all that apply**"
- Image:** A diagram of a Combitube with two inflation balloons labeled 'Inflation balloon 1' and 'Inflation balloon 2'.
- Options:**
  - A. InflationTube One / 100cc
  - B. InflationTube One / 85cc** (Selected)
  - C. InflationTube Two / 15cc
  - D. InflationTube Two / 12cc
- Feedback:** "Sorry, either A - Tube One / 100cc, or B - Tube One / 85cc is correct. This question is tricky because there are two different sizes of Combitubes. Click the forward arrow to learn more."
- Navigation Bar:** Go to Screen [input type="text" value="5"], Screen 5 of 22, Click the forward arrow to continue

Figure 8: Multiple-Choice Question

At the end of each module the user is presented with Lesson-level quizzes with two to five questions. These questions are related to the identified learning objectives. The courseware automatically provides immediate feedback and remediation based on user inputs to the system. See Figure 9 for an end-of-lesson quiz question.



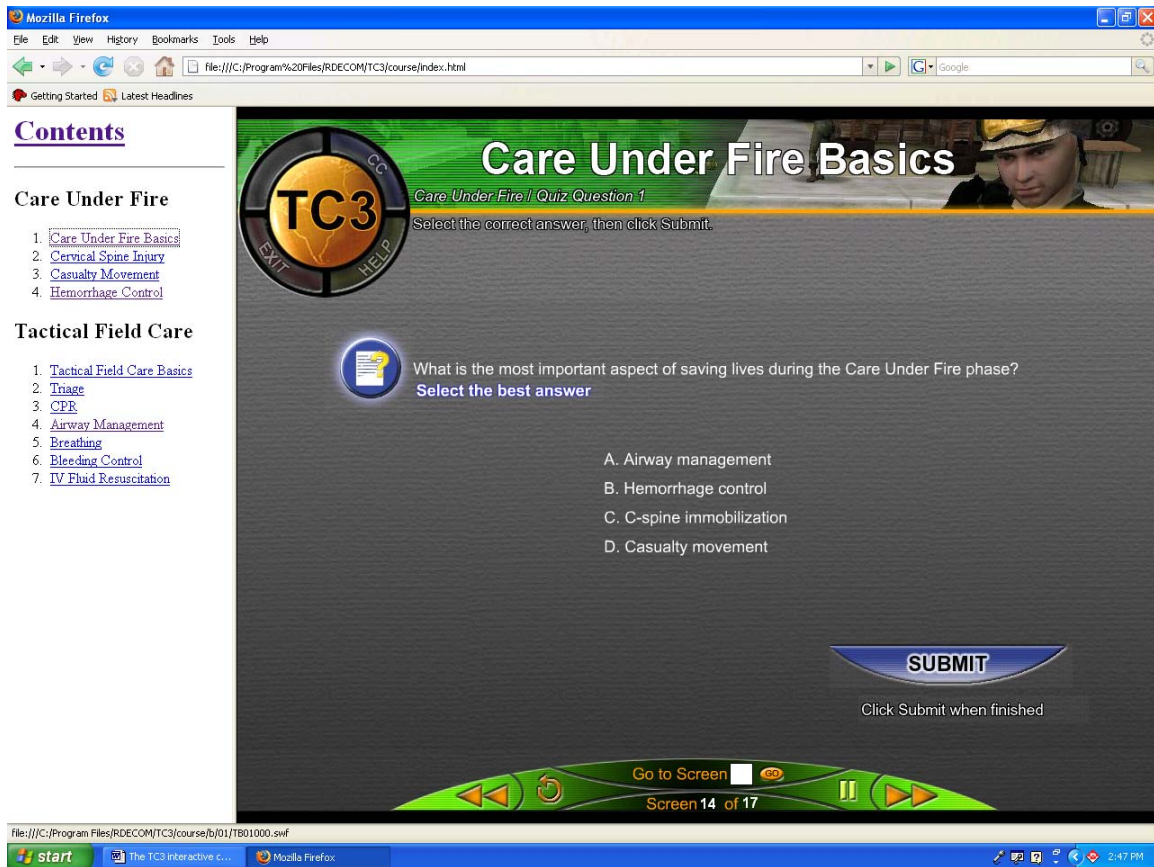


Figure 9: End-of-Lesson Quiz Question

The courseware material runs off of a JAVA applet powered by Flash Player. The slides throughout the program are filled with several embedded pictures or videos to better illustrate each topic. For instance, the procedure for performing cricothyroidotomy is shown in a short video. The “instructor” discusses certain details throughout the video, as well as right after it. This courseware was developed using the instructional materials presented by instructors at AMEDD.

### **Experiential: TC3 Game Based Simulation**

The 68W10- TC3 Sim is a game-engine based simulation that immerses students into scenario-driven events in order to teach procedures relating to the combat medic’s initial arrival



on the scene, scene assessment, scene security, triage, initial treatment, and evacuation of the casualty. Each scenario within the simulation is designed to be a short, goal-oriented training exercise that provides the means to train a group of closely related tasks within the context of a specific mission (Fowler, et al, 2005).

The simulation was developed to support initial training, as well as serve as refresher training to medics who are required to revalidate critical skills. The system operates as a stand-alone application or may be integrated into classroom instruction under the guidance of instructors.

TC3 simulation is a first-person game where the trainee plays the role of the medic assigned to a squad. Prior to this research, the TC3 simulation game was not part of the medic program of instruction. This game has the advantage of placing the medic in scenarios set in the Middle East urban environment. The combat medics' main goal in the game is to stay safe and treat casualties. Failing to follow safety guidance from squad leader can result in his or her death and will automatically end the game. The game may be played with a scenario each with a single casualty and two scenarios each with multiple casualties. The six single casualty scenarios individually address either a casualty who is an amputee, a burned victim, received a gun shot wound, a maxofacial wound, a neck wound or is experiencing multiple hemorrhages. The multiple scenario has three casualties: amputee, chest wound, and a burned victim. The last multiple casualty scenario has five casualties or mass casualties: gun shot wound, amputee, maxofacial wound, burned victim, and a deceased Soldier. During the Mass Casualty Scenarios, the Combat Medic will demonstrate tactical abilities based on doctrine. Trainees treat the wounded by right-clicking on the downed Soldiers' body parts (See Figure 10), at that point several menu options will appear to support specific procedures and operations. Some of these

procedures include tourniquet application, needle decompression, and dressing applications. When the Combat Medic is finished assessing Field Care, all of the patients must be moved to a secure location for further treatment. Once all casualties have been treated and are ready to be evacuated the user must approach the Squad leader to call in a CASEVAC. At this point the simulation will end. The user has the option to practice specific medical operations on a single casualty. Several single casualty scenarios are available and can be chosen from the main menu.

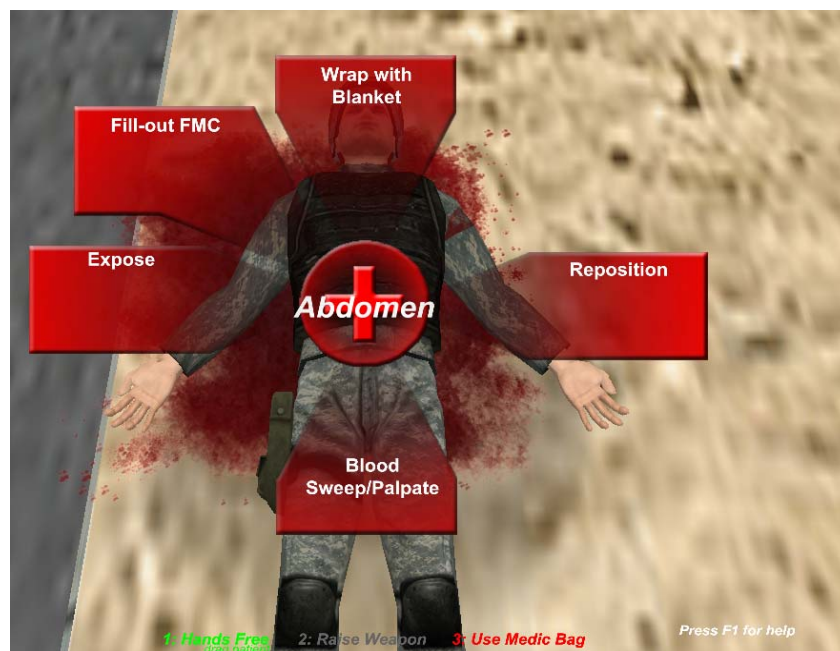


Figure 10: Treating the Wounded

### Instructional Media Validation

The validation of the instructional materials was conducted by AMEDD faculty and subject matter experts. The Traditional Power Point Training materials were developed using current training materials obtained from instructors at Fort Sam Houston. The presentation was tailored to include only the three areas of TC3: Hemorrhage Control, Airway Management and

Breathing. The presentation was reviewed by a faculty member for content validation. The material presented in the TC3 Courseware was validated through its development. Several design reviews were conducted as part of the courseware development with AMEDD subject matter experts to ensure validity of the content presented. The TC3 Game-Based Simulation validation was conducted in phases. The first prototype was evaluated by both instructors and students at Fort Sam Houston. Feedback on the content and interfaces were documented and prioritized based on available resources, changes were incorporated, and a second evaluation was conducted with instructors to validate the simulation. Feedback from experienced medics and trainers suggests the TC3 Sim, at the current stage of development, is appropriate for training the fundamentals of TC3.

### **Methodology**

The main objective of this training effectiveness evaluation is to evaluate the effectiveness of the TC3 Game-Based Simulation in supporting the learning of tactical combat casualty care principles. This study will examine three levels of Kirkpatrick's Model: User Reaction (Level 1), Knowledge Acquisition (Level 2), and Skills Transfer (Level III). The experimental study will be conducted at AMEDD, Ft. Sam Houston, Texas. The experimental study will be preceded by a pilot study also to be conducted at Ft. Sam Houston. The following is an outline of the effort followed by a description of the activities under each phase:

1. Pilot Study – To collect preliminary data using the materials and procedures designed for the TEE and to validate the instruments and make any necessary adjustments to materials and procedures before the formal event.
2. Experimental Study

- a. Independent Variables – Training Type (Three Experimental Groups – Power point based TC3 Training (currently used in the Program of Instruction), TC3 Computer-Based Courseware and a third condition in which participants receive TC3 Computer-Based Courseware and Game-Based Simulation). The block of time available for training will be the same for the three experimental groups.
- b. Dependent Variables – reaction scores, pre/post test scores, gain scores, transfer task score, self-efficacy scores, and motivation scores.
- c. Participants – Soldiers attending the 68W training at Fort Sam Houston, Texas, assigned randomly to three experimental groups.
- d. Materials
  - i. Adult Informed Consent Form (Appendix A).
  - ii. Demographic Survey (Appendix B) – The questionnaire will obtain participant specific information regarding, e.g., gender, age, yrs in medical MOS w/in army, previous civilian medical experience, amount and type of gaming experience, education, and race.
  - iii. Traditional PowerPoint Training of material covered in the TC3 course.
  - iv. TC3 Computer-Based Courseware – Computer based presentation of three modules: Hemorrhage Control, Airway Management, and Breathing.
  - v. TC3 Game-Based Simulation Training – Computer based presentation of three modules (Hemorrhage Control, Airway Management, and Breathing) and TC3 game based training scenarios with single casualties corresponding to the material covered in the courseware.

- vi. Pre/Post Tests (Appendices C and G) – Two versions available to avoid potential learning effects of the pre-test.
  - vii. Timing and Activities Form (Appendices D, E, and F) – to collect user content training time, game time, and activities engaged after completing required content training. The forms are specific to the type of training: PPT, Courseware, and Courseware/Game.
  - viii. Reaction Surveys (Appendices H and J) to collect subjective reaction to training experience and perceived self-efficacy after going through the training and completing the transfer task.
  - ix. Transfer Scenario (Appendix I) – Paper and pencil based scenarios.
  - x. Motivation Survey (Appendices K, L, and M) – Trainee Self Report Questionnaires designed to obtain subjective trainee self reports of intrinsic and extrinsic motivation.
- e. Procedures
- i. Completely Randomized Experimental Design – Participants assigned randomly to one of the three training conditions: PPT, Courseware, and Courseware/Game.
  - ii. Location: Ft. Sam’s Learning Resource Labs and classrooms.
  - iii. Groups using the courseware and game-based simulation will receive a familiarization training consisting of a tutorial for interaction with the courseware and simulation. Participants will also have access to a usability guide for the simulation that will define the function keys required to

execute specific actions. Groups using PowerPoint will receive PowerPoint familiarization training.

iv. Each training condition will last approximately 2 to 2.5 hours.

Table 3 outlines the schedule for the training Effectiveness Evaluation Experiment.

Table 3: Experimental Timetable

	<b>Self-paced, Power Point with Video Clips</b>	<b>Interactive Courseware with Questions and Feedback</b>	<b>Interactive Courseware with Questions and Feedback and Game</b>
<b>Consent Form and Demographics</b>	10 Minutes	10 Minutes	10 Minutes
<b>Pre Test</b>	10 Minutes	10 Minutes	10 Minutes
<b>Familiarization Training</b>	5 Minutes	10 Minutes	20 Minutes
<b>Content Training</b>	60 minutes	60 Minutes	60 Minutes
<b>Post Test</b>	10 Minutes	10 Minutes	10 Minutes
<b>Reaction Survey after Training</b>	15 Minutes	15 Minutes	15 Minutes
<b>Transfer Scenario Test</b>	15 Minutes	15 Minutes	15 Minutes
<b>Reaction Survey after Transfer Task</b>	10 Minutes	10 Minutes	10 Minutes
<b>Motivation Survey</b>	5 Minutes	5 Minutes	5 Minutes

Note: The times allocated in the table were based on a dry run conducted with four volunteers without any TC3 background.

### **Research Questions**

The following research questions will be addressed as part this research study:

- Do participants react positively to the introduction of an experiential tool such as the TC3 Game-Based Simulation in a training environment?
- Does this experiential tool significantly improve knowledge in TC3 principles when compared to multimedia and interaction tools?

- Does this experiential tool significantly improve critical thinking skills?
- Does this experiential tool significantly enhance trainee self efficacy?
- Does this experiential tool significantly enhance trainee intrinsic and extrinsic motivation?

### **Research Hypotheses**

The research hypotheses derive from the research questions discussed above. Measuring reaction is the first step in evaluating training effectiveness (Kirkpatrick (1959), Kaufman and Keller (1994), Wiebenga (2005)). Reaction to training will be assessed with the following proposed hypothesis:

- Do participants react positively to the introduction of an experiential tool such as the TC3 Game-Based Simulation in a training environment?
  - H1: Reaction score for the TC3 Game-Based Simulation training group will be significantly higher than reaction scores for other training treatment groups.

One method used for measuring knowledge change, i.e. knowledge gained by participants as a consequence of the training intervention (Kirkpatrick's Level II), is the administration of pre and post tests (Dimitrov and Rumrill 2003, Wiebenga 2005). Knowledge Acquisition will be addressed with the following hypotheses:

- Does the TC3 Game-Based Simulation training significantly improve training knowledge?
  - H2: Knowledge post test scores for the TC3 Game-Based Simulation training group will be significantly higher than their knowledge pretest scores.

- H3: Pre-post test gain scores for the TC3 Game-Based Simulation training group will be significantly higher than Pre-post test gain scores for other TC3 training treatment groups.
- H4: Content training time for the TC3 Game Based Simulation training group will be significantly less than the content training time for other TC3 training treatment groups.

According to Wiebenga (2005) the best way to ensure transfer of knowledge (Kirkpatrick's Level III) is to make sure the game incorporates situations that are close to what they are encountered in a job or task related situation. Skills transfer will be assessed using a paper and pencil based scenario exercise that incorporates job related tasks and will be administered after training. The following hypothesis addresses skill transfer:

- Does TC3 Game-Based Simulation training significantly improve critical thinking skills?
  - H5: Transfer Scenario test scores for the TC3 Game-Based Simulation training group will be significantly higher than Transfer Scenario test scores for other TC3 training treatment groups.

In addition, Wiebenga (2005) states that both the participant's attitude towards the content being taught as well as the game used needs to be evaluated. Therefore, in addition to evaluating training effectiveness up to level III, the roles self efficacy and motivation play in a game-based environment will be assessed with the following hypotheses:

- Does TC3 game based Simulation significantly enhance trainee self-efficacy?
  - H6: Self-Efficacy scores for the TC3 Game-Based Simulation training group will be significantly higher than self-efficacy scores for other TC3 training treatment groups.



- Does TC3 game based Simulation significantly enhance trainee intrinsic and extrinsic motivation?
  - H7: Intrinsic Motivation scores for the TC3 Game-Based Simulation training group will be significantly higher than Intrinsic Motivation scores for other TC3 training treatment groups.
  - H8: Extrinsic Motivation scores for the TC3 Game-Based Simulation training group will be significantly higher than Extrinsic Motivation scores for other TC3 training treatment groups.

### **TC3 Training**

All participants will be administered a pre-test prior to TC3 training. Participants will be randomly assigned to one of three training treatment groups: Power point based TC3 Training (currently used in the Program of Instruction), TC3 Computer-Based Courseware and a third condition in which participants receive TC3 Computer-Based Courseware and Game-Based Simulation. A number will be assigned to each participant to protect their privacy. The TC3 Courseware and the TC3 Game-Based Simulation training groups will receive familiarization training which will consist of a brief tutorial for interaction with the courseware and the game-based simulation. The TC3 Courseware and the TC3 Game-Based Simulation training groups will also have access to a usability guide which will define the keys required to execute specific actions. A computer/power point familiarization period will be provided to the Power point based TC3 Training group. All groups will be provided with training in three areas of TC3: Hemorrhage Control, Airway Management and Breathing. Although TC3 training obviously includes more than these three topic areas, given the scope of the evaluation and resources

available, a selection of topics critical to 68 W job performances was necessary. In order to select the modules for the experiment, subject matter expertise from AMEDD was consulted. Another consideration taken into account was the fact that the TC3 game based simulation contains training scenarios involving single casualties with injuries corresponding to the material available in the selected courseware modules. The TC3 Game-Based Simulation training group will complete single casualty scenarios in the game. In the scenarios, the trainee will assume the role of a combat medic assigned to a light infantry squad operating in an urban environment somewhere in the Middle East. After training the group will be asked to complete a post-test, reaction and motivation surveys, and paper and pencil based scenarios.

### **Level 1 Evaluation: User Reaction to the TC3 Training**

In order to measure user reaction to the TC3 training, the groups will be asked to provide feedback via survey questionnaires after completing the training. The groups will be asked to provide feedback on three different areas: Overall Student Reaction to Training Treatment, Learning Benefit of each Training Treatment, and Usability of the System used by each Training Treatment.

### **Overall Reaction**

In order to assess the overall reaction to the TC3 training, participants in each group will be asked to rate the training on a 1 to 5 Likert Scale (1=Poor, 2=Fair, 3=Good, 4=Very Good, and 5=Excellent) based on their experience with the assigned TC3 training treatment (see Appendix H).

## **Benefit to Training**

Benefit to training will be assessed in two different dimensions: Learning objectives met and inclusion of the training instructional media in the current POI.

To assess reaction to instructional media being effective in incorporating training objectives, participants in each group will be asked to provide feedback using a 1 to 5 Likert Scale (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree) for six training objectives in the areas of hemorrhage control, airway management, and breathing (see Appendix H).

In order to assess reaction regarding inclusion of the training instructional media in the current program of instruction, participants in each group will be asked to provide feedback using a Likert Scale from 1 to 7 (1= “Not at all” agree, 4 = “Somewhat” agree, and 7 = “Very Much” agree with the assertion) based on their experience using the instructional media. See Appendices K, L, and M: Question number 6.

## **System Usability**

The usability of an interactive system can be defined, in part, in terms of how easily a user can access and use the intended functionality of the system to meet task objectives. Interactive systems should be designed such that they are intuitive, effective, and subjectively acceptable to users (Nielsen 1993)]. System usability will be assessed in two different dimensions: Ease of use and Need for Instructor Support.

In order to assess reaction regarding ease of use, each group will be asked if the training was clear and easy to follow. Participants in each group will be asked to provide feedback using

a 1 to 5 Likert Scale (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree). See Appendix H.

In order to assess reaction regarding the need for instructor support to make the TC3 training beneficial to them, participants in each group will be asked to provide feedback using a Likert Scale from 1 to 7 (1= “Not at All” agree, 4 = “Somewhat” agree, and 7 = “Very Much” agree with the assertion) based on their experience using the instructional media. See Appendices K, L, and M: Question number 5.

### **Level II Evaluation: Knowledge Acquisition with the TC3 Training**

Level II skills acquisition will be evaluated by examining changes between pre and post training test scores. Pre-tests will be administered in order to determine if any differences exist between the experimental groups regarding prior to training knowledge. One of the main goals of this research is to determine if the use of instructional games enhances the acquisition of knowledge. Dependent variables that will be examined are pre training test score, post training test score, and a pre/post training gain score. All training content, as well as, the pre and post tests were reviewed by AMEDD faculty to ensure content validity.

### **Subjects with Traditional Power Point Training**

The experimental group with traditional power point training will have a power point familiarization overview prior to conducting the training. The group will have one hour to complete the training on the three main areas of TC3: Hemorrhage Control, Airway Management and Breathing. After training is completed, participants in the group will be asked to take a post test.

### **Subjects with TC3 Courseware Training**

The experimental group with courseware training will have a courseware familiarization overview prior to conducting the training. The group will have one hour to complete three modules of the interactive courseware: Hemorrhage Control, Airway Management and Breathing. After training is completed, participants in the group will be asked to take a post test.

### **Subjects with TC3 Courseware and Game Based Simulation Training**

The experimental group with courseware and game based simulation training will have an interface familiarization overview prior to conducting the training. In addition, a usability guide will be provided for reference on how to use the different function keys in the simulation. The group will have one hour to complete the training on the three main areas of TC3 (Hemorrhage Control, Airway Management and Breathing) as well as playing the game. The participants in the group will complete three single scenarios that correspond to the content covered. After action review will be provided after completing each single scenario. After training is completed, participants in the group will be asked to take a post test.

### **Level III Evaluation (Transfer) to TC3 Sim**

According to Hardre and Chen (2005) transfer is the ability to extend or apply learned knowledge and skills to various situations. Learning experiences produce differential effects on memory and transfer processes. Transfer depends on: initial learning (specifically deep level understanding) of the domain of application and the match between elements in the learning and performance situations. Information delivery and practice to support transfer and development interact with individual differences (in particular prior knowledge and strategies). The transfer of skills to other task related situations will be evaluated by examining post training performance

on another simulation. Idealistically, the evaluation of skills transfer should have been done in a field training exercise, but constraints in resources (not enough SMEs to evaluate performance per individual) and the necessary amounts of subjects to conduct appropriate data analysis is beyond the scope of this effort. Instead of evaluating Soldier's performance on a field exercise, a TC3 paper and pencil based scenario provided by AMEDD subject matter experts will be utilized. The participants in all treatment groups will be asked to read two TC3 scenarios and answer eleven questions. A transfer task score will be calculated based on percentage of correct answers.

### **Self-Efficacy Evaluation**

In an effort to study the role of self efficacy in student's performance in a game based environment, participants in each training group will be ask to answer questions on perceived self efficacy as part of the reaction surveys (Appendices H and J) after training and after completing the transfer task.

After completing the training and post test, participants in each group will be asked if they felt confident that they would be able to perform back on the job the tasks associated with the training objectives in the area of Hemorrhage Control, Airway Management and Breathing. They will be asked to provide feedback using a 1 to 5 Likert Scale (Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree =4, and Strongly Agree = 5). See Appendix H.

After completing the transfer task scenarios, participants in each group will be asked if they felt that the training enabled them to complete the scenarios and apply the principles associated to the training objectives. They will be asked to provide feedback using a Likert Scale

from 1 to 5 (Strongly Disagree=1, Disagree=2, Neutral=3, Agree=4, and Strongly Agree=5). See Appendix J.

### **Motivation Evaluation**

As part of the Motivation Survey (Appendices K, L, and M) 4 statements were included to gather data regarding intrinsic and extrinsic motivation. Two of the statements assess intrinsic motivation (i.e. the learner engages in an activity because it is interesting or enjoyable) and the other two assess extrinsic motivation (i.e. the learner engages in the activity because he or she desires the outcome and values it as important). The statements were taken from The Intrinsic Motivation Inventory (IMI) survey instrument. IMI is a multidimensional measurement device intended to assess participant's subjective experience related to a target activity in an experimental setting. The questionnaire was developed by Edward L. Deci, and Richard M. Ryan and is based on the Self-Determination Theory. The instrument is a seven-point Likert Scale survey that assesses seven different constructs that are attributed to motivation. The constructs assessed include 1) Interest/Enjoyment, 2) perceived competence, 3) effort/importance, 4) pressure/tension, 5) perceived choice, 6) value/usefulness, and 7) relatedness. The validity and reliability of this instrument have been established and past research suggests that inclusion or exclusion of specific subscales does not affect its reliability or validity (Deci & Ryan, 2005). The statements were selected from the two constructs that are relevant to this study: Interest/Enjoyment and value/usefulness.

