Enhancing Critical Thinking Disposition and Clinical Judgment Skills in Senior BSN Students via Electronic Interactive Simulation

A Dissertation Presented for
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Dedication

I dedicate this dissertation to my family, especially to my wonderful husband, Allen, who provided continual love and support throughout my doctoral education. I also recognize the sacrifices of our sons Chris and Robert, our daughters-in-law Margaret and Michelle, and our granddaughters Kristina, Alana, Alyssa, and Kaitlyn; all have tolerated my preoccupation and encouraged me to continue. I am inspired by you all and am so proud of each of you. To all my family, I thank you for your patience and understanding during this time. I would not have been able to complete my doctoral education without you.

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Abstract

Problem

The problem investigated in this study was the lack of empirical evidence available regarding the effectiveness of electronic interactive simulation (EIS) for developing critical thinking disposition and clinical judgment skills in the senior baccalaureate nursing student.

Aim

The aim of this study was to identify an effective method of experiential learning simulation that may be independently accessed by the learner with a goal of enhancing critical thinking disposition and clinical judgment skills of senior baccalaureate student nurses (BSN).

Purpose

The purpose of this experimental study was to compare the effects of EIS to traditional paper case studies on the critical thinking disposition and clinical judgment skills, measured by accuracy and efficiency of situational decision making, of senior nursing students enrolled in baccalaureate nursing programs in the United States.

Methods

One hundred and seventeen senior nursing students completed the randomized control study by using either the EIS or paper case study learning intervention. Repeated measures ANOVA and nonparametric tests were used to test the hypotheses that senior BSN who participate in EIS of real-life clinical scenarios over a period of two weeks will experience significant increases in clinical judgment and critical thinking disposition compared to students who receive traditional paper case study simulation.

Findings

Results showed that participants who used EIS over a two-week period increased their scores for critical thinking disposition overall and on three of the subscales. Results also indicated a positive trend, greater than the comparison group, on the remaining subscales. It is noted that many scores for the Case Study group actually decreased, suggesting that this method had a stifling effect on the development of critical thinking disposition. Retention and application of learned information was apparent for both groups, however, there was a trend for a greater change in the EIS group compared to the Case Study group. Additional research is needed to explore the effectiveness of this emerging pedagogy to add to what is known about the effects of experiential learning in the healthcare professions.

Preface

"The whole of science is nothing more than the refinement of every day thinking."
Albert Einstein (1936, p. 349)

As a fairly new and enthusiastic educator, I quickly realized that my goal is not to deliver chunks of information to be swallowed whole and regurgitated by my students. My goal, my mission, is to teach them to think. To identify ways to help stimulate their desire to reflect on what they know, see, hear, touch, and feel so that they arrive at a more comprehensive understanding. Humans do not exist in a vacuum; we are holistic beings who are greatly influenced by everything that surrounds us. Nursing education must focus on more than facts, techniques, or skills. As educators, we clearly recognize the importance of experience. However, do we truly understand and recognize the importance of experiential learning?

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AACN	American Association of Colleges of Nursing
AMED	Allied Health and Complementary Medicine
AMIQ	Acute Myocardial Infarction Questionnaire
ANCOVA	analysis of covariance
ANOVA	analysis of variance
APA	American Philosophical Association
BSN	baccalaureate student nurse
BU	Bethel University
EIS	electronic interactive simulation
ELT	Experiential Learning Theory
CCTDI	California Critical Thinking Disposition Inventory
CCTST	California Critical Thinking Skills Test
CL	confidence level
CNE	Certified Nursing Educators
CTPT	Critical Thinking Process Test
ED	emergency department
HCIT	Health Care Information Technology
HSRT	Health Science Reasoning Test
IRFI	Informal Reasoning Fallacy Instrument
MSU	Murray State University
MTSU	Middle Tennessee State University
NCLEX-RN	National Council Licensure Examination for Registered Nurse
NCSBN	National Council of State Boards of Nursing
NLN	National League for Nursing
NLNAC	National League for Nursing Accreditation Commission
SBCS	screen-based computer simulation
TAI	Triage Acuity Instrument

Chapter One: Introduction

Nursing education presents many challenges, for students and educators. The sheer volume of knowledge necessary to support the science of nursing can be daunting to deliver or retain. Yet, for the student nurse, the learning process does not stop with gaining knowledge. The preparation for professional nursing includes mastering the ability to apply the knowledge gained in today's complex healthcare arena. Efforts to ground nursing actions in empirical information are often referred to as evidence-based nursing: a process requiring that empirical knowledge be integrated with an ability to reflect and reason through multiple pieces of information in order to guide actions (Winters & Echeverri, 2012). This ability, also known as critical thinking, has been formally recognized by many organizations as an important aspect of undergraduate education, including the U.S. Department of Education, the National League for Nursing (NLN), and the American Association of Colleges of Nursing (AACN) (AACN, 2008,1998; Department of Education National Education Goals 2000 Panel, 1992; NLN, 1992; Scheffer & Rubenfeld, 2000). The concept of critical thinking is not new to nursing education; scholars report that it has been recognized as an essential nursing skill for more than fifty years (Benner, Hughes, & Sutphen, 2008; Dressel & Mayhew, 1954).