After completing the training, participants in each group will be asked to answer two questions to assess intrinsic motivation (Appendices K, L, and M; Question number 1 and 2). They will be asked to provide feedback using a Likert Scale from 1 to 7 (1= "Not at All" agree, 4

= “Somewhat” agree, and 7 = “Very Much” agree with the assertion) based on their experience using the assigned training media.

In addition to measuring intrinsic and extrinsic motivation it is important to look at other characteristics of motivated learners such as interest and persistence. As part of this research the time the user spent on task will be collected as a possible indication of motivation for all treatments, as well as, the number of iterations a user chooses to go through the training. For the experimental group that will be doing the courseware and game training the time spent going over the courseware and the time spent playing the game will be collected. Also, for the group playing the game it will be of benefit to collect the number of iterations a user goes through the game (playing different scenarios).

### **Evaluation**

The sample size required for this study is being estimated using Power Analysis. Using a power analysis table (Cohen,1992) it is anticipated that for a medium effect size, alpha level of 0.5, for the intervention to achieve power of .8 the minimum sample size required is 52 participants per treatment group. Each incoming class at AMEDD contains approximately 400 trainees. Since participation in the study is voluntary and resources to conduct the experiment are limited, it is expected that the required sample size will be obtained from multiple classes.

### **Pilot Test Results**

A pilot Study was conducted to validate the instruments, coordinate resources, and make any necessary changes to materials and procedures. The main purpose of the pilot study was to finalize logistics in preparation for the TEE. The Pilot Test was conducted on March 19, 2008 at the Department of Combat Medic Training in Fort Sam Houston, Texas. A total of 30 Soldiers



participated during the pilot test. Ten Soldiers were assigned to each experimental group: Traditional PowerPoint training, TC3 Courseware training, and TC3 Courseware/Game Based Simulation Training.

## **Resources**

The main purpose of the pilot test was to dry run the test protocols to include procedures and materials and to assess and coordinate the resources needed for the formal TEE. Fort Sam Houston has several Learning Research Centers (LRCs) that have approximately 60 computers each available for training. Early assessment of the resources identified the fact that the computers could not support running the Game. Coordination to send 20 laptops to support the TEE was accomplished prior to the pilot test. The original plan for the formal TEE prior to the pilot test was to run each session with 60 computers: 20 Gaming laptops to support the TC3 Courseware/Game Based Simulation Training, 20 computers from LRC1 to support Traditional PowerPoint training and 20 computers from the LRC2 to support TC3 Courseware training. Each session would accommodate 20 Soldiers per treatment. Three sessions were deemed appropriate to collect the necessary amount of data points (at least 156 per Power Analysis) to support data analysis.

During the pilot test ten computers were set up to support the experiment. Since each condition had slightly different instructions and familiarization procedures, the data was collected over three sessions each corresponding to the type of training. The first condition was Traditional PowerPoint training followed by the TC3 Courseware condition, and ending with the TC3 Courseware/Game Based Simulation Training. During coordination with Fort Sam management, two important issues were identified: only one LRC would be available to support

the training effectiveness evaluation and even though the LRC computers had the capability to support the TC3 Courseware, the courseware could not be loaded in the network due to security restrictions. It became apparent that the twenty laptops available would need to support both the TC3 Courseware condition and the TC3 Courseware/Game Based Simulation Training.

As a result, the following configuration was coordinated with Fort Sam Houston to support the formal TEE:

Table 4: Proposed Experimental Configuration

<b>Treatment</b>	<b>Facility</b>	<b>Number of Computers</b>	<b>Number of Subjects</b>
PPT	LRC	10	10
TC3 Courseware	Room 1	10	10
TC3 Courseware and Game	Room 2	10	10

With this configuration only 30 subjects could participate in the experiment in one session. Six sessions were needed to complete the data collection, therefore three separate events needed to be coordinated.

### **Observations**

The following are observations during the pilot test that helped delineate a plan of execution for the formal event:

- Given that data collection needed to be done in multiple sessions, scripts were developed to ensure that all the sessions were conducted the same way. During the pilot test changes to scripts and procedures were identified and annotated in order to facilitate the final TEE administration.

- Due to the aggressive POI that the combat medics currently have to complete, the window of opportunity provided by Fort Sam to access the Soldiers for the experiment is one day per training class. On this day the Soldiers take their EMT-Basic exam in the morning. In that day access to the students were granted mid morning and early afternoon. 30 Soldiers could complete the training in the morning and 30 students could complete another session in the afternoon. Plans were made to complete data collection in three separate visits to Fort Sam.
- During the pilot some of the Soldiers communicated that they were asked to volunteer to play a 20 min video game. It was clear that coordination with the trainers that were responsible to recruit participants needed to be done to ensure that they communicate the objective of the study more clearly.
- The experiment was somewhat tedious on participants. Fatigue was an obvious factor and this could affect the results of the experiment.

### **Lessons Learned**

- Since each condition has slightly different instructions and familiarization procedures, the experiment needs to be conducted in three separate rooms – one condition per room.
- Due to the tight schedule, a minimum of 6 people are needed to conduct the TEE with adequate support. Dry runs need to be conducted to bring the research team up to speed on what they should expect from the event as well as assign responsibilities.
- Coordination of the experiment needs to be done at all levels to include recruiting personnel. This is important to ensure volunteer participation and to better manage

subject’s expectations. Performance and attitudes might be affected if the subjects come in with incorrect expectations.

- The sessions take approximately 2 hours and Soldiers are exhausted from preparation the day before for the EMT-B certification exam. A break with refreshments needs to be included prior to the transfer task if possible. A close look at the protocols should be done to tailor if possible to overcome Soldier’s boredom.
- Only for an emergency should participants be able to leave the room. A couple of Soldiers were allowed to go to the bathroom and did not return right away. An interruption in the administration of the experiment should be avoided for the formal TEE.

### **Evaluation of Test Protocols and Training Materials**

As stated before, in addition to coordinating necessary resources to conduct the TEE, one of the main objectives of the pilot test was to identify any potential issues with the test protocols. Data was reviewed to determine if any changes to the materials were required.

Table 5 summarizes the technical issues and actions taken after close examination of the data collected during the Pilot Test.

Table 5: Pilot Test Data Technical Issues and Actions

<b>Instrument</b>	<b>Technical Issues</b>	<b>Action</b>
PowerPoint	The videos in the power point presentation got hung up. Students could not watch entire video on slide 1. Had to hit the right arrow to advance to the next slide.	Scripts were modified to instruct students to hit the F5 key in their terminal.
TC3 Courseware	<ul style="list-style-type: none"> <li>• Hemorrhage Control module – slide 15 with interactive question, the pictures are missing in the response option. See</li> </ul>	Both modules were revised and corrected prior to TEE.

Instrument	Technical Issues	Action
	<p>screenshot in Figure 11.</p> <ul style="list-style-type: none"> <li>• Airway Mgmt – slide 21. Participant selected ‘B’ <i>When unable to obtain an airway</i>. And feedback read... ‘<i>Great job! The NPA is the best standard airway...</i>’ This is not the correct feedback. See screenshot in Figure 12.</li> </ul>	
TC3 Game	<p>This condition seemed pretty intense for participants. During the Pilot test this was the last condition and was done late in the afternoon. Need to assess if this is related to the amount of material? Length of time? Time of day?</p>	<ul style="list-style-type: none"> <li>• A decision was made to only run two sessions per day of training, one in the morning and one in early afternoon. All the conditions per session will be done in parallel.</li> <li>• A video to introduce the interface of the game was created to help students familiarize with the tool.</li> <li>• A hand on practice using the burn victim scenario was added as part of the familiarization training to make sure each Soldier got familiar with the interface before doing their content training.</li> </ul>
Consent Form	<p>Realized that a couple of Soldiers were younger than 18 years of age. Per IRB direction, subjects need to be 18 years or older.</p>	<p>Scripts were modified to address the age of the subjects and excuse any person younger than 18.</p>
Demographics	<ul style="list-style-type: none"> <li>• When asked how many hours they spent playing games and in the computer on a typical week most of the Soldiers reported spending no time even though they considered themselves at the intermediate or expert levels. Soldiers reported that they have been on intense training for several months and might not have access to computers.</li> <li>• When asked for Duty Position most of them answered “68 W” which is their current MOS.</li> </ul>	<ul style="list-style-type: none"> <li>• The question was change to read “ Thinking over the last six months”</li> <li>• Duty Position Question was deleted from Survey as it does not provide meaningful information.</li> </ul>

<b>Instrument</b>	<b>Technical Issues</b>	<b>Action</b>
Knowledge Test	<ul style="list-style-type: none"> <li>The participants were asked to write the letter that corresponded to the correct answer in the multiple choice questions. Some of the handwritings were not legible.</li> <li>See Table 6 for further analysis and actions</li> </ul>	Changed the instructions asking subjects to circle the correct answer.
Transfer Task	<ul style="list-style-type: none"> <li>The Scenarios were provided by trainers at Fort Sam Houston and included material beyond the principles covered in the training.</li> <li>See Table 7 for analysis</li> </ul>	See Table 7 for actions taken.
Self Efficacy Surveys	<ul style="list-style-type: none"> <li>No trends observed.</li> </ul>	No action required.
Motivation Survey per Condition	<ul style="list-style-type: none"> <li>This survey was administered at the end of the training and had too many questions. After reviewing the data a trend was observed among participants providing the same scores.</li> </ul>	The surveys were reviewed to concentrate on intrinsic as well as extrinsic motivation. Questions that were addressed in other surveys were removed.
Other General Observations	<ul style="list-style-type: none"> <li>Some of the instruments had continuation pages in the back. Several students did not fill out the information.</li> </ul>	Added a note at the bottom of the page indicating that the subject needed to continue on the back.

Table 6: Knowledge Test – Observations and Actions Taken after Analysis of Pilot Data

<b>Item</b>	<b>Observation</b>	<b>Action</b>
Pre Test Question 6 Post Test Question 13	Most participants in the PowerPoint training selected the correct answer (9 out of 10). Participants on the Courseware and Game Conditions selected all options.	This question was reworded after evaluating the courseware module.
Pre Test Question 7 Post Test Question 14	Most participants selected the incorrect answer and they were consistent in selecting the same incorrect answer.	This question was deleted. Material was not covered in the modules and PowerPoint Training.
Pre Test Question 8 Post Test Question 15	Most participants selected the incorrect answer and they were consistent in selecting the same incorrect answer.	This question was deleted. Material was not covered in the modules and PowerPoint Training.

Table 7: Transfer Task – Observations and Actions Taken after Analysis of Pilot Data

<b>Item</b>	<b>Observation</b>	<b>Action</b>
<b>Scenario 1</b>		
Question 1	Most participants selected the incorrect answer and they were consistent in selecting the same incorrect answer.	This question was deleted since the principles addressing this item are covered in Care under Fire Module which was not included in the evaluation.
Question 2	All the PowerPoint Training participants answered incorrectly.	This question was deleted since the material was not covered in the PowerPoint presentation and was specific to the scenario.
Questions 5 and 7	All participants answered correctly. No variance was observed that would support differentiating among conditions.	After careful examination, questions 5 and 7 were deleted and two additional questions were added.
Question 10	Only a small portion of the subjects answered this question correctly.	This question was deleted since the principles addressing this item are covered in IV Fluid Resuscitation Module which was not included in the evaluation.
Question 12	Most participants selected the incorrect answer and they were consistent in selecting the same incorrect answer.	This question was deleted since the principles addressing this item are covered in IV Fluid Resuscitation Module which was not included in the evaluation.
<b>Scenario 2</b>		
Question 2	Only 3 participants receiving the courseware training answered correctly.	This question was deleted since the principles addressing this item are covered in Care under Fire Module which was not included in the evaluation.
Question 4	Most participants selected the incorrect answer and they were consistent in selecting the same incorrect answer.	This question was deleted because it was confusing. Two answers could possibly be selected.

Item	Observation	Action
<b>Scenario 2</b>		
Question 5	Only two PowerPoint participants answered correctly.	This question was deleted since the principles addressing this item are covered in IV Fluid Resuscitation Module which was not included in the evaluation.
Question 6	Two possible answers. Most of participants answered partially correctly.	This question was reworded to include only one correct answer.

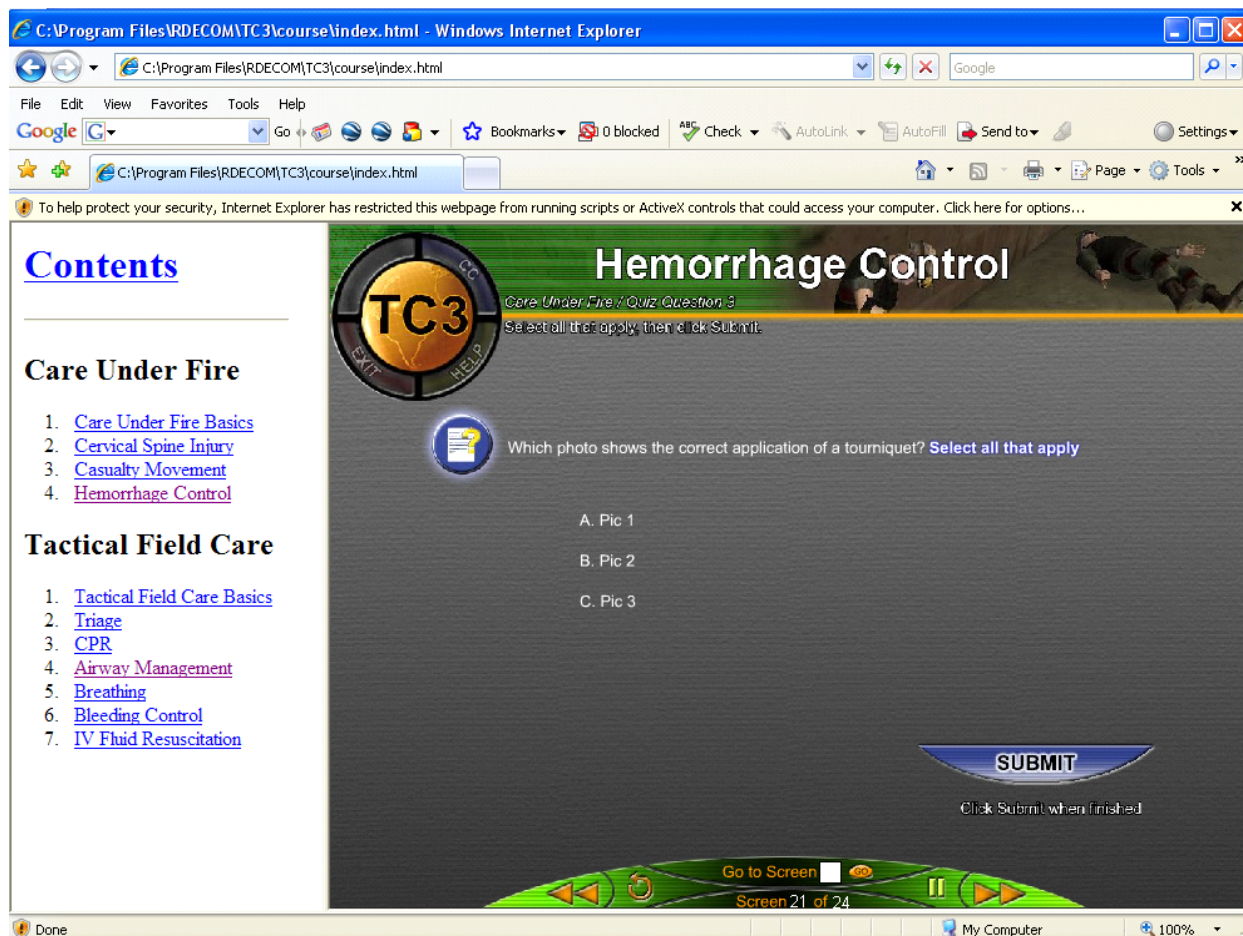


Figure 11: Missing Pictures



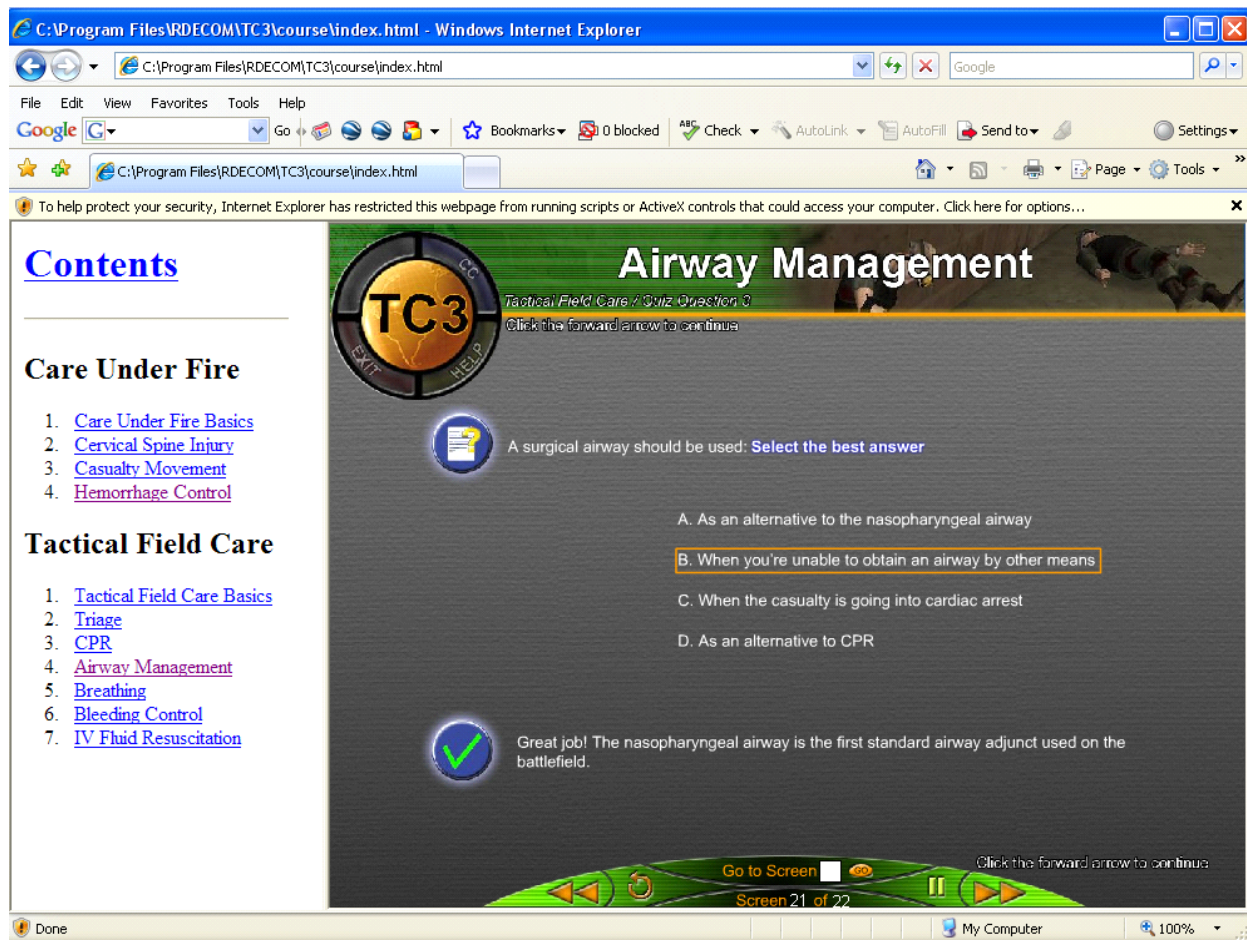


Figure 12: Incorrect Feedback

### Assessing Reaction (Level I)

A reaction survey will be used to collect information on three areas: Overall Student Reaction to Training Treatment, Learning Benefit of each Training Treatment, and Usability of the System used by each Training Treatment. Responses will be collected for each training group. One main hypothesis will be tested to assess reaction to training:

- H1: Reaction score for the TC3 Game-Based Simulation training group will be significantly higher than reaction scores for other training treatment groups.

To test H1, a one-way ANOVA for completely randomized designs will be performed to determine if reaction scores for the TC3 Game-Based Simulation training group are significantly higher than reaction scores for other training treatment groups. The relationship of the reaction scores to performance on post test and transfer task will be investigated. In addition, relationships between these variables and prior experience, gender, and age will be examined. Pearson correlation analysis will be performed to explore the relationship between these variables.

### **Assessing Knowledge Acquisition (Level II)**

Two main Hypotheses will be tested to assess if the TC3 Game-Based simulation significantly improve post training knowledge and decision-making skills. Another hypothesis will be tested to explore content training time between training treatments:

- H2: Knowledge post test scores for the TC3 Game-Based Simulation training group will be significantly higher than their knowledge pretest scores.
- H3: Pre-post test gain scores for the TC3 Game-Based Simulation training group will be significantly higher than pre-post test gain scores for other TC3 training treatment groups.
- H4: Content training time for the TC3 Game-Based Simulation training group will be significantly less than the content training time for other TC3 training treatment groups.

To test H2, a one-way ANOVA for completely randomized designs will be performed to determine if pre test scores significantly differ from post test scores for the TC3 game based simulation group. To test H3, either Analysis of Variance (ANOVA) or Analysis of Covariance (ANCOVA) using pre-tests as covariates are appropriate statistical methods for comparing

groups were there is both pre-test and post-test data (Dimitrov and Rumrill, 2003). According to the authors, when using completely randomized designs, ANCOVA can reduce error variance and could guard against systematic bias. If after the analysis, we fail to reject H3, a t-test or one way ANOVA will be used to test differences between training treatment groups. The hypothesis testing will be done with pre-post training gain scores. The same analysis will be done to test H4.

### **Assessing Skill Transfer (Level III)**

One hypothesis will be tested in order to assess if the TC3 Game-Based Simulation transfer to performance outside of the TC3 game based simulation training scenarios:

- H5: Transfer Scenario test scores for the TC3 Game-Based Simulation training group will be significantly higher than Transfer Scenario test scores for other TC3 training treatment groups.

To test H5, a one-way ANOVA for completely randomized designs will be performed to determine if transfer scores the TC3 Game-Based Simulation training group significantly differs from transfer scores for participants receiving other TC3 training treatments. The hypothesis testing will be done with transfer task scores obtained from the transfer task paper and pencil scenarios.

### **Assessing Self Efficacy**

One hypothesis will be tested in order to assess if the TC3 Game-Based Simulation training system significantly enhances trainee self-efficacy:

- H6: Self-Efficacy scores for the TC3 Game-Based Simulation training group will be significantly higher than self-efficacy scores for other TC3 training treatment groups.

To test H6, a one-way ANOVA for completely randomized designs will be performed to determine if there are any significant differences in self efficacy scores between treatments. The hypothesis testing will be done with self-efficacy scores obtained after training and after completion of the transfer task paper and pencil scenarios.

### **Assessing Motivation**

Two main hypotheses will be tested to assess intrinsic and extrinsic motivation:

- H7: Intrinsic Motivation scores for the TC3 Game-Based Simulation training group will be significantly higher than Intrinsic Motivation scores for other TC3 training treatment groups.
- H8: Extrinsic Motivation scores for participants receiving TC3 Game-Based Simulation training will be significantly higher than Extrinsic Motivation scores for other TC3 training treatment groups.

To test H7 and H8, a one-way ANOVA for completely randomized designs will be performed to determine if there are any significant differences in intrinsic and extrinsic motivation scores between treatments. The hypothesis testing will be done with intrinsic and extrinsic motivation scores obtained from responses to the Motivation Survey.

## CHAPTER FOUR: EXPERIMENT RESULTS

### Data Collection

The Training Effectiveness Evaluation Experiment was conducted at the Department of Combat Medic Training (DCMT), Fort Sam Houston, from April 17th, 2008 to June 12<sup>th</sup>, 2008. A total of 180 subjects participated in the study. All subjects were part of the 68 W training at DCMT and had completed the Emergency Management Training – Basic (EMT-B) training and certification testing. The data collection was completed in three separate visits to DCMT: April 17<sup>th</sup>, May 8<sup>th</sup> and June 12<sup>th</sup>. The following configuration (Table 8) was coordinated with Fort Sam Houston to support the Training Effectiveness Evaluation.

Table 8: Final Experimental Configuration

<b>Treatment</b>	<b>Facility</b>	<b>Number of Computers</b>	<b>Number of Subjects</b>
PPT	LRC	10	10
TC3 Courseware	Room 1	10	10
TC3 Courseware and Game	Room 2	10	10

With this configuration only 30 subjects could participate in the experiment in one session. Ten Soldiers were assigned randomly to each experimental group: Traditional TC3 PowerPoint training, TC3 Courseware training, and TC3 Courseware/Game Based Simulation Training. Two sessions were completed at each visit for a total of six sessions. Each session was facilitated by two research assistants.

## Training Effectiveness Evaluation Audience Profile

A demographics questionnaire was provided to each subject in an effort to collect data regarding age, 1<sup>st</sup> person gaming experience, computer experience, educational qualifications, gender, and ethnicity. The purpose of this questionnaire was to obtain descriptive characteristics of the trainees. The following is a discussion of the descriptive characteristics of the sample population.

### Age and Gender

When considering the adult learner population it is important to understand the fact that within the group there are nested generational subgroups (Abell 2000). Figures 13 and 14 depict the age and gender distribution for the entire sample population. Table 9 further categorizes the data into Generation X (born between 1965 and 1976) and Generation Y (born between 1977 and 1995).

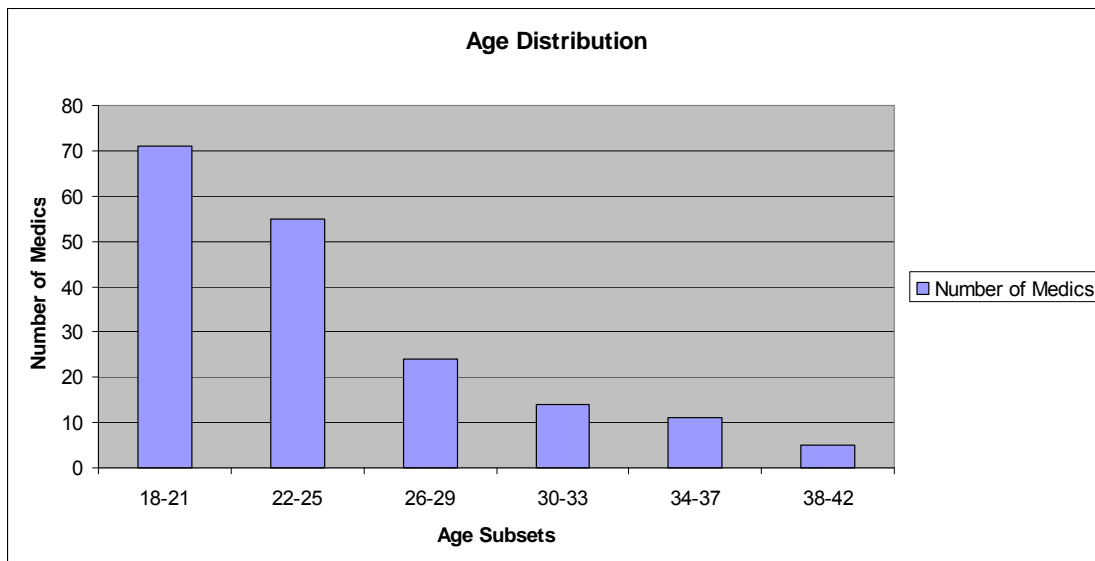


Figure 13: Age Distribution of the Entire Sample Population

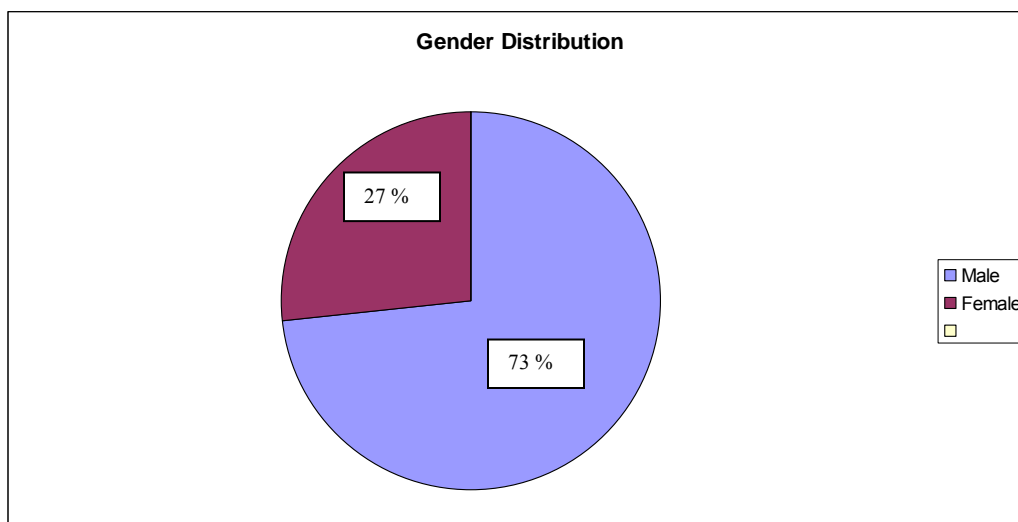


Figure 14: Gender Distribution of the Sample Population

Table 9: Gender and Generation Categorization

<b>Gender</b>	<b>Generation X Total # (Percentage)</b>	<b>Generation Y Total # (Percentage)</b>
Male	17 (12.9)	115 (87.1)
Female	6 (12.5)	42 (87.5)
Total	23 (12.7)	157 (87.3)

The sample population shows a 1:3 female to male ratio and most of the population belongs to Generation Y, i.e. people between the ages of 18 and 31. Approximately 87 % of the sample population belongs to generation Y and that is consistent among gender type, the same was observed regarding percentage of people in Generation X with approximately 13 %.

### Experience

Figures 15, 16 and 17 show Medic Combat Operations and video game experience distribution for the entire sample population. Only four subjects (2%) reported having Combat Medic experience with approximately a year of experience (average of experience reported

equals to 1.06 years). The average age of these four individuals is 25 years with standard deviation of 3.46 (24, 24, 30 and 22). Ninety two percentage (166 subjects) of the participants reported not having any combat operations experience. The average age of the people with combat experience (14 subjects) is approximately 26 (25.79) with a standard deviation of 5.56. Only two subjects were older than 31 years of age. These numbers are also consistent with the distribution among Generation X and Generation Y. When asked if they had any civilian medical experience 53 subjects (30 percent of the sample population) responded as having some type of medical background in a civilian setting. Table 10 provides a summary of the average number of years reported on three categories: EMT, Emergency Room, and Other. When asked to describe the type of duty under “Other” category subjects included the following list of occupational areas: Paramedic, Physical Therapy, Occupational therapy, Emergency Medical Services, Certified Nursing Assistant, and First Responders.

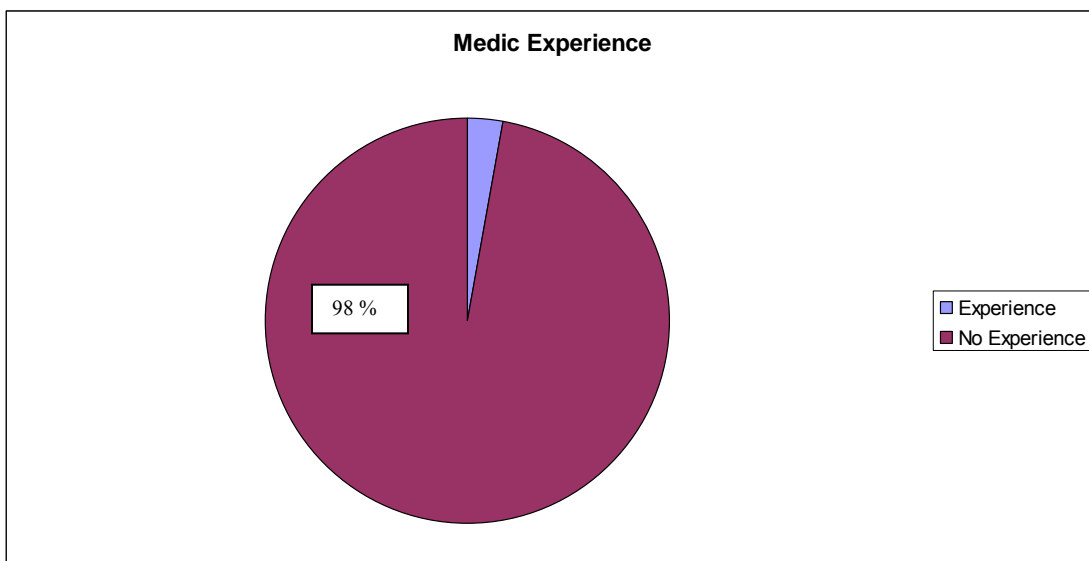


Figure 15: Combat Medic Experience



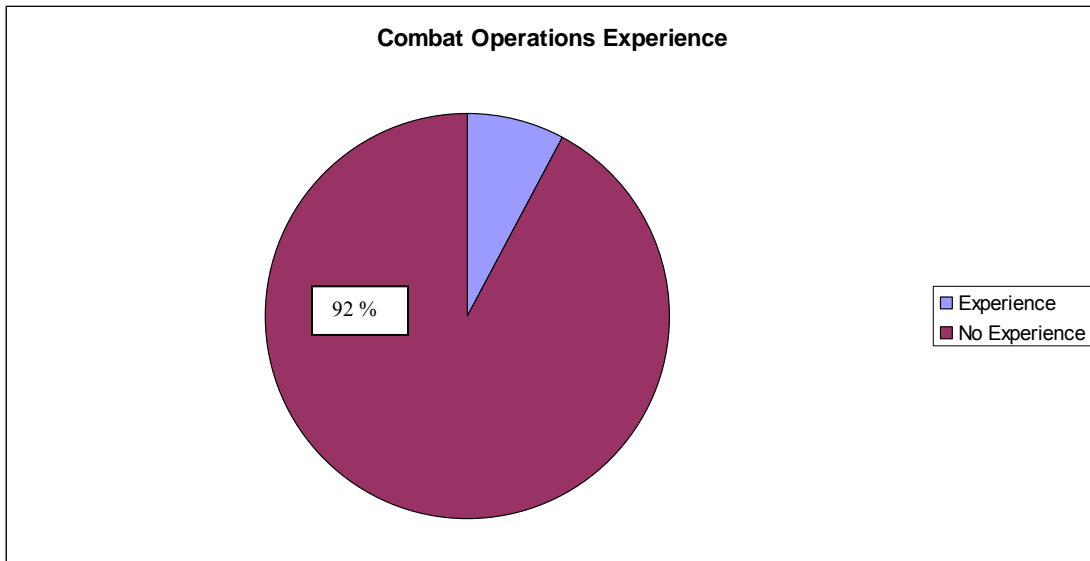


Figure 16: Combat Operations Experience

Table 10: Average Number of Years of Civilian Medical Experience

Type of Civilian Medical Experience	Average Number of Years
EMT	2.73
Emergency Room	1.68
Other	2.02

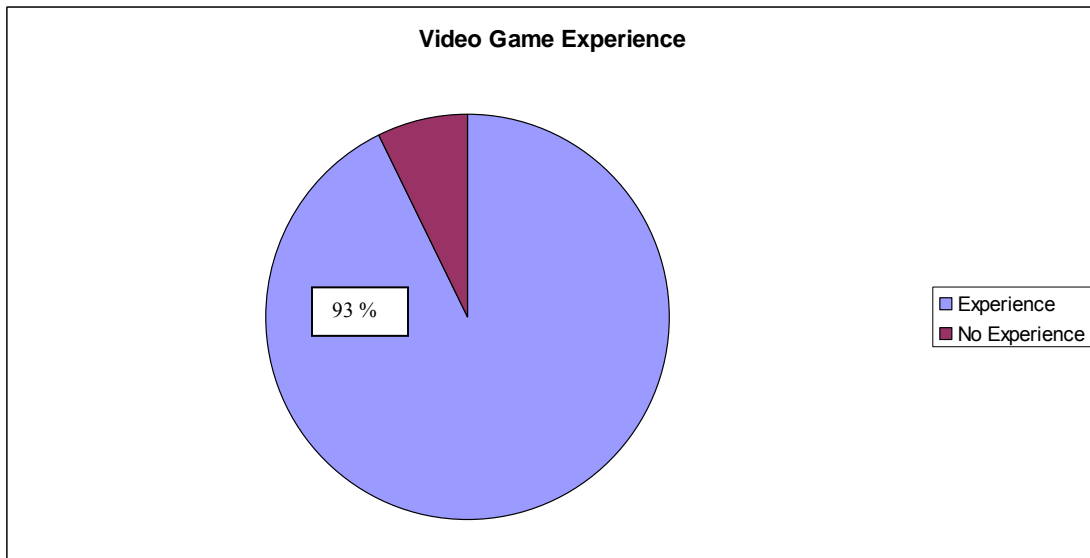


Figure 17: Video Game Experience

When asked if they had any experience playing video games on a personal computer or game system, ninety three percent of the participants (167 subjects) reported having Video Game Experience as portrait in Figure 17. Table 11 shows a breakdown of the data for the subjects that reported not having experience playing in video games.

Table 11: Descriptive Characteristics of Subjects without Video Game Experience

<b>Id #</b>	<b>Age</b>	<b>Generation</b>	<b>Gender</b>	<b>Education</b>
10	26	Y	Female	HS
18	30	Y	Female	Bachelors
1	41	X	Male	Bachelors
26	22	Y	Male	Some College
8	40	X	Male	Associate
19	18	Y	Female	HS
47	19	Y	Male	HS
115	20	Y	Female	Some College
148	19	Y	Female	HS
138	27	Y	Female	Bachelors
75	23	Y	Female	Some College
68	26	Y	Female	Associate
126	35	X	Male	Some College

Looking at the data we can see that most of the subjects (9 out of 13) had education above High School diploma. In terms of generations, most of the subjects belong to Generation Y (6 % of the Generation Y sample population) with only 3 subjects belonging to Generation X (13 % of the Generation X sample population). The majority of the subjects without video game experience were female (8 out of 13). When asked to assess their ability at a first person video game all of the subjects were consistent in selecting Beginner Level.

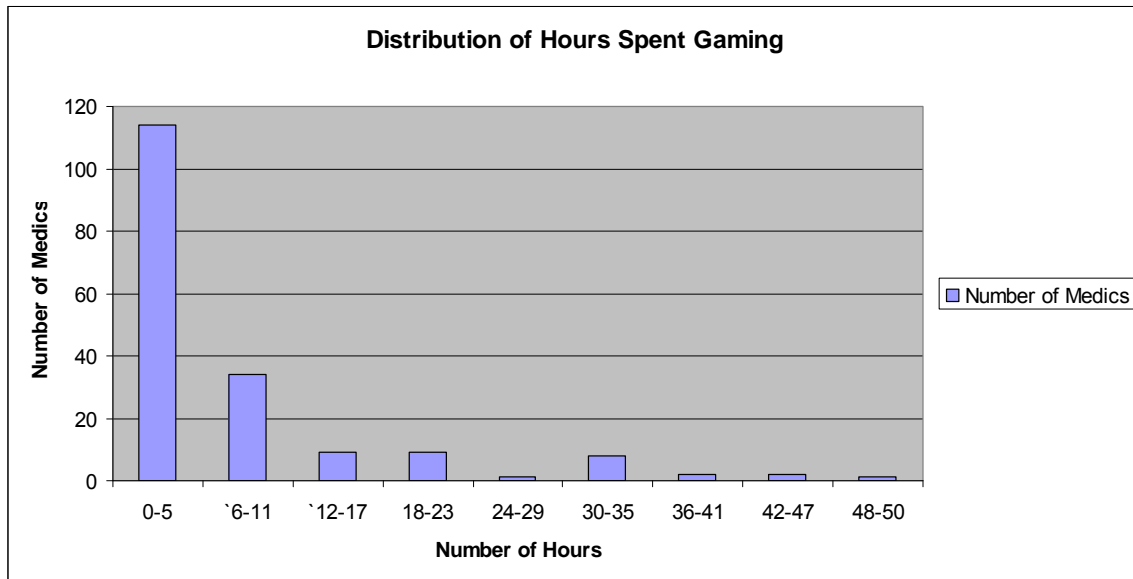


Figure 18: Distribution of Video Game Hours on a Typical Week

The subjects were asked to assess how many hours on a typical week over the last six months they spent playing video. The distribution of hours spent playing video games on a typical week is depicted in Figure 18. Forty two participants that reported having played video games also reported spending zero time on a typical week. Several subjects identified the fact that they have been in training and have not had the chance to play video games. One subject reported playing at least once a day but did not provide any estimate of time spent on a given gaming session. Several subjects provided a range of hours. An average was taken for analysis purposes. The average time spent on a typical week is 6.64 hours with a standard deviation of 9.28. The average time spent on a typical week by females is 3.40 hours with a standard deviation of 8.41 hours. The average time spent on a typical week by males is 8.00 hours with a standard deviation of 9.70 hours.

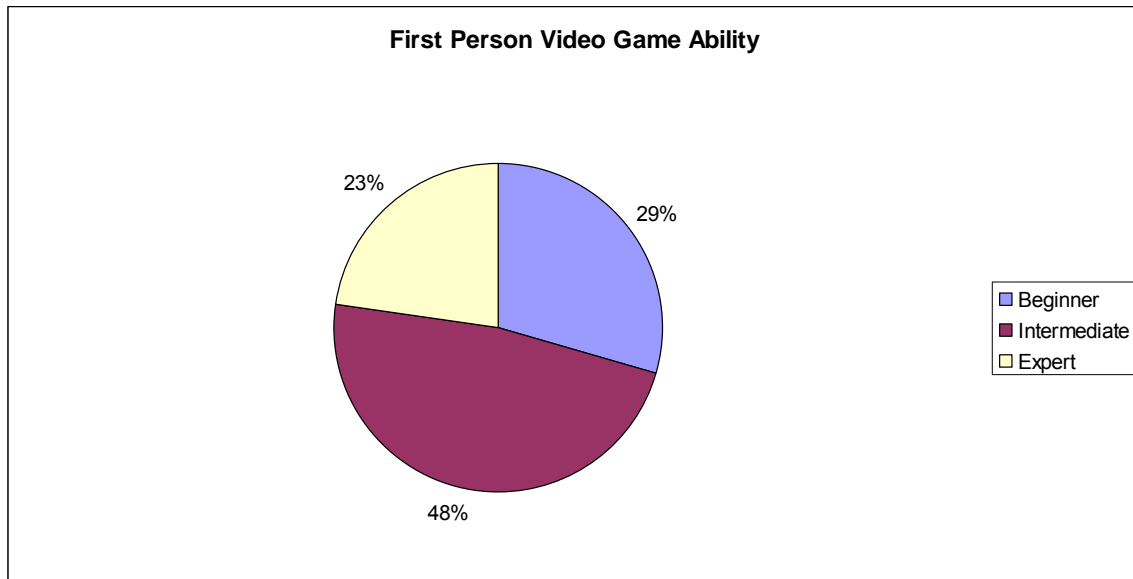


Figure 19: First Person Video Game Ability

When asked to assess their first person video game ability, 29 percent of the population rated themselves at the Beginner Level, 48 % at the Intermediate Level and 23 % at the Expert Level as depicted in Figure 19. It is important to note that amongst the beginner percentage also are included the 13 individuals that did not have any experience playing video games.

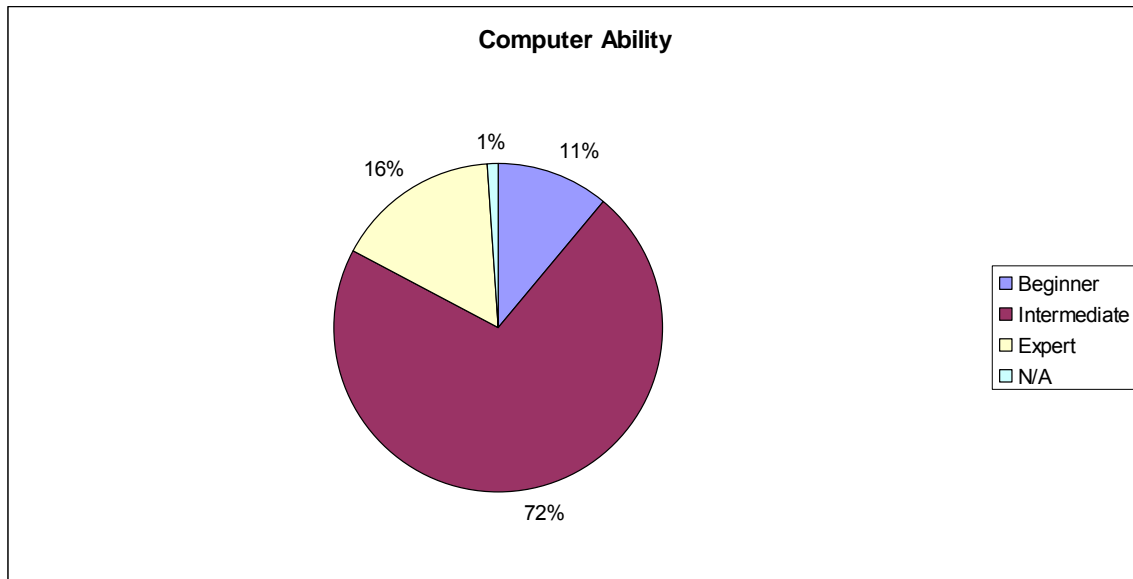


Figure 20: Computer Ability

When asked to assess computer ability, 11% of the population rated themselves at the Beginner Level, 72 % at the Intermediate Level and 16 % at the Expert Level as depicted in Figure 20. It is important to note that the 1 % denoted as N/A refers to one female that circled both Intermediate and Expert Level and a male that did not complete that portion of the survey. Table 12 summarizes the data in terms of gender.

Table 12: First Person Video Game and Computer Ability Self Assessment

Gender	First Person Video Game Ability			Computer Ability		
	Beginner	Intermediate	Expert	Beginner	Intermediate	Expert
Female	32(67%)	15(31%)	1(2%)	6(13%)	38(81%)	3(6%)
Male	21(16%)	71(54%)	40(30%)	14(11%)	91(69%)	26(20%)

Regarding first person video game ability, the majority of the female population rated themselves at the beginner level were the majority of the male population considered themselves at the intermediate level. In terms of computer ability, the majority of the female population rated themselves at the intermediate level. The same was observed with the male population. In terms of generation, out of 6 females belonging to generation X, five of them rated themselves at the beginner level in terms of first person video game and one female considered herself at the intermediate level. In contrast, five of the generation X females considered themselves at the intermediate level in terms of computer ability and one female considered herself between intermediate and expert level. In the male population, of the 17 males belonging to generation X, 8 males rated themselves at the beginner level in terms of first person video game experience, 7 at the intermediate level and 2 at the expert level. In contrast, 12 males rated themselves at the intermediate level in terms of computer ability, 2 at the beginner level and 3 at the expert level.

The subjects were asked to assess how many hours on a typical week over the last six months they work on a computer. The distribution of hours spent on the computer on a typical week is depicted in Figure 21. Thirty participants reported spending zero time working on the computer on a typical week. Several subjects identified the fact that they have been in training and don't have a computer available. One subject reported working in the computer every day but did not provide any estimate of time spent on a typical day. Two subjects reported spending a lot of time in the computer but also did not provide an estimate of time. Several subjects provided a range of hours. An average was taken for analysis purposes. The average time spent on a typical week for the entire sample population is 13.71 hours with a standard deviation of 16.82. The average time spent on a typical week by females is 12.51 hours with a standard

deviation of 17.38 hours. The average time spent on a typical week by males is 14.05 hours with a standard deviation of 16.64 hours.