The Importance of Critical Thinking in Nursing Education

Critical thinking is considered a priority in nursing education, and therefore, an essential component for professional nurse preparation (McEwen & Brown, 2002; Naber, 2011; Reed & Kromrey, 2001). The Commission on Collegiate Nursing Education (CCNE), one of the two accrediting bodies for nurse education, includes critical thinking as an outcome indicator for undergraduate baccalaureate nursing education (AACN, 2008). Nursing education's other accrediting body, the National League for Nursing Accreditation Commission (NLNAC), also offers guidelines that call for nurse educators to create learning opportunities that promote the development of critical thinking skills (NLN, 2005). One basis for these guidelines is the belief that nurses need critical thinking skills, in addition to high levels of vigilance, to detect patient status changes and make clinical judgments about which, if any, nursing interventions are needed (Buerhaus et al., 2005).

Defining Critical Thinking for the Nursing Profession

Many nursing scholars agree that critical thinking is an important, or even essential, skill. However, a lack of clarity about the concept continues throughout the nursing literature. Numerous scholars have defined critical thinking attributes and—despite multiple definitions (AACN, 2008; American Philosophical Association [APA], 1990; NLNAC, 2002; Paul, 1993; Scheffer & Rubenfeld, 2000; Turner, 2005; Watson & Glaser, 1980)—some common concepts have emerged.

Watson and Glaser's (1980) work on critical thinking focused on the ability to recognize the existence of a problem and then apply attitudes and evidence-based knowledge to support a logical course of action. The American Philosophical Association (APA) conducted a Delphi study that defined the components of critical thinking as interpretation, analysis, evaluation, inference, explanation, and self-regulation (APA, 1990). Paul (1993), a key scholar in the APA's Delphi study, advanced interpretations of the findings by proposing that critical thinking is the ability to analyze and improve the quality of one's own thinking, based on sound criteria and standards.

In an effort to formulate a consensus definition of critical thinking applied to nursing, Scheffer and Rubenfeld (2000) conducted a study using the Delphi technique to build upon the APA's definition. The resulting definition included both cognitive skills and "habits of the mind" such as "confidence, contextual perspective, creativity, flexibility, inquisitiveness, intellectual integrity, intuition, open-mindedness, perseverance, and reflection" (p. 357). The NLNAC (2002) refined existing definitions to include the idea that critical thinking is a nonlinear process that leads to clinical judgment. Like NLNAC, the AACN (2008) interpreted critical thinking as a foundation of decision making. While variation is apparent in the definitions, there are many consistent points as well. One is that critical thinking is a teachable, non-linear process that should be included in curriculum design (Benner et al., 2008). Other consistent points are the concepts of analysis, reasoning, inference, open-mindedness, judgment, and decision making (Turner, 2005). The ambiguity surrounding the meaning of critical thinking has created difficulties and Turner (2005) proposed that it remains an immature concept.

The lack of consensus in defining critical thinking in nursing practice is further complicated by, or perhaps even caused by, the terms *critical thinking*, *clinical reasoning*, *clinical judgment*, and *decision making* being used interchangeably in the nursing literature. This confuses the understanding of critical thinking and limits the ability to measure it (Alfaro-LeFevre, 2008; Benner et al., 2008). In order to understand these concepts, brief explanations and definitions are provided.

Critical thinking is a broad term that includes reasoning that occurs both inside and outside the clinical setting. Clinical reasoning is a more specific term that refers to the process of critical thinking within the clinical arena (Alfaro-LeFevre, 2008). The AACN defines clinical reasoning as "The process used to assimilate information… and make decisions regarding patient care" (AACN, 2008, p. 36). The term clinical reasoning, therefore, refers to reasoning about specific aspects of clinical care and may not extend to other decisions, such as patient room assignments or staff allocation.