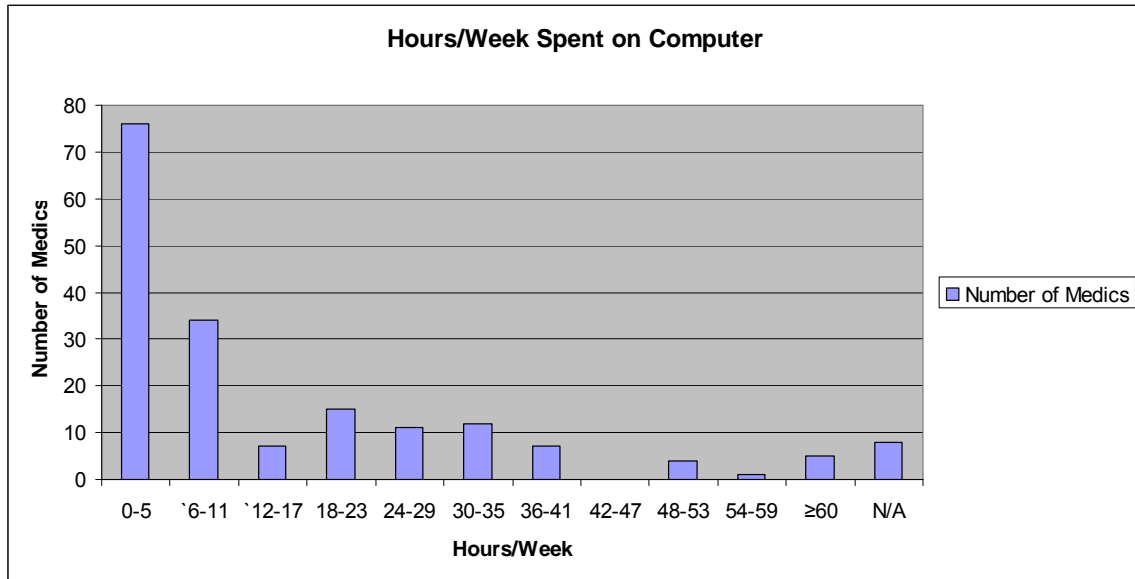


Figure 21: Distribution of Computer Time on a Typical Week

## Education

Figure 22 depicts the frequency distribution for the highest level of education for the entire sample population. Table 13 breaks down the frequency in gender and generation.

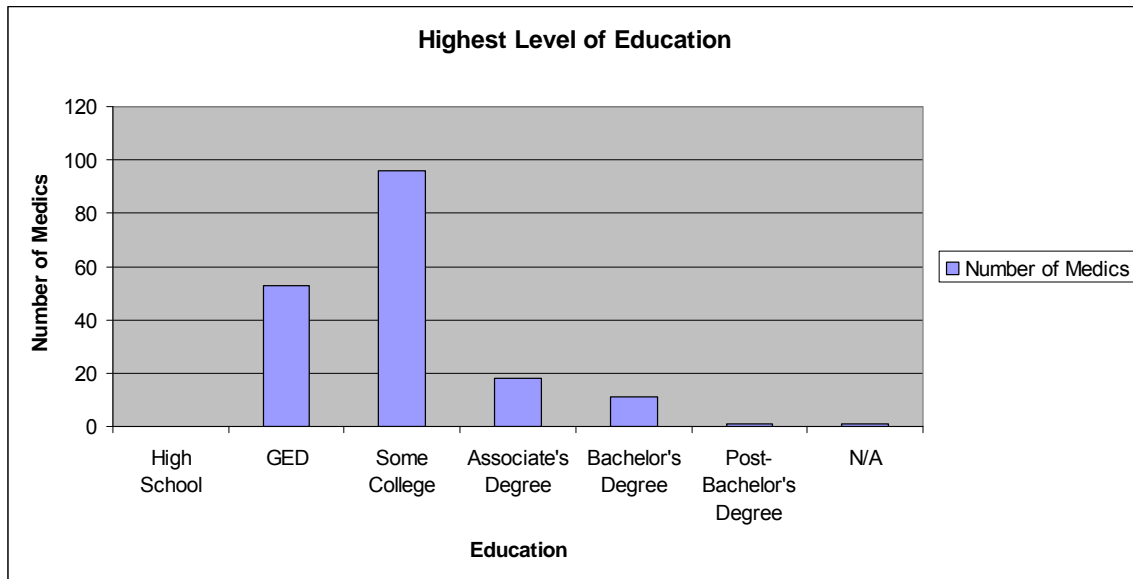


Figure 22: Level of Education Distribution

Table 13: Level of Education Gender and Generation Frequency

Level of Education	Female Gen X	Female Gen Y	Male Gen X	Male Gen Y
HS/GED	0	14	3	36
Some College	4	19	5	68
Associate	2	6	4	6
Bachelors	0	3	4	4
Post Bachelors	0	0	1	0

Fifty three subjects reported having completed high school graduation requirements. Most of them are males belonging to generation Y. Ninety six subjects reported completion of some college credits with the majority belonging to Generation Y regardless of gender. Eighteen subjects reported having completed an associate’s degree with the majority belonging to Generation Y regardless of gender. Eleven subjects reported having completed a bachelor’s degree most of them belonging to generation Y (four male subjects belonged to Gen X). The



majority of subjects from Generation X completed education level beyond some college level with most of them earning associate degree, bachelors degree and post bachelor's degree.

### Ethnicity

Figure 23 depicts the frequency distribution in terms of ethnicity for the entire sample population. Table 14 breaks down the frequency in terms of ethnic background.

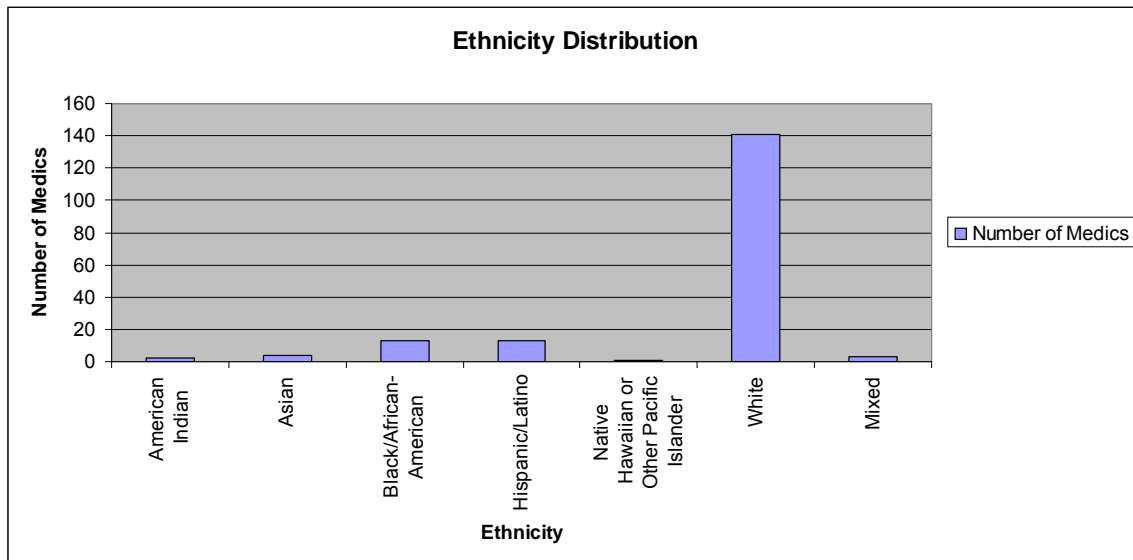


Figure 23: Ethnicity Distribution

Table 14: Ethnicity Frequency

<b>Ethnicity</b>	<b>Number of Medics</b>
American Indian	2
Asian	4
Black/African-American	13
Hispanic/Latino	13
Native Hawaiian or Other Pacific Islander	1
White	141
Mixed	3
N/A	3

Three subjects did not answer the ethnicity inquiry.

Table 15 summarizes the demographic data of the sample population and provides a profile of the population subjected to the training effectiveness evaluation.

Table 15: Sample Population Profile

<b>Age</b>	Range: 18 to 42 Generation X: 13% Generation Y: 87%
<b>Gender</b>	Male: 73% Female: 27% Male to Female Ratio: 3 to1
<b>Experience</b>	Combat Operations: 8% Combat Medic: 2 % Civilian Setting: 29%
<b>Video Game</b>	Experience: 93 % Ability: Beginner: 29% Intermediate: 48% Expert: 23%
<b>Computer</b>	Ability: Beginner: 11% Intermediate: 72% Expert: 16%
<b>Education</b>	HS: 30 % Some College: 53% Associate: 10% Bachelor: 6% Post Bachelor: 1%
<b>Ethnicity</b>	American Indian: 1% Asian: 2% Black/African-American: 7% Hispanic/Latino: 7% Native Hawaiian or Other Pacific Islander: 1% White: 78% Mixed: 2%

### **Level I Evaluation – User Reaction to TC3 Training**

In order to assess Medic trainees' reaction to TC3 training treatment, the participating Medic trainees were asked to provide feedback via survey questions on three different areas: Overall Student Reaction to Training Treatment, Learning Benefit of each Training Treatment, and Usability of the System used by each Training Treatment. The reaction of 171 individuals was analyzed. The inputs from 9 individuals were omitted due to missing data. One individual was excused for being 17 years of age. Two individuals were excused after completing portion of the training: one became ill and the other Soldier assisted the sick Soldier. The rest of the missing data was due to incomplete surveys.

To investigate the relationship that descriptive characteristics have in terms of reaction to training and performance on pre-post test and transfer task, as hypothesized by Bae (2002), a simple correlation analysis was performed. Descriptive characteristics categories used in this research were: age, medical experience and level of education. The Pearson product moment coefficient of correlation,  $r$ , was calculated. The coefficient of correlation provides a quantitative measure of the strength of the linear relationship or "association" between two variables. The purpose of this analysis was not to imply causality but to look if there was a linear trend between the variables and the nature of the association between the variables. In addition, the null hypothesis of  $\rho = 0$  (*no linear relationship*), where  $\rho$  is an estimate of the sample correlation coefficient  $r$ , was tested. The values of  $r$  near zero observed indicate that there is almost no linear correlation between the variables but does not mean that there is no correlation at all since there might be a non linear correlation between the variables. Also, other factors may contribute to the relationship between the variables that were not considered in the analysis since only simple correlation analysis was performed. These correlations are not part of the

experimental design and therefore do not have the power over avoiding Type II error as described by Cohen (1992).

One main hypothesis was tested to assess reaction towards the TC3 training:

- H1: Reaction scores for the TC3 Game-Based Simulation training group will be significantly higher than reaction scores for other TC3 training treatment groups.

In order to investigate if there was any differences in reaction to training between treatments, a one way analysis of variance (ANOVA) was performed using  $\alpha = 0.05$  (Critical value of the F statistic = 3.00) to compare treatment means in terms of post training reaction in the different areas.

#### **Data Collected to Analyze Hypothesis One: Level I Overall Student Reaction to Training**

After receiving the TC3 training treatments, the participating Medic trainees were asked to rate the training on a Likert Scale from 1 to 5 (Poor = 1, Fair = 2, Good = 3, Very Good = 4, and Excellent = 5). See Appendix H.

Table 16 provides results of the correlation analysis per treatment group with highlighted (\*) statistical reactions. Table 17 provides results of the one way ANOVA using  $\alpha = 0.05$  to investigate hypothesis H1.

Table 16: Overall Reaction to Training

<b>Overall Reaction</b>	<b>Age</b>	<b>Medical Experience</b>	<b>Education</b>	<b>Pre-Post Test Performance</b>	<b>Transfer Task Performance</b>
TC3 PPT Training	<b>Correlation</b> $r = -0.17$  t Stat = -1.28 p= 0.2046  Critical Value = 2.0  95 % CI = -0.41 to 0.09	<b>Correlation</b> $r = -0.14$  t Stat = -1.04 p= 0.3026  Critical Value = 2.0  95 % CI = -0.38 to 0.13	<b>Correlation</b> $r = -0.29$  t Stat = -2.31* p= 0.0247*  Critical Value = 2.0  95 % CI = -0.51 to 0.04	<b>Correlation</b> $r = -0.12$  t Stat = 7.26 p= 0.3716  Critical Value = 2.0  95 % CI = -0.37 to 0.14	<b>Correlation</b> $r = -0.25$  t Stat = -1.94 p= 0.0574  Critical Value = 2.0  95 % CI = -0.48 to 0.01
TC3 Courseware	<b>Correlation</b> $r = -0.11$  t Stat = -0.82 p= 0.4161  Critical Value = 2.0  95 % CI = -0.36 to 0.16	<b>Correlation</b> $r = -0.10$  t Stat = -0.78 p= .4379  Critical Value = 2.0  95 % CI = -0.36 to 0.16	<b>Correlation</b> $r = -0.12$  t Stat = -0.86 p= 0.3915  Critical Value = 2.0  95 % CI = -0.37 to 0.15	<b>Correlation</b> $r = 0.09$  t Stat = 0.69 p= 0.4947  Critical Value = 2.0  95 % CI = -0.17 to 0.34	<b>Correlation</b> $r = -0.16$  t Stat = -1.18 p= 0.2444  Critical Value = 2.0  95 % CI = -0.41 to 0.11
TC3 Game-Based Simulation Training	<b>Correlation</b> $r = -0.22$  t Stat = -1.74 p= 0.0875  Critical Value = 2.0  95 % CI = -0.45 to 0.03	<b>Correlation</b> $r = -0.05$  t Stat = -0.37 p= 0.7129  Critical Value = 2.0  95 % CI = -0.30 to 0.21	<b>Correlation</b> $r = -0.2$  t Stat = -1.59 p= 0.1168  Critical Value = 2.0  95 % CI = -0.44 to 0.05	<b>Correlation</b> $r = 0.10$  t Stat = 0.73 p= 0.4654  Critical Value = 2.0  95 % CI = -0.16 to 0.34	<b>Correlation</b> $r = 0.10$  t Stat = 0.79 p= 0.4301  Critical Value = 2.0  95 % CI = -0.15 to 0.35

### **Bae’s Hypothesized Influence of Descriptive Characteristics**

Influence of descriptive characteristics were statistically correlated for higher reaction scores for the cross between groups receiving TC3 PPT training and those within that group that had lower levels of education (Pearson’s Coefficient of Correlation  $r = - 0.29$ ,  $p = 0.0247$ ).

Table 17: Overall Reaction between Treatments

<b>Overall Reaction</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>
TC3 PPT Training	57	3.8	0.9	2.25	0.1082
TC3 Courseware	57	4.1	0.8		
TC3 Game-Based Simulation Training	57	3.9	0.8		

### **Analysis of Hypothesis One: Results for Overall Student Reaction to Training Treatment**

ANOVA analysis indicates that as a group, medic trainees on average rated the training as “Very Good” regardless of the training treatment received. There was not a significant difference in Overall Reaction between training treatments ( $p$  value = 0.1082).

### **Data Collected to Analyze Hypothesis One: Learning Benefit of each Training Treatment**

Benefit to training was assessed in two different dimensions: Learning Objectives Met and Inclusion of Training Instructional Media in the current Program of Instruction (POI).

## Learning Objectives Met

After completing the training, Medic trainees were asked if they felt they could accomplish six tasks derived from the training objectives in the area of Hemorrhage Control, Airway Management and Breathing. They provided feedback using a Likert Scale from 1 to 5 (Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree =4, and Strongly Agree = 5). See Appendix H. The average of the responses was calculated for analysis purposes. Table 18 provides results of the correlation analysis per treatment group with highlighted (\*) statistical reactions. Table 19 provides results of the one way ANOVA using  $\alpha = 0.05$  to investigate hypothesis H1.

Table 18: Benefit to Training – Learning Objectives Met

<b>Benefit to Training</b>	<b>Age</b>	<b>Medical Experience</b>	<b>Education</b>	<b>Pre-Post Test Performance</b>	<b>Transfer Task Performance</b>
<b>TC3 PPT Training</b> Learning Objectives Met	<b>Correlation</b> $r = -0.13$  t Stat = -0.98 p= 0.3294  Critical Value = 2.0  95 % CI = -0.37 to 0.13	<b>Correlation</b> $r = -0.01$  t Stat = -0.01 p= 0.9192  Critical Value = 2.0  95 % CI = -0.27 to 0.24	<b>Correlation</b> $r = -0.03$  t Stat = -0.20 p= 0.8404  Critical Value = 2.0  95 % CI = -0.28 to 0.23	<b>Correlation</b> $r = -0.09$  t Stat = -0.67 p= 0.5037  Critical Value = 2.0  95 % CI = -0.34 to 0.17	<b>Correlation</b> $r = -0.11$  t Stat = -0.85 p= 0.3963  Critical Value = 2.0  95 % CI = -0.36 to 0.15

<b>Benefit to Training</b>	<b>Age</b>	<b>Medical Experience</b>	<b>Education</b>	<b>Pre-Post Test Performance</b>	<b>Transfer Task Performance</b>
<b>TC3 Courseware Training</b>	<b>Correlation</b> <i>r</i> = -0.20	<b>Correlation</b> <i>r</i> = -0.09	<b>Correlation</b> <i>r</i> = -0.40	<b>Correlation</b> <i>r</i> = 0.05	<b>Correlation</b> <i>r</i> = -0.23
Learning Objectives Met	t Stat = -1.50 p = 0.1391	t Stat = -0.64 p = 0.5232	t Stat = -3.20 p = 0.0023*	t Stat = 0.40 p = 0.6900	t Stat = -1.79 p = 0.0795
	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0
	95 % CI = -0.44 to 0.07	95 % CI = -0.34 to 0.18	95 % CI = -0.60 to -0.15	95 % CI = -0.21 to 0.31	95 % CI = -0.47 to 0.03
<b>TC3 Game-Based Simulation Training</b>	<b>Correlation</b> <i>r</i> = -0.33	<b>Correlation</b> <i>r</i> = 0.05	<b>Correlation</b> <i>r</i> = -0.11	<b>Correlation</b> <i>r</i> = 0.06	<b>Correlation</b> <i>r</i> = 0.26
Learning Objectives Met	t Stat = -2.70 p = 0.0091*	t Stat = 0.42 p = 0.6775	t Stat = -0.85 p = 0.3989	t Stat = 0.42 p = 0.6727	t Stat = 2.01 p = 0.0487*
	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0
	95 % CI = -0.54 to -0.09	95 % CI = -0.20 to 0.30	95 % CI = -0.35 to 0.15	95 % CI = -0.20 to 0.31	95 % CI = 0.00 to 0.48

### **Bae's Hypothesized Influence of Descriptive Characteristics**

Influence of descriptive characteristics was statistically correlated with higher responses in meeting objectives for the cross between:

1. The group receiving TC3 Courseware Training and those within the group that had lower levels of education ( $r = -0.40$ ,  $p = 0.0023$ ).
2. The group receiving TC3 Game-Based Simulation and those within that group who were younger participants.



Table 19: Benefit to Training – Learning Objectives Met – Analysis between Treatments

<b>Benefit to Training Learning Objectives Met</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>
TC3 PPT Training	57	4.206	0.549	0.08	0.9188
TC3 Courseware	57	4.234	0.694		
TC3 Game-Based Simulation Training	57	4.187	0.577		

### **Analysis of Hypothesis One: Reaction to Learning Objectives Met**

As a group, medic trainees on average “Agree” that the training objectives were met during training regardless of training treatment. There were no significant differences in medic post training reaction in terms of the training treatment having met the training objectives of Hemorrhage Control, Airway Management and Breathing ( $p$  value = 0.9188).

### **Inclusion of Training in Current Program of Instruction**

After completing the training, Medic trainees were asked if they believed that it would be of value to include the training system in the TC3 program of instruction. Participants were asked to circle a number on a Likert Scale from 1 to 7 (1= “Very Much” agree, 4 = “Somewhat” agree, and 7 = “Very Much” agree with the assertion) based on their experience using the assigned training instructional media. See Appendices K, L, and M: Question number 6. Table 20 provides results of the correlation analysis per treatment group with highlighted (\*) statistical reactions. Table 21 provides results of the one way ANOVA using  $\alpha = 0.05$  to investigate hypothesis H1.

Table 20: Benefit to Training – Inclusion in POI

<b>Benefit to Training</b>	<b>Age</b>	<b>Medical Experience</b>	<b>Education</b>	<b>Pre-Post Test Performance</b>	<b>Transfer Task Performance</b>
<b>TC3 PPT Training</b>  Program of Instruction	<b>Correlation</b> $r = 0.15$  <b>t Stat</b> = 1.14 $p = 0.2587$  Critical Value = 2.0  95% CI = -0.11 to 0.39	<b>Correlation</b> $r = -0.11$  <b>t Stat</b> = -0.86 $p = 0.3953$  Critical Value = 2.0  95% CI = -0.36 to 0.15	<b>Correlation</b> $r = 0.14$  <b>t Stat</b> = 1.04 $p = 0.3039$  Critical Value = 2.0  95% CI = -0.12 to 0.38	<b>Correlation</b> $r = -0.04$  <b>t Stat</b> = -0.33 $p = 0.7422$  Critical Value = 2.0  95% CI = -0.30 to 0.21	<b>Correlation</b> $r = 0.20$  <b>t Stat</b> = 1.56 $p = 0.1240$  Critical Value = 2.0  95% CI = -0.06 to 0.44
<b>TC3 Courseware Training</b>  Program of Instruction	<b>Correlation</b> $r = -0.03$  <b>t Stat</b> = -0.25 $p = 0.8006$  Critical Value = 2.0  95% CI = -0.29 to 0.23	<b>Correlation</b> $r = 0.01$  <b>t Stat</b> = 0.07 $p = 0.9418$  Critical Value = 2.0  95% CI = -0.25 to 0.27	<b>Correlation</b> $r = -0.04$  <b>t Stat</b> = -0.31 $p = 0.7544$  Critical Value = 2.0  95% CI = -0.30 to 0.22	<b>Correlation</b> $r = 0.13$  <b>t Stat</b> = 0.94 $p = 0.3525$  Critical Value = 2.0  95% CI = -0.14 to 0.37	<b>Correlation</b> $r = -0.16$  <b>t Stat</b> = -1.18 $p = 0.2449$  Critical Value = 2.0  95% CI = -0.40 to 0.11
<b>TC3 Game Based Simulation Training</b>  Program of Instruction	<b>Correlation</b> $r = 0.01$  <b>t Stat</b> = 0.06 $p = 0.9527$  Critical Value = 2.0  95% CI = -0.25 to 0.26	<b>Correlation</b> $r = -0.15$  <b>t Stat</b> = -1.13 $p = 0.2632$  Critical Value = 2.0  95% CI = -0.39 to 0.11	<b>Correlation</b> $r = 0.13$  <b>t Stat</b> = 1.01 $p = 0.3188$  Critical Value = 2.0  95% CI = -0.13 to 0.38	<b>Correlation</b> $r = -0.10$  <b>t Stat</b> = -0.75 $p = 0.4544$  Critical Value = 2.0  95% CI = -0.35 to 0.16	<b>Correlation</b> $r = 0.23$  <b>t Stat</b> = 1.77 $p = 0.0818$  Critical Value = 2.0  95% CI = -0.03 to 0.46

### **Bae’s Hypothesized Influence of Descriptive Characteristics**

Descriptive Characteristics were not statistically correlated with recommended inclusion in the current program of instruction.

Table 21: Benefit to Training – Inclusion in POI – Analysis between Treatments

<b>Benefit to Training Inclusion in POI</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>
TC3 PPT Training	57	5.89	0.152	1.00	0.3712
TC3 Courseware	57	6.18	0.141		
TC3 Game-Based Simulation Training	57	5.98	0.153		

### **Analysis of Hypothesis One: Reaction to Inclusion in Program of Instruction**

As a group, medic trainee responses on average tended toward “Very Much” agreement (6 on a 7 Likert Scale where 7 was “Very Much” and 4 was “Somewhat”) that the training materials and media (multimedia, interactive and experiential) should be incorporated in the program of instruction regardless of training treatment. There was not a statistical significant difference in reaction between training treatments ( $p$  value = 0.3712).

### **Data Collected to Analyze Hypothesis One: System Usability**

System Usability was assessed in two different dimensions: Ease of Use and Need for Instructor Support.

## Ease of Use

After completing the training, Medic trainees were asked if the training was clear and easy to follow. They provided feedback using a Likert Scale from 1 to 5 (Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4 and Strongly Agree = 5). See Appendix H. Table 22 provides results of the correlation analysis per treatment group with highlighted (\*) statistical reactions. Table 23 provides results of the one way ANOVA using  $\alpha = 0.05$  to investigate hypothesis H1.

Table 22: Usability – Ease of Use

<b>Usability</b>	<b>Age</b>	<b>Medical Experience</b>	<b>Education</b>	<b>Pre-Post Test Performance</b>	<b>Transfer Task Performance</b>
<b>TC3 PPT Training</b>	<b>Correlation</b> $r = -0.01$	<b>Correlation</b> $r = -0.04$	<b>Correlation</b> $r = -0.15$	<b>Correlation</b> $r = -0.05$	<b>Correlation</b> $r = -0.14$
Ease of Use	<b>t Stat</b> = -0.10 p= 0.9223	<b>t Stat</b> = -0.30 p= 0.7620	<b>t Stat</b> = -1.13 p= 0.2632	<b>t Stat</b> = -0.40 p= 0.6892	<b>t Stat</b> = -1.05 p= 0.2982
	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0
	95% CI = -0.27 to 0.25	95% CI = -0.30 to 0.22	95% CI = -0.39 to 0.11	95% CI = -0.31 to 0.21	95% CI = -0.38 to 0.12
<b>TC3 Courseware Training</b>	<b>Correlation</b> $r = -0.01$	<b>Correlation</b> $r = -0.02$	<b>Correlation</b> $r = -0.26$	<b>Correlation</b> $r = 0.08$	<b>Correlation</b> $r = -0.16$
Ease of Use	<b>t Stat</b> = -0.04 p= 0.9676	<b>t Stat</b> = -0.17 p= 0.8620	<b>t Stat</b> = -1.99 p= 0.0514	<b>t Stat</b> = 0.63 p= 0.5314	<b>t Stat</b> = -1.18 p= 0.2433
	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0
	95% CI = -0.27 to 0.26	95% CI = -0.28 to 0.24	95% CI = -0.49 to 0.00	95% CI = -0.18 to 0.34	95% CI = -0.40 to 0.11

<b>Usability</b>	<b>Age</b>	<b>Medical Experience</b>	<b>Education</b>	<b>Pre-Post Test Performance</b>	<b>Transfer Task Performance</b>
<b>TC3 Game-Based Simulation Training</b>	<b>Correlation</b> $r = -0.31$	<b>Correlation</b> $r = 0.02$	<b>Correlation</b> $r = -0.26$	<b>Correlation</b> $r = 0.16$	<b>Correlation</b> $r = 0.19$
	<b>t Stat</b> = -2.49 $p = 0.0158^*$	<b>t Stat</b> = 0.13 $p = 0.8949$	<b>t Stat</b> = -2.07 $p = 0.0431^*$	<b>t Stat</b> = 1.19 $p = 0.2402$	<b>t Stat</b> = 1.45 $p = 0.1513$
Ease of Use	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0
	95% CI = -0.53 to -0.06	95% CI = -0.24 to 0.27	95% CI = -0.49 to -0.01	95% CI = -0.10 to 0.40	95% CI = -0.07 to 0.42

### **Bae's Hypothesized Influence of Descriptive Characteristics**

Descriptive statistics were statistically correlated for higher responses for usability for the cross between the group receiving TC3 Game-Based Simulation and:

1. Medic trainees within that group who were younger participants ( $r = -0.31$ ,  $p$  value = 0.0158).
2. Medic trainees with lower levels of education ( $r = -0.26$ ,  $p$  value = 0.0431).

Table 23: Usability Ease of Use – Analysis between Treatments

<b>Usability Ease of Use</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>
TC3 PPT Training	57	4.2	0.8	1.15	0.3178
TC3 Courseware	57	4.4	0.8		
TC3 Game-Based Simulation Training	57	4.4	0.8		

### **Analysis of Hypothesis One: Reaction to Ease of Use**

As a group, medic trainees on average “Agree” that the training system was easy to use regardless of the training treatment received. There was no significant difference in reaction between training treatments ( $p$  value = 0.3178).

### **Instructor Support**

After completing the training, Medic trainees were asked if they felt that an instructor was necessary to make their TC3 training beneficial to them. Participants were asked to circle a number on a Likert Scale from 1 to 7 (1= “Very Much” agree, 4 = “Somewhat” agree, and 7 = “Very Much” agree with the assertion) based on their experience using the assigned training media. See Appendix K, L, and M: Question number 5. Table 24 provides results of the correlation analysis per treatment group with highlighted (\*) statistical reactions. Table 25 provides results of the one way ANOVA using  $\alpha = 0.05$  to investigate hypothesis H1.

Table 24: System Usability – Instructor Support

Usability	Age	Medical Experience	Education	Pre-Post Test Performance	Transfer Task Performance
<b>TC3 PPT Training</b>	<b>Correlation</b> $r = -0.10$	<b>Correlation</b> $r = 0.02$	<b>Correlation</b> $r = -0.21$	<b>Correlation</b> $r = 0.12$	<b>Correlation</b> $r = -0.07$
Need of Instructor	<b>t Stat</b> = -0.76 p= 0.4516	<b>t Stat</b> = 0.18 p= 0.8598	<b>t Stat</b> = -1.57 p= 0.1218	<b>t Stat</b> = 0.91 p= 0.3678	<b>t Stat</b> = -0.54 p= 0.5922
	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0
	95% CI = -0.35 to 0.16	95% CI = -0.24 to 0.28	95% CI = -0.44 to 0.06	95% CI = -0.14 to 0.37	95% CI = -0.32 to 0.19
<b>TC3 Courseware Training</b>	<b>Correlation</b> $r = 0.07$	<b>Correlation</b> $r = 0.16$	<b>Correlation</b> $r = 0.11$	<b>Correlation</b> $r = -0.30$	<b>Correlation</b> $r = 0.24$
Need of Instructor	<b>t Stat</b> = 0.54 p= 0.5902	<b>t Stat</b> = 1.18 p= 0.2423	<b>t Stat</b> = 0.85 p= 0.3994	<b>t Stat</b> = -2.30 p= 0.0253*	<b>t Stat</b> = 1.84 p= 0.0710
	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0
	95% CI = -0.19 to 0.33	95% CI = -0.11 to 0.40	95% CI = -0.15 to 0.36	95% CI = -0.52 to -0.04	95% CI = -0.02 to 0.47
<b>TC3 Game-Based Simulation Training</b>	<b>Correlation</b> $r = 0.35$	<b>Correlation</b> $r = -0.16$	<b>Correlation</b> $r = 0.04$	<b>Correlation</b> $r = 0.06$	<b>Correlation</b> $r = 0.19$
Need of Instructor	<b>t Stat</b> = 2.84 p= 0.0062*	<b>t Stat</b> = -1.19 p= 0.2409	<b>t Stat</b> = 0.34 p= 0.7383	<b>t Stat</b> = 0.43 p= 0.6656	<b>t Stat</b> = 1.50 p= 0.1392
	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0	Critical Value = 2.0
	95% CI = 0.11 to 0.56	95% CI = -0.40 to 0.11	95% CI = -0.21 to 0.30	95% CI = -0.20 to 0.31	95% CI = -0.06 to 0.43

### Bae's Hypothesized Influence of Descriptive Characteristics

Descriptive characteristics were statistically correlated for higher responses indicating the need from an instructor support for the cross between the TC3 Game-Based Simulation training

group and those within that group who were older participants ( $r = 0.35$ ,  $p = 0.0062$ ). This result could be the fact that after action review available for the game was in the form of instructor led AAR. For participants in the game environment the feedback was provided via paper copy of recommended steps validated by a subject matter expert. If students had questions about the recommended course of action, instructors were not available to support.

Table 25: System Usability – Instructor Support – Analysis between Treatments

<b>Usability Need of Instructor</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>
TC3 PPT Training	57	4.63	1.85	3.08	0.0485*
TC3 Courseware	57	3.83	1.58		
TC3 Game-Based Simulation Training	57	4.34	1.77		

### **Analysis of Hypothesis One: Reaction to Need for Instructor Support**

As a group, medic trainee responses were statistically different ( $p$  value = 0.0485) amongst treatments and indicate that on average the groups “Somewhat” felt that an instructor was necessary to make their TC3 training beneficial to them (See Table 25 above).

In order to identify which interventions have significantly different mean reaction responses to instructor intervention both a one-way ANOVA and  $t$  statistics were calculated to explore the differences among pair of treatments. Table 26 provides results of this analysis.



Table 26: System Usability – Instructor Support

<b>Usability Need of Instructor</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>	<b>t Statistic</b>
TC3 PPT Training	57	4.63	1.85	6.13*	0.0148*	2.48*
TC3 Courseware	57	3.83	1.58			
TC3 PPT Training	57	4.63	1.85	0.73	0.395	0.85
TC3 Game-Based Simulation Training	57	4.34	1.77			
TC3 Courseware	57	3.83	1.58	2.61	0.1088	-1.62
TC3 Game-Based Simulation Training	57	4.34	1.77			

As a group, medic trainee responses on average indicate that TC3 PPT training would benefit more from an instructor available during training more than TC3 Courseware training that TC3 Courseware training ( $p$  value = 0.0148).

### Gender Analysis

In addition to the descriptive characteristics proposed by Bae (2002), a gender analysis was performed to explore if there were differences between males and females regarding their overall reaction as well as their performance both in pre-post gain scores and transfer scores as hypothesized by Ferdig (2007). An ANOVA analysis and a t statistic (Critical value for the t statistic = 2.0) were calculated for each type of training treatment group. These results are not part of the experimental design and therefore do not have the power over avoiding Type II error as described by Cohen (1992). Table 27 provides results of this analysis.

Table 27: Gender Analysis

<b>Gender</b>	<b>Overall Reaction</b>	<b>Pre-Post Test Performance</b>	<b>Transfer Task Performance</b>
<b>TC3 PPT Training</b> Female vs. Male	NF=11; NM=46 Mean F = 3.7; Mean M=3.8 SDF=1.1; SDM = 0.9  F Stat = 0.11 <b>p</b> value = 0.7455 <i>t</i> Stat = 0.33	NF=12; NM= 46 Mean F = 0.10; Mean M=0.17 SDF=0.16; SDM = 0.14  F Stat = 2.14 <b>p</b> value = 0.1486 <i>t</i> Stat = 1.46	NF=12; NM=46 Mean F = 0.71; Mean M=0.72 SDF=0.14; SDM=0.12  F Stat = 0.03 <b>p</b> value = 0.8597 <i>t</i> Stat = 0.18
<b>TC3 Courseware Training</b> Female vs. Male	NF=20; NM=35 Mean F=4.0; Mean M=4.2 SDF=1.1; SDM=0.7  F Stat = 0.92 <b>p</b> value = 0.3416 <i>t</i> Stat = 0.96	NF=20; NM= 37 Mean F=0.27; Mean M=0.25 SDF=0.13; SDM=0.14  F Stat = 0.25 <b>p</b> value = 0.6184 <i>t</i> Stat = -0.50	NF=20; NM=37 Mean F=0.76; Mean M=0.79 SDF=0.11; SDM=0.13  F Stat = 0.62 <b>p</b> value = 0.4350 <i>t</i> Stat = 0.79
<b>TC3 Game-Based Simulation Training</b> Female vs. Male	NF=13; NM=46 Mean F = 3.8; Mean M=3.9 SDF=0.8; SDM=0.9  F Stat = 0.01 <b>p</b> value = 0.9348 <i>t</i> Stat = 0.08	NF=13; NM=46 Mean F=0.26; Mean M=0.24 SDF=0.20; SDM=0.12  F Stat = 0.33 <b>p</b> value = 0.5693 <i>t</i> Stat = -0.57	NF=13; NM=46 Mean F=0.80; Mean M=0.80 SDF=0.14; SDM=0.14  F Stat = 0.03 <b>p</b> value = 0.8621 <i>t</i> Stat = -0.17

### **Ferdig’s Hypothesized Influence of Gender**

From this analysis it can be inferred that no difference was observed between females and males regarding overall reaction to training. It is also of importance to note that the training intervention did not contribute to differences in overall reaction between genders.

## **Level II Evaluation – Knowledge Acquisition**

A Pre test was administered to each participant prior to training. The purpose of the pre test was to measure prior knowledge and to determine if there were any differences between treatment sample populations. After the subjects completed the training a post test was administered.

Two main Hypotheses were tested to assess if the TC3 Game-Based Simulation significantly improve post training knowledge and decision-making skills. Another hypothesis was tested to explore content training time between training treatments:

- H2: Knowledge post test scores for the TC3 Game-Based Simulation training group will be significantly higher than their knowledge pretest scores.
- H3: Pre-post test gain scores for the TC3 Game-Based Simulation training group will be significantly higher than pre-post test gain scores for other TC3 training treatment groups.

H4: Content training time for the TC3 Game-Based Simulation training group will be significantly less than the content training time for other TC3 training treatment groups.

### **Data Collected to Analyze Hypotheses Two and Three: Level II Knowledge Acquisition**

In order to measure acquisition of knowledge, a gain score was calculated subtracting the pre test score from the post test score. The knowledge acquisition of 179 individuals was analyzed. One individual was excused for being 17 years of age and did not complete any of the training. In an effort to determine if there were any differences in pre-training knowledge in participants between treatments, a one way ANOVA was performed using  $\alpha = 0.05$ . In addition,

Cohen's (1992) defined Effect Size (ES)  $d$  was calculated for statistical significant results. Table 28 provides results of this analysis.

Table 28: Pre Test Data Analysis between Treatments

<b>Pre Test</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>
TC3 PPT Training	60	0.5878	0.0172	0.75	0.4717
TC3 Courseware	59	0.6174	0.01748		
TC3 Game-Based Simulation Training	60	0.6071	0.01733		

It can be inferred from this analysis that there was no difference observed regarding pre training knowledge amongst groups regardless of the training intervention received ( $p$  value = 0.4717).

A one way ANOVA using  $\alpha = 0.05$  was used to test hypothesis H2 regarding acquisition of TC3 principles knowledge, i.e. differences between pre and post tests within treatment. Statistically significant differences between pre and post test scores were found. Results are highlighted (\*) in Table 29. A one way ANOVA and ANCOVA (using pre test as a covariate) test hypothesis H3 regarding differences between treatments and results are provided in Table 30. Either Analysis of Variance (ANOVA) or Analysis of Covariance (ANCOVA) using pre-tests as covariates are appropriate statistical methods for comparing groups where there is both pre-test and post-test data (Dimitrov and Rumrill, 2003). According to the authors, ANCOVA provides a more powerful test than ANOVA and using pretest as covariates reduces the error variance. Statistically significant differences in gain scores were found and are highlighted by an asterisk (\*).

Table 29: Pre and Post Test ANOVA for TC3 Training Groups

<b>Treatment</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>
TC3 PPT					
Pre Test Scores	60	0.59	0.1307	43.88*	< 0.0001*
Post Test Scores	60	0.74	0.1231		
TC3 Courseware					
Pre Test Scores	59	0.62	0.1402	136.11*	< 0.0001*
Post Test Scores	59	0.88	0.1022		
TC3 Game-Based Sim					
Pre Test Scores	60	0.61	0.1318	140.52*	< 0.0001*
Post Test Scores	60	0.85	0.0925		

### Analysis of Hypothesis Two: Knowledge Acquisition within Treatment

ANOVA results indicate that acquisition of knowledge occurred for all treatment groups (see Table 29 above).

Table 30: Pre-Post Test Gain Scores ANOVA and ANCOVA Data Analysis

<b>Pre and Post Test Gain Scores</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>ANOVA</b>	<b>ANCOVA</b>
TC3 PPT Training	60	0.1522	0.14	<i>F</i> Statistic 11.42	<i>F</i> Statistic 33.18
TC3 Courseware	59	0.2635	0.13	<i>p</i> value < 0.0001*	<i>p</i> value < 0.0001*
TC3 Game-Based Simulation Training	60	0.2464	0.14		

### Analysis of Hypothesis Three: Knowledge Acquisition between Treatments

Results from the ANOVA and ANCOVA analyses indicate that significant statistical difference was found between treatments (See Table 30 above).

In order to identify which interventions have significantly different gain scores, a one way ANOVA and *t* statistics were calculated to explore the differences among pair of treatments. Table 31 provides results of this further analysis.

Table 31: Pre-Post Test Gain Scores ANOVA between Treatments Data Analysis

<b>Pre and Post Test Gain Scores</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b><i>F</i> Statistic</b>	<b><i>p</i> value</b>	<b><i>t</i> Statistic</b>
TC3 PPT Training TC3 Courseware	60 59	0.152 0.264	0.143 0.135	19.25	< 0.0001*	-4.39*
TC3 PPT Training TC3 Game-Based Simulation Training	60 60	0.152 0.246	0.143 0.136	13.80	0.0003*	-3.71*
TC3 Courseware TC3 Game-Based Simulation Training	59 60	0.264 0.246	0.135 0.136	0.48	0.4908	0.69

The ANOVA analysis indicate that significant statistical difference was found in gain scores between the TC3 PPT treatment group and the TC3 Courseware (*p* value equals < 0.0001 and ES *d* = 0.83) and TC3 Game-Based Simulation training treatment groups (*p* = 0.0003 and ES *d* = 0.70). It is of importance to note that in average a 9% increased in knowledge test performance was observed between the TC3 PPT training group and the TC3 Game-Based Simulation group. In addition, in average an 11% increased in knowledge test performance was observed between the TC3 PPT training group and the TC3 Courseware training group.

### **Analysis of Knowledge Acquisition between Treatments per Content Training Area**

The knowledge acquisition analysis described above was done examining differences in gain scores between treatments based on a test that evaluated performance of three areas of TC3: Hemorrhage Control, Airway Management and Breathing. In an effort to examine more in depth

the differences observed between the treatment groups regarding acquisition of knowledge, an analysis was performed to explore if difference in content training modules (i.e. Hemorrhage Control, Airway Management and Breathing) were observed between treatment groups. For each participant, percentages of missed questions in each content area were calculated. A one way ANOVA using  $\alpha = 0.05$  was used to explore differences between treatment groups in the areas of Hemorrhage Control, Airway Management and Breathing. Statistically significant differences were found between treatment groups. The following is a summary of findings per content training module:

- Hemorrhage Control – no significant difference was found in percentage of missed questions between treatment groups ( $p = 0.3609$ ) in the area of hemorrhage control.
- Airway Management - the ANOVA analysis indicates that significant statistical difference was found in percentage of missed questions between the TC3 PPT and the TC3 Courseware ( $p = 0.0002$  and ES  $d = 0.59$ ) treatment groups. The TC3 Courseware treatment group experienced a 16 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. Also, significant statistical difference was found in percentage of missed questions between the TC3 Courseware and TC3 Game-Based Simulation treatment groups ( $p = 0.0277$  and ES  $d = 0.44$ ) in the area of airway management. The TC3 Courseware treatment group experienced an 8% decrease in percentage of missed questions from what was observed in the TC3 Game-Based Simulation treatment group.
- Breathing - the ANOVA analysis indicate that significant statistical difference was found in percentage of missed questions between the TC3 PPT treatment group and the TC3 Courseware ( $p < 0.0001$  and ES  $d = 1.37$ ) and TC3 Game-Based Simulation ( $p < 0.0001$

and ES  $d = 0.37$ ) training treatment groups. The TC3 Courseware treatment group experienced a 23 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. The TC3 Game-Based Simulation treatment group experienced a 20 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. No significant difference was found in percentage of missed questions between the TC3 Courseware and TC3 Game-Based Simulation treatment groups ( $p = 0.2865$ ) in the area of breathing.

### **Ferdig's Hypothesized Influence of Gender**

Gender analysis indicates no difference between females and males regarding performance in knowledge test (See Table 27 above).

### **Relationship between Reaction to Training and Performance in Knowledge Test**

Medic trainees responses were statistically correlated for the TC3 Courseware training group with higher gain scores and lower scores of reaction towards needing an instructor during training ( $r = -0.30$ ,  $p = 0.0253$ ). See Table 24 above. This is of significance since the courseware training system was developed as a distance learning tool to support medic sustainment training.

### **Data Collected to Analyze Hypothesis Four: Differences in Content Training Time between Treatments**

In an effort to look more in-depth at the differences observed between the TC3 PTT Training group, TC3 Courseware Training group and TC3 Game-Based Simulation Training group, an analysis of Content Training Time was performed to test H4. Each participant was asked to record the time they spent on content training (See Appendices D, E and F).

Participants in the TC3 PPT training group recorded the time they spent going over the



PowerPoint presentation. Participants in the TC3 Courseware Training group recorded the time it took them to complete the three training modules. Participants in the TC3 Game-Based Simulation training group were asked to record the time they spent going over the three courseware modules, as well as, the time they spent completing the game scenarios. A one way ANOVA tests H4. Statistically significant difference in content training time amongst groups was found (Highlighted in Table 32). These finding are discussed further below.

Table 32: Content Training Time Data Analysis

<b>Content Training Time</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>
TC3 PPT Training	60	32.2	8.0	22.86*	< 0.0001*
TC3 Courseware	59	42.0	7.7		
TC3 Game-Based Simulation Training	60	36.4	8.1		

#### **Analysis of Hypothesis Four: Differences in Content Training Time between Treatments**

ANOVA analysis indicate that statistically difference in content training time was observed amongst treatments ( $p$  value = <0.0001). In order to identify which interventions have significantly different mean content training both a one way ANOVA and  $t$  statistics were calculated to explore the differences among pair of treatments. Table 33 provides results of this further analysis.

Table 33: Content Training Time between Treatments Data Analysis

<b>Content Training Time</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>	<b>t Statistic</b>
TC3 PPT Training TC3 Courseware	60 59	32.2 42.0	8.0 7.7	46.59*	< 0.0001*	-6.83*
TC3 PPT Training TC3 Game-Based Simulation Training	60 60	32.2 36.4	8.0 8.1	08.36*	0.0046*	-2.89*
TC3 Courseware TC3 Game-Based Simulation Training	59 60	42.0 36.4	7.7 8.1	14.59*	0.0002*	3.82*

ANOVA analysis indicates that statistically significant differences in content training time were observed amongst pair of treatments (see Table 33).

These results are of relevance since even though there was no significant difference in gain scores between the TC3 Courseware training group and the TC3 Game-Based Simulation training group (H3), there was a significant difference in content training time (H4). The TC3 Game-Based Simulation training group spent less time going over the courseware training modules than the TC3 Courseware training group. With less content training time, the TC3 Game-Based Simulation training group was able to perform at the same level as the TC3 Courseware group. One reason that could explain the difference in training time between the groups could be the desire that some of the participants demonstrated in engaging with the TC3 Game-Based Simulation system.

### **Relationship between Content Training Time and Performance in Knowledge Test**

In order to explore if there was any relationship between content training times and gain scores, Pearson coefficient of correlation was calculated for the different treatment groups.

Table 34 provides the results of the analysis.

Table 34: Training Time and Pre Post Gain Scores

<b>Gain Scores vs. Training Time</b>	<b>Pearson Coefficient of Correlation</b>	<b><i>t</i> Statistic</b>	<b><i>p</i> value</b>	<b>95% CI</b>
TC3 PPT Training Gain Scores vs. Content Training Time	0.12	0.96	0.3432	-0.13 to 0.36
TC3 Courseware Training Gain Scores vs. Content Training Time	-0.03	-0.24	0.8082	-0.29 to 0.23
TC3 Game-Based Sim Training Gain Scores vs. Content Training Time	0.17	1.34	0.1850	-0.08 to 0.41
TC3 Game-Based Sim Training Gain Scores vs. Content Training plus Game Time	-0.01	-0.07	0.9421	-0.26 to 0.24

The Analysis indicates that gain scores were not statistically correlated with content training time regardless of the training treatment.

### **Level III Evaluation – Skill Transfer**

According to Hardre and Chen (2005) transfer is the ability to extend or apply learned knowledge and skills to various situations. In order to assess the transfer of knowledge and skills acquired during training into a task related situation, a paper and pencil based scenario exercise was administered to each participant after completing the training. One hypothesis was tested in order to assess if the TC3 Game-Based Simulation transfer to performance outside of the TC3 game based simulation training scenarios:

H5: Transfer Scenario test scores for the TC3 Game-Based Simulation training group will be significantly higher than Transfer Scenario test scores for other TC3 training treatment groups.

**Data Collected to Analyze Hypothesis Five: Level III Skill Transfer**

Two combat casualty care scenarios were presented to the participants. They were asked to answer eleven questions regarding the care to be provided to the casualties based on the principles learned during the training. See Appendix I. A grade was assigned to each participant based on the number of correct answers. The training transfer of 177 individuals was analyzed. The inputs from 3 individuals were omitted due to missing data. One individual was excused for being 17 years of age. Two individuals were excused after completing portion of the training: one became ill and the other Soldier assisted the sick Soldier. The rest of the missing data was due to incomplete questions. To test H5, a one-way ANOVA using  $\alpha = 0.05$  was performed. Statistically significant differences in transfer task scores were found and are highlighted in Table 35.

Table 35: Transfer Scenario Scores Data Analysis

<b>Transfer Scenario Test Scores</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>	<b>t Statistic</b>
TC3 PPT Training	60	0.717	0.1231	6.91 *	0.0098 *	-2.63 *
TC3 Courseware	60	0.776	0.1239			
TC3 PPT Training	60	0.717	0.1231	12.00 *	0.0007 *	-3.45 *
TC3 Game-Based Simulation Training	60	0.800	0.1398			
TC3 Courseware	57	0.776	0.1239	0.90	0.3435	-0.95
TC3 Game-Based Simulation Training	60	0.800	0.1398			

### **Analysis of Hypothesis Five: Skill Transfer**

ANOVA analysis indicates that the TC3 Courseware and the TC3 Game-Based Simulation training groups scored higher in the transfer task test ( $p$  value = 0.0007 & ES  $d$  = 0.50 and  $p$  value = 0.0007 & ES  $d$  = 0.60 respectively) than the TC3 PPT training group. No significant difference was found for the game-based simulation training group and the TC3 Courseware training group. It is of importance to note that in average a 9% increased in transfer scenario performance was observed between the TC3 PPT training group and the TC3 Game-Based Simulation group.

### **Analysis of Skill Transfer Performance between Treatments per Content Training Area**

The skill transfer analysis described above was done examining differences in transfer test scores between treatments based on a test that evaluated skill transfer performance in three areas of TC3: Hemorrhage Control, Airway Management and Breathing. In an effort to examine more in depth the differences observed between the treatment groups regarding skill transfer, an analysis was performed to explore if difference in performance in the areas of Hemorrhage Control, Airway Management and Breathing were observed between treatment groups. For each participant, percentages of missed questions in each content area were calculated. A one way ANOVA using  $\alpha = 0.05$  was used to explore differences in skill transfer performance between treatment groups in the areas of Hemorrhage Control, Airway Management and Breathing. Statistically significant differences were found between treatment groups. The following is a summary of findings:

- Hemorrhage Control – the ANOVA analysis indicate that significant statistical difference was found in percentage of missed questions in the transfer test between the TC3 PPT

treatment group and the TC3 Courseware ( $p = 0.0495$  and ES  $d = 0.33$ ) and TC3 Game-Based Simulation ( $p = 0.0015$  and ES  $d = 0.65$ ) training treatment groups. The TC3 Courseware treatment group experienced a 7 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. The TC3 Game-Based Simulation treatment group experienced an 11 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. No significant difference was found in percentage of missed questions between the TC3 Courseware and TC3 Game-Based Simulation treatment groups ( $p = 0.3394$ ) in the area of hemorrhage control.

- Airway Management - the ANOVA analysis indicate that significant statistical difference was found in percentage of missed questions between the TC3 Game-Based Simulation treatment group and the TC3 Courseware ( $p = 0.0032$  and ES  $d = 0.57$ ) and TC3 PPT ( $p = 0.0002$  and ES  $d = 0.73$ ) training treatment groups. The TC3 Game-Based Simulation treatment group experienced a 24 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. The TC3 Game-Based Simulation treatment group experienced a 20 % decrease in percentage of missed questions from what was observed in the TC3 Courseware treatment group. No significant statistical difference was found in percentage of missed questions between the TC3 PPT and TC3 Courseware treatment groups ( $p = 0.3703$ ) in the area of airway management.
- Breathing - the ANOVA analysis indicate that no significant difference was found in percentage of missed questions between treatment groups ( $p = 0.7184$ ) in the area of breathing.

### **Ferdig’s Hypothesized Influence of Gender**

Gender analysis indicates no difference between females and males regarding performance in transfer task test (See Table 27 above).

### **Relationship between Reaction to Training and Performance in Transfer Task Test**

Medic trainees responses were statistically correlated for the TC3 Game-Based Simulation group with higher performance in transfer task scores and higher scores of reaction towards having met the training objectives ( $r = 0.26$ ,  $p$  value = 0.0487). See Table 18 above.

### **Relationship between Content Training Time and Performance in Transfer Task Test**

In order to explore if there was any relationship between content training time and the performance in transfer task, Pearson coefficient of correlation was calculated for the different interventions. Table 36 provides the results of the analysis.

Table 36: Training Time and Transfer Test Scores

<b>Transfer Scores vs. Time</b>	<b>Pearson Coefficient of Correlation</b>	<b><i>t</i> Statistic</b>	<b><i>p</i> value</b>	<b>95% <i>CI</i></b>
TC3 PPT Training Transfer Scores vs. Content Training Time	0.18	1.35	0.1822	-0.08 to 0.42
TC3 Courseware Training Transfer Scores vs. Content Training Time	-0.19	-1.46	0.1505	-0.43 to 0.07
TC3 Game-Based Sim Training Transfer Scores vs. Content Training Time	0.08	0.57	0.5707	-0.18 to 0.33
TC3 Game-Based Sim Training Transfer Scores vs. Content Training plus Game Time	0.07	0.52	0.6018	-0.19 to 0.32

The Analysis indicates that transfer task scores were not statistically correlated with content training time regardless of the training treatment.

### **Self-Efficacy Evaluation**

Self efficacy has proven to be an important factor in the area of academic achievement in traditional learning settings (Hodges 2008) and research suggest that people with high efficacy typically manifest higher confidence levels (Lanigan 2008). Self efficacy was assessed after training and after completing the scenarios. The following hypothesis was tested in order to assess if the TC3 Game-Based Simulation training system significantly enhances trainee self-efficacy:

- H6: Self-Efficacy scores for the TC3 Game-Based Simulation training group will be significantly higher than self-efficacy scores for other TC3 training treatment groups.

### **Data Collected to Analyze Hypothesis Six: Self Efficacy**

After completing the training and post test, Medic trainees were asked if they felt confident that they would be able to perform back on the job the tasks associated with the training objectives in the area of Hemorrhage Control, Airway Management and Breathing. After completing the scenarios, Medic trainees were asked if they felt that the training enabled them to complete the scenarios and apply the principles associated to the training objectives in the area of Hemorrhage Control, Airway Management and Breathing. They provided feedback using a Likert Scale from 1 to 5 (Strongly Disagree=1, Disagree=2, Neutral=3, Agree=4 and Strongly Agree=5). See Appendices H and J respectively. The average of the responses was calculated for analysis purposes. To test H6, a one-way ANOVA for completely randomized designs was performed to determine if self-efficacy scores significantly differ for the TC3 Game-



Based Simulation Training group. Table 37 provides results of the self efficacy analysis after training. Table 38 provides results of the self efficacy analysis after transfer task.

Table 37: Self-Efficacy Scores after Training Data Analysis

<b>Self Efficacy After Content Training</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>	<b>t Statistic</b>
TC3 PPT Training	57	4.200	0.518	0.01	0.9083	-0.12
TC3 Courseware	57	4.213	0.687			
TC3 PPT Training	57	4.200	0.518	0.14	0.7128	0.37
TC3 Game-Based Simulation Training	57	4.164	0.540			
TC3 Courseware	57	4.213	0.687	0.18	0.6683	0.43
TC3 Game-Based Simulation Training	57	4.164	0.540			

#### **Analysis of Hypothesis Six: Self Efficacy after Training**

ANOVA results indicate that Medic trainees “Agree” that they should be able to perform the tasks associated with the training on the battlefield. There was no significant difference in self efficacy scores after training between training treatments (See Table 37 above).

Table 38: Self-Efficacy Scores after Transfer Task Data Analysis

<b>Self Efficacy After Transfer Task</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>	<b>t Statistic</b>
TC3 PPT Training	57	4.123	0.567	0.66	0.4187	-0.81
TC3 Courseware	57	4.211	0.586			
TC3 PPT Training	57	4.123	0.567	1.51	0.2220	-1.23
TC3 Game-Based Simulation Training	57	4.251	0.551			
TC3 Courseware	57	4.211	0.586	0.15	0.7016	-0.38
TC3 Game-Based Simulation Training	57	4.251	0.551			

### **Analysis of Hypothesis Six: Self Efficacy after Transfer Task**

ANOVA results indicate that as a group, medic trainees on average “Agree” that the training enabled them to complete the transfer task scenarios. There was no significant difference in self efficacy scores after transfer task between training treatments (See Table 38 above).

### **Relationship between Self Efficacy and Performance in Knowledge Test**

In order to explore if there was any relationship between Self Efficacy scores after training and the pre post test gain scores, Pearson coefficient of correlation was calculated for the different interventions. The Analysis indicates that self efficacy scores were not statistically correlated with performance in knowledge test. See Table 39 below for results of the analysis.

Table 39: Self-Efficacy after Training and Pre Post Gain Scores

<b>Self Efficacy After Content Training vs Pre-Post Gain Scores</b>	<b>Pearson Coefficient of Correlation</b>	<b><i>t</i> Statistic</b>	<b><i>p</i> value</b>	<b>95% <i>CI</i></b>
TC3 PPT Training	0.07	0.51	0.6153	-0.19 to 0.32
TC3 Courseware Training	-0.01	-0.08	0.9326	-0.27 to 0.25
TC3 Game-Based Sim Training	0.09	0.67	0.5085	-0.17 to 0.34

### **Relationship between Self Efficacy and Performance in Transfer Task Test**

In order to explore if there was any relationship between Self Efficacy scores after transfer task and the transfer task scores, Pearson coefficient of correlation was calculated for the

different interventions. The Analysis indicates that self efficacy scores were not statistically correlated with performance in transfer task test. See Table 40 below for results of the analysis.

Table 40: Self-Efficacy after Transfer Task and Transfer Task Scores

<b>Self Efficacy After Transfer Task vs Transfer Task Scores</b>	<b>Pearson Coefficient of Correlation</b>	<b><i>t</i> Statistic</b>	<b><i>p</i> value</b>	<b>95% <i>CI</i></b>
TC3 PPT Training	0.09	0.64	0.5222	-0.18 to 0.34
TC3 Courseware Training	0.02	0.13	0.8941	-0.24 to 0.28
TC3 Game-Based Sim Training	0.11	0.86	0.3931	-0.15 to 0.36

### **Motivation Evaluation**

Motivation was assessed in two different categories: Intrinsic and Extrinsic Motivation. Intrinsic motivation assesses if the learner finds the activity interesting or enjoyable and extrinsic motivation assesses if the learner feels the activity could be beneficial and adds some value to their learning experience. Two main hypotheses were tested to assess trainee intrinsic and extrinsic motivation:

- H7: Intrinsic Motivation scores for the TC3 Game-Based Simulation training group will be significantly higher than Intrinsic Motivation scores for other TC3 training treatment groups.
- H8: Extrinsic Motivation scores for the TC3 Game-Based Simulation training group will be significantly higher than Extrinsic Motivation scores for other TC3 training treatment groups.

**Data Collected to Analyze Hypothesis Seven: Intrinsic Motivation**

After completing the training, Medic trainees were asked to answer two questions to assess intrinsic motivation (Appendices K, L, and M; Question number 1 and 2). Participants were asked to circle a number on a Likert Scale from 1 to 7 (1= “Very Much” agree, 4 = “Somewhat” agree, and 7 = “Very Much” agree with the assertion) based on their experience using the assigned training media. The average of the two responses was calculated for analysis purposes. To test H7, a one-way ANOVA for completely randomized designs and *t* statistic was calculated to determine if Intrinsic Motivation scores significantly differ for the TC3 Game-Based Simulation Training group. Table 41 provides results of this analysis.

Table 41: Intrinsic Motivation Scores after Training Data Analysis

<b>Intrinsic Motivation Scores</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b><i>F</i> Statistic</b>	<b><i>p</i> value</b>	<b><i>t</i> Statistic</b>
TC3 PPT Training	57	5.789	1.293	0.55	0.4587	-0.74
TC3 Courseware	57	5.947	0.948			
TC3 PPT Training	57	5.789	1.293	2.62	0.1085	1.62
TC3 Game-Based Simulation Training	57	5.417	1.164			
TC3 Courseware	57	5.947	0.948	7.12 *	0.0088*	2.67*
TC3 Game-Based Simulation Training	57	5.417	1.164			

**Analysis of Hypothesis Seven: Intrinsic Motivation**

As a group, medic trainees on average agree (mean values for intrinsic motivation were between 5 and 6 of a Likert Scale were 4 = “Somewhat” agree and 7 = “Very Much” agree) that they were intrinsically motivated during training regardless of the training treatment received. The TC3 Courseware training group scored higher than the TC3 Game-Based Simulation training group (*p* =0.0088 and ES *d* = 0.50).

### Relationship between Intrinsic Motivation and Performance in Knowledge Test and Transfer Task Test

To explore if there was any relationship between Intrinsic Motivation Scores and performance in Pre-Post Test Gain Scores and performance in the transfer task scores, Pearson coefficient of correlation was calculated for the different treatment groups. The Analysis indicates that intrinsic motivation scores were not statistically correlated with performance in knowledge test and transfer task test. Table 42 below provides the results of the analysis.

Table 42: Intrinsic Motivation, Pre-Post Gain Scores, and Transfer Task Scores Correlation Analysis

<b>Intrinsic Motivation vs Performance</b>	<b>Pearson Coefficient of Correlation</b>	<b><i>t</i> Statistic</b>	<b><i>p</i> value</b>	<b>95% <i>CI</i></b>
TC3 PPT Training	0.05	0.36	0.7169	-0.21 to 0.30
• Pre-Post Gain Scores	-0.03	-0.22	0.8239	-0.29 to 0.23
• Transfer Task				
TC3 Courseware Training	0.12	0.86	0.3929	-0.15 to 0.36
• Pre-Post Gain Scores	-0.15	-1.13	0.2651	-0.40 to 0.11
• Transfer Task				
TC3 Game-Based Sim Training	0.00	-0.01	0.9903	-0.26 to 0.25
• Pre-Post Gain Scores	0.11	0.80	0.4276	-0.16 to 0.35
• Transfer Task				

### Data Collected to Analyze Hypothesis Eight: Extrinsic Motivation

After completing the training, Medic trainees were asked to answer two questions to assess extrinsic motivation (Appendices K, L, and M; Question number 3 and 4). Participants were asked to circle a number on a Likert Scale from 1 to 7 (1= “Very Much” agree, 4 = “Somewhat” agree, and 7 = “Very Much” agree with the assertion) based on their experience using the assigned training media. The average of the two responses was calculated for analysis

purpose. To test H8, a one-way ANOVA for completely randomized designs was performed to determine if Extrinsic Motivation scores significantly differ for the TC3 Game-Based Simulation Training group. Table 43 provides results of this analysis.

Table 43: Extrinsic Motivation Scores after Training Data Analysis

<b>Extrinsic Motivation Scores</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>	<b>t Statistic</b>
TC3 PPT Training	57	5.877	1.115	2.24	0.1371	-1.50
TC3 Courseware	57	6.167	0.942			
TC3 PPT Training	57	5.877	1.115	0.00	0.9485	-0.06
TC3 Game-Based Simulation Training	57	5.890	1.053			
TC3 Courseware	57	6.167	0.942	2.18	0.1426	1.48
TC3 Game-Based Simulation Training	57	5.890	1.053			

### **Analysis of Hypothesis Eight: Extrinsic Motivation**

As a group, medic trainees on average agree (mean values for intrinsic motivation were between 5 and 6 of a Likert Scale were 4 = “Somewhat” agree and 7 = “Very Much” agree) that they were extrinsically motivated during training regardless of the training treatment received. There was no significant difference observed regarding extrinsic motivation scores regardless of the training treatment received.

### **Relationship between Extrinsic Motivation and Performance in Knowledge Test and Transfer Task Test**

To explore if there was any relationship between Extrinsic Motivation Scores and performance in Pre-Post Test Gain Scores and performance in the transfer task scores, Pearson coefficient of correlation was calculated for the different treatment groups. The Analysis indicates that extrinsic motivation scores were not statistically correlated with performance in knowledge test and transfer task test. See Table 44 below for results of the analysis.

Table 44: Extrinsic Motivation, Pre-Post Gain Scores, and Transfer Task Scores Correlation Analysis

<b>Extrinsic Motivation vs Performance</b>	<b>Pearson Coefficient of Correlation</b>	<b><i>t</i> Statistic</b>	<b><i>p</i> value</b>	<b>95% CI</b>
TC3 PPT Training				
• Pre-Post Gain Scores	-0.15	-1.10	0.2745	-0.39 to 0.12
• Transfer Task	0.10	0.72	0.4773	-0.17 to 0.34
TC3 Courseware Training				
• Pre-Post Gain Scores	-0.05	-0.38	0.7065	-0.31 to 0.21
• Transfer Task	-0.13	-1.0	0.3188	-0.38 to 0.13
TC3 Game-Based Sim Training				
• Pre-Post Gain Scores	-0.03	-0.23	0.8205	-0.28 to 0.23
• Transfer Task	0.23	1.82	0.0744	-0.02 to 0.46

### Secondary Activity Analysis

In addition to measuring intrinsic and extrinsic motivation it is important to look at other characteristics of motivated learners such as interest and persistence in training activities (Garris, et al, 2002). As part of this research the number of iterations a user chose to go through the training was collected as a possible indicator of motivation in engaging in training. For the experimental group that received the TC3 game based simulation the number of iterations a user went through the game (playing different scenarios) was also collected. Table 35 summarizes the data collected.

Table 45: Summary of Collected Data

Intervention	Number of Times Going Over Training	Activities Engaged After Training
TC3 PowerPoint Training	<ul style="list-style-type: none"> <li>• # of participants going over training once = 41 (72 %)</li> <li>• # of participants going over training twice = 14 (24 %)</li> <li>• # of participants going over training three times = 2 (4%)</li> </ul>	<ul style="list-style-type: none"> <li>• # of participants reading a Magazine = 13</li> <li>• # of participants playing Sudoku = 5</li> <li>• # of participants doing Word Puzzles = 5</li> <li>• # of participants playing Computer Games = 4</li> </ul>
TC3 Courseware Training	<ul style="list-style-type: none"> <li>• # of participants going over the modules once = 49 (83 %)</li> <li>• # of participants going over at least one training module more than once = 10 (17 %)</li> </ul>	<ul style="list-style-type: none"> <li>• # of participants reading a Magazine = 8</li> <li>• # of participants playing Sudoku = 3</li> <li>• # of participants doing Word Puzzles = 0</li> <li>• # of participants playing Computer Games = 36</li> </ul>
TC3 Game Based Simulation	<ul style="list-style-type: none"> <li>• # of participants going over the modules once = 58 (97 %)</li> <li>• # of participants going over at least one training module more than once = 2 (3 %)</li> <li>• # of participants going over the game scenarios once = 33 (55 %)</li> <li>• # of participants going over at the training scenarios more than once = 27 (45 %)</li> </ul>	<ul style="list-style-type: none"> <li>• # of participants reading a Magazine = 8</li> <li>• # of participants playing Sudoku = 3</li> <li>• # of participants doing Word Puzzles = 0</li> <li>• # of participants playing Computer Games = 25</li> <li>• # of participants that continued playing the TC3 Game = 11 (18%)</li> </ul>

Of the participants receiving TC3 PPT training, 72 percent went through the presentation only once, 24 percent went through the presentation twice and 4 percent went through the presentation a third time. Of the participants receiving TC3 Courseware training, 83 percent completed each module only once and 17 percent reported going over at least one training module more than once. Of the participants receiving the Game Based simulation training, 97 percent went through the training modules once and 3 percent reported going over at least one



training module more than once. In addition to content training 55 percent of the participants completed the required training scenarios only once but 45 percent went over the training scenarios more than once. 18 percent of the participants continue to play the game after completing training.

**Relationship between Secondary Activity and Performance in Knowledge Test and Transfer task Test**

To explore if engaging in the game more time as a secondary activity after training have an impact on performance in pre-post test and transfer task for the TC3 Game Based simulation training group, a ANOVA analysis was performed to compare the performance between the group that played the game and engaged in different activities and the group that continued to play the game as a secondary activity. These results are not part of the experimental design and therefore do not have the power over avoiding Type II error as described by Cohen (1992).Table 46 provides the results of the analysis.

Table 46: Game as a Secondary Activity Analysis

<b>Performance Analysis</b>	<b>n</b>	<b>Mean</b>	<b>SD</b>	<b>F Statistic</b>	<b>p value</b>	<b>t Statistic</b>
Pre Post Test Gain Performance						
• Game as a Secondary Activity	11	0.2078	0.1445	0.99	0.3247	0.99
• Other Secondary activity	48	0.2530	0.1342			
Transfer Test Performance						
• Game as a Secondary Activity	11	0.8264	0.1182	0.55	0.4631	-0.74
• Other Secondary activity	48	0.7917	0.1452			

Results from the ANOVA analysis indicate that there was no significant difference observed regarding performance in gain scores and transfer task test scores between the group in the TC3 Game-Based Simulation that continue to engage in the game as a secondary task and the group who chose other activities after training. It is also of value to note that 3 % in transfer task score was observed for the group that engaged in the game as a secondary activity.

## **CHAPTER FIVE: SUMMARY OF FINDINGS AND CONCLUSIONS, RESEARCH LIMITATIONS, LESSONS LEARNED AND FUTURE RESEARCH**

### **Research Relevance**

The linear battlefield limits the number of trained medical personnel attached to maneuver elements. There is a need to fill the gap with some type of medical capability at the individual Soldier level in order to improve the survivability of the Soldier in combat. As cited by retired Lieutenant Colonel Donald L. Parsons (Parsons, 2006), “improving care at the point of wounding is the best medicine. The process has to start long before Soldiers ever see the battlefield and the first step is training and then more training.”

There is a growing advocacy for the use of instructional games as a tool to provide cognitive skills. The Army is currently pursuing the use of instructional games in an effort to improve effectiveness in training. There are some advantages to this concept when compared to live, virtual and constructive simulations. If developed to be run on a PC, games provide a low cost alternative to training. They can be distributed easily, therefore there is potential to minimize time and logistics. If the Soldier has access to a PC, he or she could play the game any time, anywhere.

The Department of Combat Medic Training (DCMT) is constantly challenged with increasing number of trainees and limited resources. They are constantly seeking new venues that will enhance the current tools and methods used for initial skills and sustainment training of Army Combat Medics (68Ws) who are faced with responding to today’s battlefield casualty situations. New technologies for training readiness are needed to provide medics with greater opportunities to develop and test their decision making and technical medical skills. The Army is

considering the use of the TC3 Sim game as a tool to improve the training of individual Soldiers as well as improve the readiness of combat medics (Fowler, Smith & Litteral, 2005).

The intent of this research was to measure training effectiveness of the TC3 Game- Based Simulation as an instructional game to teach the concepts of tactical combat casualty care using the Kirkpatrick model (1959). The first three levels were evaluated: Reaction, Knowledge Acquisition, and Skill Transfer. Once the Soldiers leave medic training and are assigned to their new duty stations, due to scattering of these medics to various units around the world, it is extremely difficult to evaluate the impact of organization performance by the TC3 training program. The effects of three levels of training treatments were compared in trainee performance: Multimedia, Interaction, and Experiential Learning. Experiments were conducted at DCMT to evaluate the training effectiveness in supporting the 68W10 Healthcare Specialist Course program of instruction (POI). The goal of this research was to address an important question: Can instructional games as experiential tools encourage learning? i.e., is this game an effective tool to train Soldiers the aspects of TC3?

### **Summary of Findings and Conclusions**

The particular gap in the literature that this research focuses on is the potential use of computer instructional games for learning by young adults. The focus of this research was the assessment of three different training treatments for combat medic trainees. One of those treatments involved the use of a simulation game as a supplement to more traditional training. An experiment was designed such that statistical differences in effectiveness between treatments could be discerned at  $\alpha = 0.05$  and  $\beta = 0.20$ . Statistically significant findings were the following:

### **Level I Reaction**

In terms of overall reaction to training, no difference was observed regardless of the training received (H1). As a group medic trainees on average rated the training as “Very Good” regardless of the training treatment. As a group, medic trainees on average “Agree” that the training objectives were met during training, that the training (materials and technology) should be incorporated in the program of instruction, and that the technology was easy to use regardless of the training treatment. When looking at descriptive characteristics as hypothesized by Bae (2002) and Ferdig (2007), no significant difference in overall reaction to training was observed regardless of training treatment or gender. Regarding the need of an instructor during training, medic trainee responses were statistically significant for the group with TC3 PPT training.

### **Level II Knowledge Acquisition**

Post test scores improved over pre-test scores for all treatment groups (H2). Additionally, significant statistical differences were found in knowledge gain scores between the TC3 PPT treatment group and both the TC3 Courseware and TC3 Game-Based Simulation training treatment groups (H3). Medic trainees’ responses were statistically correlated for the TC3 Courseware training group with higher gain scores and lower scores of reaction towards needing an instructor during training. This is of significance since the courseware training system was developed as a distance learning tool to support medic sustainment training. In average a 9% increased in knowledge test performance was observed between the groups receiving the TC3 PPT training (current training intervention at DCMT) and the TC3 Game-Based Simulation. In average an 11% increased in knowledge test performance was observed between the TC3 PPT and the TC3 Courseware training groups. In terms of content training area, no significant

difference in performance in the area of hemorrhage control was observed between treatment groups. Statistical significant difference in performance in the area of breathing was found between the group with TC3 PPT training and both the TC3 Courseware and TC3 Game-Based Simulation training treatment groups. The TC3 Courseware treatment group experienced a 23 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. The TC3 Game-Based Simulation treatment group experienced a 20 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. Statistical significant difference in performance in the area of airway management was found between the group with TC3 Courseware training and both the TC3 PPT and TC3 Game-Based Simulation training treatment groups. The TC3 Courseware treatment group experienced a 16 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. The TC3 Courseware treatment group experienced an 8 % decrease in percentage of missed questions from what was observed in the TC3 Game-Based Simulation treatment group. Statistically significant difference in content training time was observed between the TC3 Courseware and the TC3 Game-Based Simulation training treatment groups (H4). The TC3 Game-Based Simulation training group spent less time going over the courseware training modules than the TC3 Courseware training group. With less content training time, the TC3 Game-Based Simulation group was able to perform at the same level as the TC3 Courseware group. One reason that could explain the difference in training time between the groups could be the desire that some of the participants demonstrated in engaging with the TC3 Game-Based Simulation system. No linear correlation between content training time and performance in pre-post gain scores was observed regardless of the training intervention received.

### **Level III Skill Acquisition**

The TC3 Courseware and TC3 Game-Based Simulation training groups scored statistically higher in the transfer task test than the TC3 PowerPoint training group (H5). Higher performance in transfer task test scores were observed for the TC3 Game-Based Simulation group with higher scores of reaction towards having met the training objectives during training. In average a 9% increased in transfer scenario performance was observed between the TC3 PPT and the TC3 Game-Base simulation training groups. In terms of content training area, no significant difference in performance in the area of breathing was observed between treatment groups. Statistical significant difference in performance in the area of hemorrhage control was found between the group with TC3 PPT training and both the TC3 Courseware and TC3 Game-Based Simulation training treatment groups. The TC3 Courseware treatment group experienced a 7 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. The TC3 Game-Based Simulation treatment group experienced an 11 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. Statistical significant difference in performance in the area of airway management was found between the group with TC3 Game-Based Simulation and both the TC3 PPT and TC3 Courseware training treatment groups. The TC3 Game-Based Simulation treatment group experienced a 24 % decrease in percentage of missed questions from what was observed in the TC3 PPT treatment group. The TC3Game-Based Simulation treatment group experienced a 20 % decrease in percentage of missed questions from what was observed in the TC3 Courseware treatment group. Even though the overall performance of the transfer task did not indicate statistical difference between the TC3 Game-Based Simulation and the TC3 Courseware, when looking at the performance per TC3 area, a statistical significant difference was observed

between the TC3 Game-Based Simulation and TC3 Courseware treatment groups in the area of airway management. No linear correlation was observed between content training time and performance in transfer task scores regardless of the training treatment received.

### **Self-Efficacy**

As a group, medic trainees on average “Agree” that they should be able to perform the tasks associated with the training: in the first case on the battlefield and in the second case enabling them to complete the scenarios. No significant difference in self-efficacy was found between treatment groups (H6). No linear correlation was observed between Self-Efficacy after training and after transfer task scores and performance in gain scores and transfer task test scores regardless of the training treatment received.

### **Motivation**

As a group, medic trainees on average agree that they were intrinsically and extrinsically motivated regardless of the training treatment received. The TC3 Courseware training group scored intrinsic motivation higher than the TC3 Game-Based Simulation training group (H7). There was no statistically significant difference observed regarding extrinsic motivation scores between the TC3 Game-Based Simulation Training group and the TC3 PPT training or TC3 Courseware training groups (H8). No linear correlation was observed between intrinsic and extrinsic motivation and performance in Pre-Post Gain Scores and Transfer Task Scores.

In addition to the designed experiment, correlations of Bae’s (2002) descriptive characteristics (age, experience, and education level) and Ferdig’s (2007) gender were tracked along with the test of hypotheses. These correlations and results are not part of the experimental design and therefore do not have the power over avoiding Type II error as described by Cohen



(1992). The statistically significant correlations are listed below with due caution to the astute reader in the hope of potentially contributing insights to possible future research into the correlations and results observed. The following are statistically significant findings:

- Higher overall reaction scores were observed for participants with lower levels of education in the TC3 PPT training group.
- Higher reaction scores towards having met that training objectives were observed for participants with lower levels of education in the TC3 Courseware training group.
- Higher reaction scores towards having met that training objectives were observed amongst younger participants in the TC3 Game-Based Simulation group.
- Higher reaction scores towards finding the technology easy to use were observed amongst younger participants and participants with lower levels of education in the TC3 Game-Based Simulation group.
- Higher reaction scores towards needing an instructor during training were observed amongst older participants in the TC3 Game-Based Simulation group.
- No difference was observed between females and males regarding overall reaction to training and performance in knowledge and transfer task.

### **Experimental Limitations**

Experimental Limitations arise primarily from scope. Limitations result in terms of resources, subjects, experimental methodology and games considered. The experimental limitations encountered are believed to not been significant enough to dismiss any of the findings. Each topic is discussed in turn below.

## **Resources**

Evaluating beyond the Kirkpatrick's third level was difficult to accomplish. Once the Soldiers leave the school at DCMT and are assigned to their new duty stations, it is extremely difficult to evaluate the impact of organization performance by the TC3 program. Level three evaluations was accomplished using paper and pencil scenarios due to the fact that in order to evaluate hands on task in a lane environment would have required instructor participation and resources and time constraints limited their participation. In addition, participant's performance at the conclusion of the 68W course is sensitive information that DCMT can not release.

The experiment was conducted with three experimental groups: TC3 PPT Training, TC3 Courseware, and TC3 Game Based Simulation. It would have been ideal to consider a fourth experimental group: PPT and TC3 Game Based Simulation were the content training would have been provided by the PPT presentation. That would have completely isolated the performance due to the game portion of the training. Again limitations in access to students and resources prevented the inclusion of a fourth experimental group.

DCMT has several learning resource centers with at least 60 computers per center. Due to the fact that the courseware and game could not be placed in the network, only 20 gaming computers were available to support both the courseware group and the game group. This limited the amount of participants per session and prevented conducting a fourth experimental group.

## **Subjects**

In order to conduct the experiment with at least 156 participants, the experiment was conducted at the Department of Combat Medic Training School. Access to the student

population was constraint. First, the window of opportunity was very limited. Students could be accessed only one day during their training. The day participants could participate was the same day they tested for EMT B certification. Fatigue was a major factor observed from the students. This might have impacted their motivation and performance. Especially in the Game intervention which was more intense that the other two interventions.

Most of the student population at the school is young recruits with no combat experience and medical experience. This factor was a constraint in the analysis of data specifically to identify if experience and age could impact performance, self efficacy and motivation in a game environment.

### **Experimental Methodology**

To gather feedback from participants, they were asked to complete surveys. Missing values of sections not completed by participants was an issue. Data was missing not only on surveys but also on transfer scenarios and demographic instrument. The major problem observed was with instruments that had continuation pages in the back. It would have been beneficial to provide electronic input via computer software surveys to capture the data.

Participants were asked to record time of training and training activities. During the experiment constant reminder for time stamping was required. This issue could have been avoided if a built in tool in the game and courseware be available to capture time on task. The same applied for the PPT group.

Even though a pilot test was performed and the surveys were streamlined to only have the necessary data for analysis, the experiment was long and students were asked to fill out too many surveys. This could have impacted their answers. In addition, during the pilot test it was noticed

that even though specific instructions were given to students regarding the modules to do training on, some of the participants chose the wrong modules. This issue was fixed by blocking the links and allowing only the links associated with the experiment to work.

The participants in the game experimental group were provided with game interface training. The amount of time for training was constrained by the experimental window available from the school to avoid conflicting with the regular program of instruction. It would have been of benefit to provide extra game interface training. In addition, participants in the game experimental group were provided with after action review on the training scenarios via paper. This was due to the fact that after action capability in the game was not completely developed. It would have been beneficial to run the experimental group with a more robust AAR capability that would provide immediate feedback and remediation without the intervention of an instructor.

### **Games**

Only one game was evaluated during this research study. There are other games that have been developed to support 68 W training, but their developmental stage was not at the same level as the TC3 Game-Based Simulation. In addition, the limitations explained above precluded the evaluation of multiple games.

### **Lessons Learned**

Several lessons learned were drawn from the experiment and could be addressed in follow on research and experimentation. None of the limitations addressed are believed to impact the findings of this research.

In terms of experimental methodology and logistics it would have been of benefit to capture most of the survey data via computer software. This would not only address the issue of missing data but would also ease the input of the data for analysis. Many hours were dedicated to data input. Also, time stamping of computer-based activities should be captured via the software to prevent having to constantly remind participants to collect the data.

Even though most of the data gathered for reaction was done through questionnaires, some of the areas in the questionnaire need improvement. Additional feedback would have been of benefit in the area of reaction to overall training. It would have been of help to ask the participants which features they liked from the training. This would have given insight towards the factors that might motivate learners in a game environment.

Being able to perform a pilot test to validate test instruments and protocols was instrumental in the success of the follow on experimentation. Early Coordination of the experiment needs to be done at all levels to include recruiting personnel. This was of importance to ensure volunteer participation and to better manage subject's expectations.

### **Recommended Future Research**

Advocacy of gaming tools to support training has been a trend observed in recent years. This research focused on instructional game, i.e., games that have been developed to support specific learning objectives. Reaction to training in a game environment was explored, as well as, acquisition of knowledge and transfer of skills. Also the role of self-efficacy and motivation in a game environment was considered as possible factors to improve performance.

When looking closely at the descriptive characteristics observed in the sample population, most of the participants belonged to Generation Y. Even though most of them

reported having experience with video games, the majority of them do not engage in playing at a regular basis. The majority of the people that reported not having experience with video games had higher levels of education (Associate Degrees, Bachelors, and Post Bachelors Education). Of the people that reported time spent during a typical week, the majority reported playing less than 5 hours a week. Most of the population rated themselves at the Intermediate level in terms of First Person game. In terms of gender, the majority of females rated at the beginner level were the majority of males consider themselves at the intermediate level. The design of this research experiment does not provide sufficient power to make conclusions on these findings. For future research, sets of experiments designed with gender, education level, and generation identification may clarify if these population characteristics are determinate on outcome.

Simple correlation analysis was performed to explore the relationship between descriptive characteristics, as hypothesized by Bae (2002) and Ferdig (2007), overall reaction, and performance in the training environment. For future research, it would be of benefit to explore non linear relationships between variables as well as multiple regression analysis. In addition, no difference was observed between females and males regarding overall reaction to training

Due to limitations on resources, the game-based simulation training was incorporated with courseware content training. It would have been ideal to consider a fourth experimental group: PPT and TC3 Game Based Simulation were the content training would have been provided by the PPT presentation. Future research should consider completely isolating the performance due to the game portion of the training.

Due to constraints in time and resources at DCMT, level III evaluation was accomplished using paper and pencil scenarios. Future research should consider evaluating performance at lane training and field exercises, where hands on skills evaluation can be performed.

One area that was not addressed in this research is to look at how it would be more effective to incorporate the game component in the program of instruction. For future research, it would be of benefit to explore different ways of incorporating the game in order to see if differences in performance are observed. The game could be incorporated as an extra curricular activity in addition to traditional instruction. This particular scenario would augment trainees' time of skill practice. Another possibility could be introducing the tool into the traditional classroom environment but being facilitated by an instructor in order to provide feedback on students' performance in an AAR (After Action Review) fashion.

As part of this research effort it was found that the game-based simulation group spent less time in content training compared to the courseware group. With less content training the game-based simulation group was able to perform at the same level in knowledge test and transfer task. Future research should consider looking at whether or not trainees would use the game as a tool to improve on transfer skills if time is available after training. Also, it would be of benefit to explore the amount of time trainees would consider engaging in gaming activities after receiving training.

Finally, it would be of benefit for future research to conduct longitudinal research, i.e. collect repeated observations of trainees over long periods of time, to explore the impact of game-based simulation training would have in performance on task related activities and retention of TC3 knowledge and skills.

**APPENDIX A: CONSENT FORM**



# C

## Brooke Medical Center Adult Informed Consent

PARTICIPANT # \_\_\_\_\_

DATE \_\_\_\_\_

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### Information for People Who Take Part in Research Studies

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**Title of Study:** "Evaluating the transfer of learning through a game-based simulation for Combat Medics"

**Principal Investigator:** Teresita Marie Sotomayor

**Study Location(s):** ARMY Medical Department Center and School (AMEDDC&S)  
Department of Combat Medic Training (DCMT)  
Ft. Sam Houston, TX 78234-6115

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If you choose not to participate in this research study, your decision will not affect your eligibility for care or any other benefits to which you are entitled.

#### Description/Purpose of Research:

You are being asked to consider participation in this research study because you have just finished EMT-B and are about to begin Tactical Combat Casualty Care (TC3) training. We are assessing the effectiveness of a new TC3 training system designed to be used during your TC3 training program at AMEDD. This study will enroll approximately 186 subjects (30 for the Pilot Study and 156 for the Training Effectiveness Evaluation).

#### General Information about the Research Study

1. The purpose of the study is to evaluate the effectiveness of a new TC3 training system in teaching tactical combat casualty care knowledge and skills to 68Ws.
2. We want to find out if the training helps soldiers learn TC3 knowledge and skills, and if the knowledge and skills can help soldiers complete a casualty simulation.

#### Plan of Study

During your participation in this study:

1. You will be asked to complete a demographic questionnaire and a pre-test.
2. You will then be randomly assigned to receive one of three types of TC3 training. Randomization is a process like flipping a coin and means you will have a chance of being assigned to any of the three

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types of TC3 training. The three types of training train the same TC3 knowledge and skills, just in different ways. Training will last approximately 1.5 hours.

3. After the training you will be asked to complete a post test and an opinion survey.
4. You will then be given a 15minute break (and asked not to discuss the training) and offered refreshments.
5. After the break you will be asked to respond to a paper and pencil casualty simulation, and asked to complete a final self report survey.

- **Payment for Participation**

You will not be paid for your participation in this study.

**Benefits of Being a Part of this Research Study**

- The benefits of the proposed research are multi-pronged: 1) The new training will supplement the current TC3 training curriculum and soldiers participating in this research will benefit from this additional training.; 2) The combat medicine community in general will benefit from examining the effectiveness of an engaging, accessible training system.

**Risks of Being a Part of this Research Study**

- While we anticipate no risk of bodily harm whatsoever, we acknowledge that privacy is a potential concern. Your identity and privacy will be protected (see below). In addition, the training includes graphic images reflecting real combat injuries.

**Confidentiality of Your Records**

- Your privacy and research records will be kept confidential to the extent of the law. Authorized research personnel and authorized personnel from the BAMC Review Board may inspect the records from this research project.

The results of this study may be published. However, the data obtained from you will be combined with data from other people in the publication. The published results will not include your name or any other information that would in any way personally identify you. By signing this consent document, you give permission for information gained from your participation in this study to be published.

A code number will identify all assessments and surveys. Matching lists of names (from consent forms) and code numbers will be kept in a locked storage facility at RDECOM-STTC in Orlando, Fl. All assessments and surveys will be maintained in a locked research file at RDECOM-STTC in Orlando, Fl. Members of the study team (including the principal investigator, and other research team members) will have access to the data.

**Volunteering to Be Part of this Research Study**

- You must be 18 years of age or older to participate. Your decision to participate in this research study is completely voluntary. You are free to participate in this research study or to withdraw at any time. If you choose not to participate, or if you withdraw, there will be no penalty or loss of benefits that you are entitled to receive. Choosing not to participate in this study, or choosing to withdraw, will not in any way affect your MOS training or record in the US Army.

**Questions and Contacts**

IRB# C.2008.105e

2

Rev: 9/99

- If you have any questions about this research study, please contact **Teresita Sotomayor**, Science and Technology Manager, US Army RDECOM-STTC, 407-384-3969.

Mrs. Sotomayor is working under the supervision of Dr. Michael Proctor at the University of Central Florida. If you have any questions about this research study, you may contact Dr. Proctor by phone at 407-823-3413, or by email at [mproctor@mail.ucf.edu](mailto:mproctor@mail.ucf.edu).

- If you have questions about your rights as a person who is taking part in a research study, you may contact the Brooke Army Medical Center Protocol Coordinators, (210)916-2598 or BAMC Judge Advocate General, (210) 916-2031.

Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board. Questions or concerns about research participants' rights may be directed to the UCF IRB Office, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246, or by campus mail 32816-0150. The hours of operation are 8:00 AM until 5:00 PM, Monday thru Friday except on University of Central Florida official holidays. The telephone numbers are (407) 882-2276 and (407) 823-2901. The IRB email is : [IRB@mail.ucf.edu](mailto:IRB@mail.ucf.edu)

**Your Consent—By signing this form I agree that:**

- I have fully read or have had read and explained to me this informed consent form describing a research project.
- I have had the opportunity to question one of the persons in charge of this research and have received satisfactory answers.
- I understand that I am being asked to participate in research. I understand the risks and benefits, and I freely give my consent to participate in the research project outlined in this form, under the conditions indicated in it.
- I understand that all identifying names (spoken or written) will be omitted from presentation or publication.
- I have been given a signed copy of this informed consent form, which is mine to keep.

Signature of Participant	Printed Name of Participant	Date
--------------------------	-----------------------------	------

**Investigator Statement**

I have carefully explained to the subject the nature of the above protocol. I hereby certify that to the best of my knowledge the subject signing this consent form understands the nature, demands, risks and benefits involved in participating in this study.

Signature of Investigator Or Authorized Research Investigators designated by the Principal Investigator	Teresita Marie Sotomayor Printed Name of Investigator  Phone:407-384-3969 or 407-342-4148	Date
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**Institutional Approval of Study and Informed Consent**

This research project/study and informed consent form were reviewed and approved by the BAMC Review Board for the protection of human subjects. This approval is valid until the date provided below. The board may be contacted at (210) 916-2598.

**Approval Consent Form Expiration Date:** 26 January 2009

IRB# C.2008.105e

## **APPENDIX B: DEMOGRAPHIC SURVEY**

# 1

## Demographics Survey

Participant # \_\_\_\_\_

Please fill in the blanks or circle the appropriate response from the choices given.

NAME (optional): \_\_\_\_\_

1. Age (in years) \_\_\_\_\_

Circle which best characterizes you

2.           Left-handed           Right-handed

3.           Male           Female

4. Do you have any experience in combat operations?    Yes       No

5. If you answered "Yes" above, do you have combat experience as a medic?   Yes   No

    If you answered 'Yes' above, please specify how long: \_\_\_\_\_Years   \_\_\_\_\_Months

6. Do you have any type of medical background in a civilian setting?   Yes    No

    If you answered 'Yes' above, please circle below:

    a. EMT: Years \_\_\_\_\_ Months \_\_\_\_\_

    b. Emergency Room: Years \_\_\_\_\_ Months \_\_\_\_\_

    c. Other (Describe): \_\_\_\_\_ Years \_\_\_\_\_ Months \_\_\_\_\_

7. Do you have any experience playing video games on a personal computer or game system?

          Yes           No

8. Thinking over the last six months, how many hours did you play video games on a typical week? \_\_\_\_\_

9. How would you rate your ability at a first-person video games?

          Beginner       Intermediate       Expert

CONTINUED ON BACK

10. Thinking over the last six months, how many hours did you work on a Computer on a typical week? \_\_\_\_\_

11. How would you rate your ability with computers?

Beginner      Intermediate      Expert

12. Mark highest level of education completed:

Some HS \_\_\_ HS/GED \_\_\_ Some College Credits \_\_\_ Associate \_\_\_

Bachelor Degree \_\_\_ Post-Bachelor \_\_\_

13. Ethnicity- Select which best characterizes you:

American Indian or Alaska Native \_\_\_

Asian \_\_\_

Black or African American \_\_\_

Hispanic or Latino \_\_\_

Native Hawaiian or Other Pacific Islander \_\_\_

White \_\_\_

**APPENDIX C: PRE-POST TEST VERSION A**

**TACTICAL COMBAT CASUALTY CARE  
KNOWLEDGE ASSESSMENT (vA)**

**Instructions:** Circle the correct answer for each question.

1. What is the primary medical care provided in Care Under Fire?
  - a) airway
  - b) spinal injury
  - c) hemorrhage
  - d) needle chest decompression
  
2. Where on the chest would you perform a needle chest decompression?
  - a) above the first rib
  - b) second intercostal space (between the first and second ribs )
  - c) third intercostal space (between the second and third ribs)
  - d) fifth intercostals space (between the fourth and fifth ribs)
  
3. What gauge and length of needle/catheter would you use for Needle Chest Decompression?
  - a) 14 gauge, 2inch
  - b) 16 gauge, 2 inch
  - c) 14 gauge, 3.5 inch
  - d) 18 gauge, 3.5 inch
  
4. What is the primary method to control life-threatening hemorrhage?
  - a) pressure bandage
  - b) hemostatic dressing
  - c) field dressing
  - d) tourniquet
  
5. If a casualty has a maxillofacial injury, in what position would you evacuate them?
  - a) recovery
  - b) supine
  - c) prone
  - d) standing

**CONTINUE TO NEXT PAGE**



6. If the wound is not an extremity wound, which method of hemorrhage control is most appropriate?
- a) tourniquet
  - b) HemCon Bandage
  - c) pressure dressing
7. Which of the below is not one of the three preventable causes of death on the battlefield?
- a) spinal injury
  - b) tension pneumothorax
  - c) hemorrhage
  - d) airway blockage
8. Which airway adjunct should you do as your last attempt?
- a) combitube
  - b) King LT
  - c) cric
9. What signs of hemorrhage will you not be able to assess on the battle field?
- a) rapid pulse
  - b) large pools of blood
  - c) low blood pressure
10. In which case would you use a surgical airway?
- a) instead of performing CPR
  - b) in the case of inhalation injury
  - c) when the patient has a sucking chest wound
  - d) if the patient is not screaming
11. What type of dressing would be indicated for a chest wall injury?
- a) hemostatic
  - b) pressure
  - c) occlusive
12. How would you identify that the casualty has a penetrating chest wound?
- a) lack of breath sounds on the injured side
  - b) small cuts on his chest
  - c) patient complains of chest pain

CONTINUE TO NEXT PAGE

13. If you are performing a needle decompression, you should tape the dressing on all four sides.
- a) true
  - b) false
14. How would you identify a tension pneumothorax?
- a) complaints of trouble breathing
  - b) progressive respiratory distress after dressing is applied
  - c) a sucking chest wound

**APPENDIX D: TIMING AND ACTIVITIES FORM – POWERPOINT  
TRAINING TIME DATA**

### 3

#### TC3 PowerPoint Training

You have one hour to complete the PowerPoint training. Please record the time you start the training. When you complete the training you may go back through the PowerPoint as many times as you want for the entire one hour period. When you feel you are fully prepared for the test please record the time of training completion. If you feel that you have completed your study and you have extra time left during this one hour study period, you may take a break and pick up a magazine or engage in another activity of your preference but you can not leave your seat or distract other people studying.

Start Time \_\_\_\_\_

Finish Time \_\_\_\_\_

Number of times went over the PowerPoint presentation \_\_\_\_\_

If you took any breaks during the training , what was the total time you took for those breaks? \_\_\_\_\_

If you engaged in another activity after training, please specify:

Magazine: \_\_\_\_\_

Sudoku: \_\_\_\_\_

Word Puzzle: \_\_\_\_\_

Computer Game (i.e. Solitaire, Pinball): \_\_\_\_\_

Other: \_\_\_\_\_

**APPENDIX E: TIMING AND ACTIVITIES FORM – COURSEWARE  
TRAINING TIME DATA**

### 3

#### TC3 Courseware Training

You have one hour to complete the courseware training. Please record the time you start the training. You must complete *only the following three* modules of the courseware: Hemorrhage Control, Airway Management, and Breathing. When you complete the training you may go back through the three modules as many times as you want for the entire one hour period. When you feel you are fully prepared for the test please record the time of training completion. If you feel that you have completed your study and you have extra time left during this one hour study period, you may take a break and pick up a magazine or engage in another activity of your preference but you can not leave your seat or distract other people studying.

Start Time \_\_\_\_\_

Finish Time \_\_\_\_\_

Number of times went over the hemorrhage control module \_\_\_\_\_

Number of times went over the Airway Management module \_\_\_\_\_

Number of times went over the Breathing module \_\_\_\_\_

If you took any breaks during the training , what was the total time you took for those breaks? \_\_\_\_\_

If you engaged in another activity after training, please specify:

Magazine: \_\_\_\_\_

Sudoku: \_\_\_\_\_

Word Puzzle: \_\_\_\_\_

Computer Game (i.e. Solitaire, Pinball): \_\_\_\_\_

Other: \_\_\_\_\_

**APPENDIX F: TIMING AND ACTIVITIES FORM – COURSEWARE  
AND GAME TRAINING TIME DATA**

# 3

## TC3 Courseware and Game Training

You have one hour to complete the courseware and game training. Please record the time you start the courseware training. You must complete *only the following three* modules of the courseware: Hemorrhage Control, Airway Management, and Breathing. After completing the courseware training, record the time of completion. Proceed to play *only the following three* single casualty scenarios of the game: Amputee, Chest Wound, and Maxofacial Wound. Record the time you start playing the game as well as the completion time. When you complete the training you may go back through the three modules or play the three scenarios as many times as you want for the entire one hour period. If you feel that you have completed your study and you have extra time left during this one hour study period, you may take a break and pick up a magazine or engage in another activity of your preference but you can not leave your seat or distract other people studying.

Start Time Courseware \_\_\_\_\_

Finish Time Courseware \_\_\_\_\_

Number of times went over the hemorrhage control module \_\_\_\_\_

Number of times went over the Airway Management module \_\_\_\_\_

Number of times went over the Breathing module \_\_\_\_\_

Start Time Game \_\_\_\_\_

Finish Time Game \_\_\_\_\_

Number of times played the Amputee scenario \_\_\_\_\_

Number of times played the Chest Wound scenario \_\_\_\_\_

Number of times played the Maxilofacial scenario \_\_\_\_\_

If you took any breaks during the training, what was the total time you took for those breaks? \_\_\_\_\_

If you engaged in another activity after training, please specify:

Magazine: \_\_\_\_\_

Sudoku \_\_\_\_\_

Word Puzzle: \_\_\_\_\_

Computer Game (i.e. Solitaire, Pinball): \_\_\_\_\_

Other: \_\_\_\_\_



**APPENDIX G: PRE-POST TEST VERSION B**

**TACTICAL COMBAT CASUALTY CARE  
KNOWLEDGE ASSESSMENT (vB)**

**Instructions:** Circle the correct answer for each question.

1. What is the primary medical care provided in Care Under Fire?
  - a) airway
  - b) spinal injury
  - c) hemorrhage
  - d) needle chest decompression
  
2. How would you identify a tension pneumothorax?
  - a) complaints of trouble breathing
  - b) progressive respiratory distress after dressing is applied
  - c) a sucking chest wound
  
3. What gauge and length of needle/catheter would you use for Needle Chest Decompression?
  - a) 14 gauge, 2inch
  - b) 16 gauge, 2 inch
  - c) 14 gauge, 3.5 inch
  - d) 18 gauge, 3.5 inch
  
4. If you are performing a needle decompression, you should tape the dressing on all four sides.
  - a) true
  - b) false
  
5. Where on the chest would you perform a needle chest decompression?
  - a) above the first rib
  - b) second intercostal space (between the first and second ribs )
  - c) third intercostal space (between the second and third ribs)
  - d) fifth intercostals space (between the fourth and fifth ribs)

**CONTINUE TO NEXT PAGE**

6. How would you identify that the casualty has a penetrating chest wound?
  - a) lack of breath sounds on the injured side
  - b) small cuts on his chest
  - c) patient complains of chest pain
  
7. What is the primary method to control life-threatening hemorrhage?
  - a) pressure bandage
  - b) hemostatic dressing
  - c) field dressing
  - d) tourniquet
  
8. What type of dressing would be indicated for a chest wall injury?
  - a) hemostatic
  - b) pressure
  - c) occlusive
  
9. If a casualty has a maxillofacial injury, in what position would you evacuate them?
  - a) recovery
  - b) supine
  - c) prone
  - d) standing
  
10. In which case would you use a surgical airway?
  - a) instead of performing CPR
  - b) in the case of inhalation injury
  - c) when the patient has a sucking chest wound
  - d) if the patient is not screaming
  
11. What signs of hemorrhage will you not be able to assess on the battle field?
  - a) rapid pulse
  - b) large pools of blood
  - c) low blood pressure
  
12. Which airway adjunct should you do as your last attempt?
  - a) combitube
  - b) King LT
  - c) cric

CONTINUE TO NEXT PAGE

13. If the wound is not an extremity wound, which method of hemorrhage control is most appropriate?
- a) tourniquet
  - b) HemCon Bandage
  - c) pressure dressing
14. Which of the below is not one of the three preventable causes of death on the battlefield?
- a) spinal injury
  - b) tension pneumothorax
  - c) hemorrhage
  - d) airway blockage

## **APPENDIX H: REACTION SURVEY – POST-TRAINING**

# 5

Participant # \_\_\_\_\_

## TC3 Training Effectiveness Survey

**Guidelines:** Read each of the following questions and circle the number that most appropriately represents your opinion.

LEARNING OBJECTIVES MET	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Now that I have completed the TC3 training, I am able to:					
Identify the signs and symptoms of hemorrhage	1	2	3	4	5
Describe the techniques required to stop life threatening hemorrhage	1	2	3	4	5
Identify the signs and symptoms of, and treatments for penetrating chest wounds.	1	2	3	4	5
Identify the signs and symptoms of, and treatments for tension pneumothorax	1	2	3	4	5
Identify compromised airway problems	1	2	3	4	5
Determine the appropriate technique required to treat compromised airways.	1	2	3	4	5
KNOWLEDGE INCREASE	None	Basic	Good	Sound	Expert
My level of knowledge and skill on TC3 before completing the training was:	1	2	3	4	5
My level of knowledge and skill on TC3 after completing the training is:	1	2	3	4	5
ON-THE-JOB CONFIDENCE	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Now that I have completed the TC3 training, I am confident that I will be able to perform the following back on the job.					
Identify the signs and symptoms of hemorrhage	1	2	3	4	5
Describe the techniques required to stop life threatening hemorrhage	1	2	3	4	5
Identify the signs and symptoms of, and treatments for penetrating chest wounds.	1	2	3	4	5
Identify the signs and symptoms of, and treatments for tension pneumothorax	1	2	3	4	5
Identify compromised airway problems	1	2	3	4	5
Determine the appropriate technique required to treat compromised airways.	1	2	3	4	5

CONTINUE TO NEXT PAGE

1  
Training

<b>EFFECTIVENESS OF MATERIALS &amp; METHODS</b>	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neutral</b>	<b>Agree</b>	<b>Strongly Agree</b>
The training was clear and easy to follow.	1	2	3	4	5
The presentation of TC3 material was effective.	1	2	3	4	5

<b>OVERALL REACTION</b>	<b>Poor</b>	<b>Fair</b>	<b>Good</b>	<b>Very Good</b>	<b>Excellent</b>
My overall rating of the training is:	1	2	3	4	5

	<b>Too Slow</b>	<b>Just Right</b>	<b>Too Fast</b>
The overall pace of the training was:	1	2	3

	<b>Not at all Relevant</b>	<b>Somewhat Relevant</b>	<b>Neutral</b>	<b>Relevant</b>	<b>Very Relevant</b>
How relevant is this training to your job?	1	2	3	4	5

	<b>Very Unimportant</b>	<b>Unimportant</b>	<b>Neutral</b>	<b>Important</b>	<b>Very Important</b>
How important is this training to your job?	1	2	3	4	5

## **APPENDIX I: TRANSFER SCENARIO**



# 6

Participant # \_\_\_\_\_

## Scenarios

**Instructions:** Please read the following scenarios, and answer the corresponding questions to the best of your ability by circling the letter of your choice.

### Scenario 1

On this evening, you are conducting checkpoint operations overlooking a major thoroughfare, in Mosul that has been a frequent target of nighttime insurgent small arms and mortar fire. As evening falls into night small car approaches the roadblock at a high rate of speed. Soldiers in the platoon fire on the vehicle disabling it. But before they are able to reach the vehicle to inspect it, you hear a rumble in the sky over head and hear an explosion. A mortar strikes the vehicle launching shrapnel toward the Soldiers.

Amid the small arms fire you witness a young 19 year-old Soldier fall to the ground grabbing his lower legs. You can see blood also pooling at his side.

Suddenly, another Soldier falls grabbing his right leg while yelling in pain.

Other soldiers in the platoon are rushing to return fire and secure the area.

The injured Soldiers are screaming for you, the medic for help. But the mortar rounds are still coming in and the small arms fire continues. The security team looks to the medic for guidance and the tired young medic must decide what to do. American lives are at stake...



The squad is establishing fire superiority at present.

You call out to the casualties and the Soldier with minimal lower legs wounds answers you, he begins to try to get up. You direct him to move himself to the CCP.

**CONTINUE TO NEXT PAGE**

The other casualty lies still in the road, you have suppressed the incoming enemy fire, you move out to him

- 1) What should your first step be?
  - a. Perform a rapid blood sweep and apply tourniquet if necessary
  - b. Move the patient to the CCP
  - c. Give the casualty pain medication

You quickly determine that he has a partial amputation to his left leg and smaller shrapnel wounds to his right leg. You apply a tourniquet.

At the CCP, you have removed his armor and taken his initial vitals and they are as follows:

LOC = altered mental status

BP= 60 palpable at carotid

R = 24 (decreased breath sounds on the right side)

P= weak and thready

- 2) What type of airway adjunct would you use on this Soldier?
  - a. None
  - b. Combi-tube
  - c. NPA
  - d. Cric

You check his tourniquet, and all the bleeding has been stopped,

- 3) What should you do now?
  - a. Leave the tourniquet as it is
  - b. Consider loosening the tourniquet, and tighten if bleeding resumes
  - c. Take off the tourniquet and try to stop the bleeding with hemostatic agents

After re-checking his breathing you find that you can no longer hear any breath sounds on the right side, and is developing progressive respiratory distress.

- 4) How should you treat the Soldier?
  - a. Do nothing
  - b. Begin CPR
  - c. Use Needle Decompressing
  - d. Reapply the occlusive dressing
- 5) If the casualty does not have a Tension Pneumothorax and you perform a needle decompression what will happen?
  - a. Creates a Tension Pneumothorax
  - b. No additional damage
  - c. Casualty goes into shock

CONTINUE TO NEXT PAGE

- 6) In needle decompression, where would you insert the needle?
- 1<sup>st</sup> intercostal space
  - 2<sup>nd</sup> intercostal space
  - 5<sup>th</sup> intercostal space

Checking for additional wounds you find the small wounds to his lower right leg.

- 7) What type of treatment should these wounds and his stump receive?
- No further treatment
  - Dressing and bandages
  - Gauze dressings

### Scenario 2

While en route to a supply point in Al Fallūjah, you hear the sounds of a not so distant battle. As the vehicle you are riding in traverses the hostile streets, streets that the S-2 has listed as "black" you start to feel a bit uneasy.

Suddenly you feel a violent shaking and a loud explosion as your vehicle hits an IED. The smell of smoke and explosives fills the vehicle burning your eyes and nose. You quickly dismount the burning vehicle to assess the current situation and observe another passenger in the LMTV that has sustained serious facial injuries, dismounting and attempting to return fire. He soon collapses with difficulty breathing.

Other members of the convoy follow hastily setting up perimeter security and begin to establish fire superiority. The PL tells you to prepare the casualty so he can be evacuated and allow the convoy to move out of the area.



The convoy is establishing security at the present and no other IED's have been identified.

- 1) Would you consider the scene safe?
- Yes
  - No
- If not please write a sentence explaining why.

CONTINUE TO NEXT PAGE

The casualty is bleeding severely from his face, his airway is threatened, but he is able to breathe.

You have moved the Soldier to the CCP and have gotten the initial vital signs.

LOC - no altered mental status  
BP - radial pulses palpable bilateral  
R - 24 per minute  
P - Strong

Observation reveals the following: large fragmentary wound to the lower right mandible with a large portion of bone and tissue missing. He also has a laceration with minimal bleeding on the upper right arm.

- 2) What type of airway adjunct would you use in this case?
  - a. None
  - b. NPA
  - c. Combi-tube
  - d. Cric
  
- 3) Given the severe facial bleeding, which of the following *would not* be used to control the bleeding?
  - a. HemCon bandage
  - b. Tourniquet
  - c. Emergency bandage
  
- 4) You can feel the Soldier's pulse in both wrists. From this you know that his blood pressure is:
  - a. Systolic over 80 mmHg
  - b. Diastolic over 90 mmHg
  - c. Systolic over 110 mmHg
  - d. Diastolic under 80 mmHg

The Soldier's vital are now  
LOC - no altered mental status  
BP - radial bilateral present  
R - 20  
P - strong

## **APPENDIX J: REACTION SURVEY – POST-TRANSFER**

*TC3 Training Effectiveness Survey*

**Guidelines:** This survey is similar to the one you completed previously. However in this survey we are interested in learning how effective the training was in helping you complete the paper and pencil scenarios. Think about your experience completing the scenarios, then read each of the following questions and circle the number that most appropriately represents your opinion.

<b>ON-THE-JOB CONFIDENCE</b>	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neutral</b>	<b>Agree</b>	<b>Strongly Agree</b>
In completing the paper and pencil scenario the training I received enabled me to:					
Identify the signs and symptoms of hemorrhage	1	2	3	4	5
Describe the techniques required to stop life threatening hemorrhage	1	2	3	4	5
Identify the signs and symptoms of, and treatments for penetrating chest wounds.	1	2	3	4	5
Identify the signs and symptoms of, and treatments for tension pneumothorax	1	2	3	4	5
Identify compromised airway problems	1	2	3	4	5
Determine the appropriate technique required to treat compromised airways.	1	2	3	4	5
<b>OVERALL REACTION</b>	<b>Strongly Disagree</b>	<b>Disagree</b>	<b>Neutral</b>	<b>Agree</b>	<b>Strongly Agree</b>
I used the skills and knowledge I acquired from the TC3 training to complete the scenario.	1	2	3	4	5
	<b>Not at all Relevant</b>	<b>Somewhat Relevant</b>	<b>Neutral</b>	<b>Relevant</b>	<b>Very Relevant</b>
The skills and knowledge I acquired from the TC3 training I received was relevant to completing the scenario.	1	2	3	4	5
	<b>Very Unimportant</b>	<b>Unimportant</b>	<b>Neutral</b>	<b>Important</b>	<b>Very Important</b>
The TC3 training I received was important in completing the scenario.	1	2	3	4	5

**APPENDIX K: MOTIVATION SURVEY – POWERPOINT**

# 8

TC3 PowerPoint Training Survey

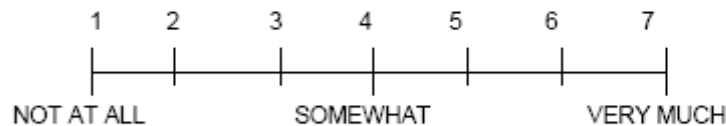
Participant # \_\_\_\_\_

NAME (optional): \_\_\_\_\_

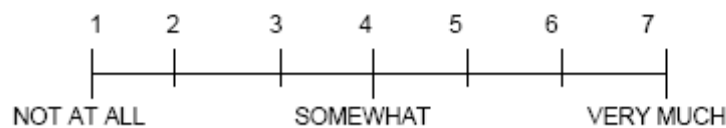
1. Did you complete the TC3 PowerPoint presentation within the one hour that you were given?
  - a. Yes (If yes, go to question 2)
  - b. No (If no, go to question 3)
  
2. If you completed the TC3 PowerPoint presentation within the one hour you were given, how many minutes did it take you to complete it? \_\_\_\_\_
  
3. If you did not complete the TC3 PowerPoint within the one hour you were given, how many more minutes do you think that you need to complete it? \_\_\_\_\_

Please circle the number which best indicates your response.

1. Did you enjoy going through the PowerPoint presentation?



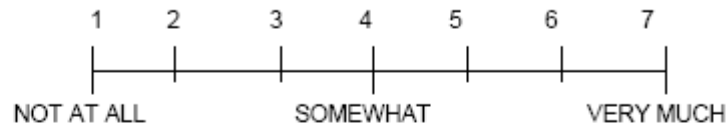
2. Would you describe going thru the presentation as a very interesting activity?



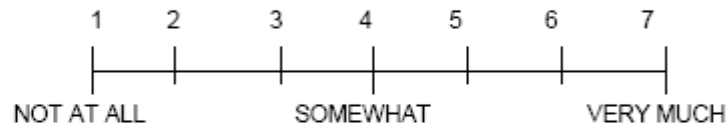
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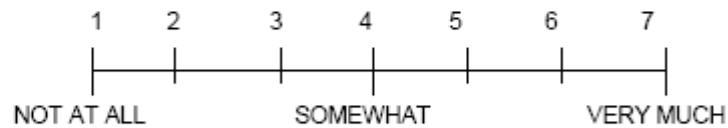
3. Do you believe that going over the PowerPoint presentation will be of some value to you in making tactical combat casualty care decisions?



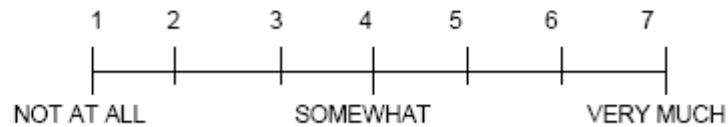
4. Would you be willing to go over the PowerPoint because you feel it could be beneficial to you?



5. Do you feel an instructor is necessary to make the PowerPoint Presentation beneficial to you?



6. Do you believe it will be of value to include this training system in the TC3 program of instruction?



**APPENDIX L: MOTIVATION SURVEY – COURSEWARE**

# 8

TC3 Courseware Survey

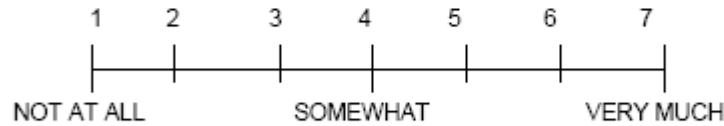
Participant # \_\_\_\_\_

NAME (optional): \_\_\_\_\_

1. Did you complete the TC3 courseware within the one hour that you were given?
  - a. Yes (If yes, go to question 2)
  - b. No (If no, go to question 3)
  
2. If you completed the TC3 courseware within the one hour you were given, how many minutes did it take you to complete it? \_\_\_\_\_
  
3. If you did not complete the TC3 courseware within the one hour you were given, how many more minutes do you think that you need to complete it? \_\_\_\_\_

Please circle the number which best indicates your response.

1. Did you enjoy interacting with the courseware?

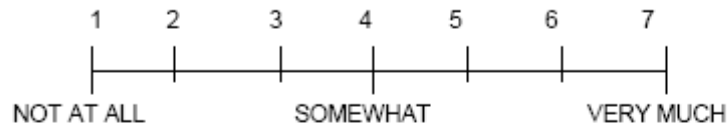


2. Would you describe going thru the courseware as a very interesting activity?

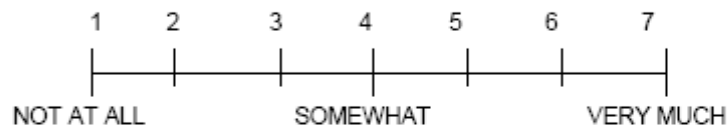


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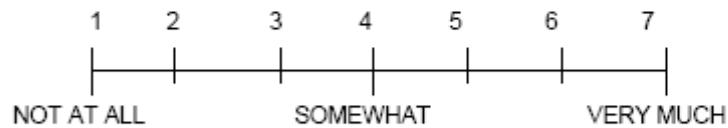
3. Do you believe that going over the interactive courseware could be of some value to you in making tactical combat casualty care decisions?



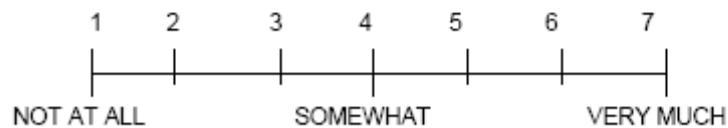
4. Would you be willing to go over the courseware again because you feel it could be beneficial to you?



5. Do you feel an instructor is necessary to make the interactive courseware beneficial to you?



6. Do you believe it will be of value to include this training system in the TC3 program of instruction?



**APPENDIX M: MOTIVATION SURVEY – GAME**

# 8

TC3 Courseware and Game Training Survey

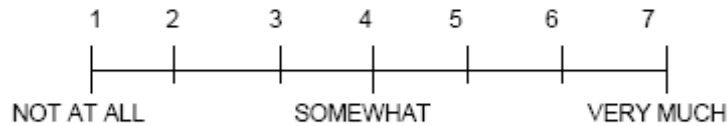
Participant # \_\_\_\_\_

NAME (optional): \_\_\_\_\_

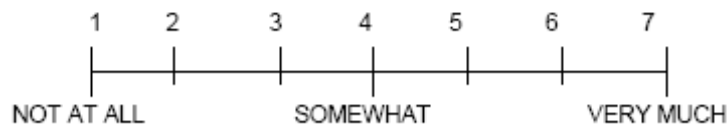
1. Did you complete the TC3 courseware and game based simulation within the one hour that you were given?
  - a. Yes (If yes, go to question 2)
  - b. No (If no, go to question 3)
  
2. If you completed the training within the one hour you were given, how many minutes did it take you to complete it? \_\_\_\_\_
  
3. If you did not complete the training within the one hour you were given, how many more minutes do you think that you need to complete it? \_\_\_\_\_

Please circle the number which best indicates your response.

1. Did you enjoy playing the TC3 simulation game?

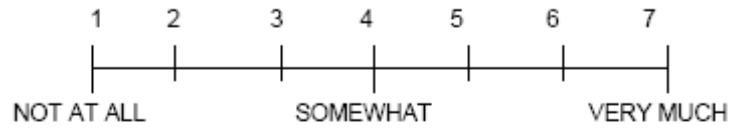


2. Would you describe playing the TC3 simulation game as a very interesting activity?

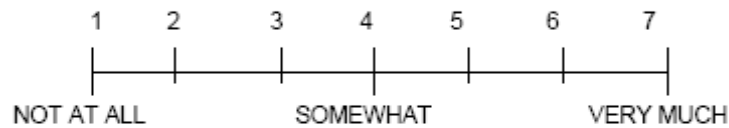


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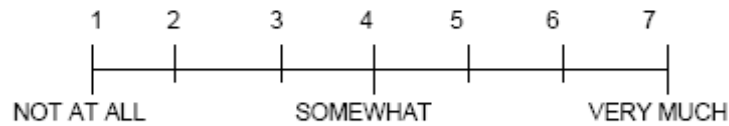
3. Do you believe that playing the TC3 simulation game could be of some value to you in making tactical combat casualty care decisions?



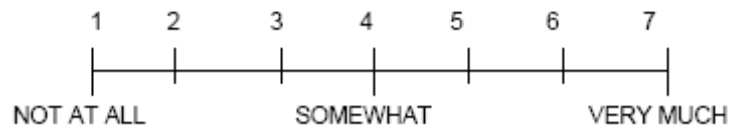
4. Would you be willing to play the TC3 simulation game again because you feel it could be beneficial to you?



5. Do you feel an instructor is necessary to make the TC3 simulation game beneficial to you?



6. Do you believe it will be of value to include this training system in the TC3 program of instruction?



**APPENDIX N: UCF IRB APPROVAL**





University of Central Florida Institutional Review Board  
Office of Research & Commercialization  
12201 Research Parkway, Suite 501  
Orlando, Florida 32826-3246  
Telephone: 407-823-2901, 407-882-2901 or 407-882-2276  
[www.research.ucf.edu/compliance/irb.html](http://www.research.ucf.edu/compliance/irb.html)

**Corrected Copy**  
**Notice of Expedited Initial Review and Approval**

From : UCF Institutional Review Board  
FWA00000351, Exp. 5/07/10, IRB00001138  
To : Teresita Sotomayor and Michael D. Proctor  
Date : March 26, 2008  
IRB Number: SBE-08-05561

Study Title: **Teaching Tactical Combat Casualty Care Using the TC3 Sim Game-based Simulation: A Study to Measure Training Effectiveness**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Chair on 3/26/2008. **The expiration date is 3/25/2009.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).  
NOTE: this study received dual review by Brooke Medical Center IRB and UCF IRB.

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at <http://iris.research.ucf.edu>.

**Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies.** The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 03/26/2008 04:55:05 PM EST

IRB Coordinator

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