The terms clinical judgment and decision making are quite different from critical thinking and clinical reasoning. While critical thinking is considered a process, clinical judgment and decision making are considered outcomes. These concepts are related: clinical judgment represents an outcome of the process of critical thinking and clinical reasoning. Further, clinical judgment identifies a conclusion, decision, or opinion (AACN, 2008; Alfaro-LeFevre, 2008). A clinical judgment is the decision a nurse makes in the context of the clinical setting to provide or not provide a given patient-care intervention. It is important to recognize that critical thinking is *how* a nurse arrives at a decision and clinical judgment is *what* a nurse decides to do. The following figure illustrates the relationship between critical thinking and clinical judgment (see Figure 1).

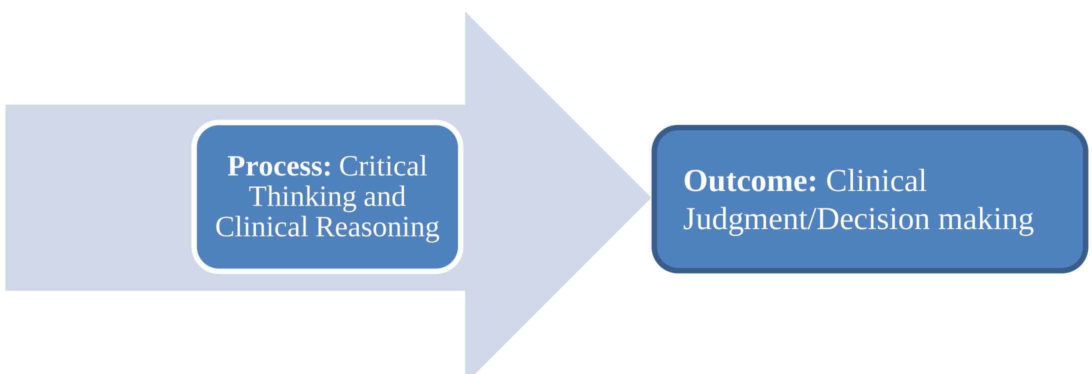

Figure 1. The Relationship between Critical Thinking and Clinical Judgment (*adapted from Alfaro-LeFevre's, 2008).*

For this study, critical thinking includes clinical reasoning and is defined as “all or part of the process of questioning, analysis, synthesis, interpretation, inference, inductive and deductive reasoning, intuition, application, and creativity” (AACN, 2008, p. 36). Also for this study, clinical judgment is defined as the “outcomes of critical thinking in nursing practice” (AACN, 2008, p. 36). Clinical judgment includes decision making that takes place in a specific clinical scenario and is defined as *situational decision making*.

Lack of Experiential Learning Opportunities in Nursing Education

Based on an assumption that critical thinking skills are important, nursing educators must create learning opportunities that encourage the use of critical thinking skills and thereby improve clinical judgments. This is especially true considering the prevalence of high complexity of care, shorter inpatient stays, and an aging population with chronic and acute illnesses. Educators recognize that experience is a necessary component for developing these skills and traditionally such experience occurred in the patient care setting. However, the shortage of nurses, nursing faculty, and clinical sites limits student access to actual patient care experiences. As the availability of clinical sites decreases, so does the time students spend in clinical learning. Another challenge for nursing education is that higher patient acuity levels are accompanied by public demand for increased practitioner proficiency, competency, and high-level thinking. Calls for increased quality and safety in healthcare from consumers, and the Institute of Medicine (Kohn, Corrigan, & Donaldson, 1999), have prompted a demand for alternative experiential learning opportunities (Cronenwett et al., 2007; Gregory, Guse, Dick, & Russell, 2007). In response to this demand, numerous experiential learning pedagogies have been studied in the nursing literature (Aebersold, Tschannen, & Bathish, 2012; Becker, 2007; Benner, Stannard, & Hooper, 1996; Bremner & Brannan, 2000; Chau et al., 2001; Farrar & Suggs, 2010; Horan, 2009; Lasater, 2007; Linden, 2008; Ravert, 2004; Rubenfeld & Scheffer, 2001).

Simulation in Nursing Education

Simulation—when used as an experiential learning pedagogy to promote critical thinking and clinical judgment skills—has increased dramatically in nursing education (Aebersold et al., 2012; Berragan, 2011; Bremner & Brannan, 2000; Cioffi, Purcal, & Arundell, 2005; Decker, Jeffries, Settles, Groom, & Dlugasch, 2010; Dreifuerst, 2009; Farrar & Suggs, 2010; Forsberg, Georg, Ziegert, & Fors, 2011; Guise, Chambers, & Välimäki, 2012; Horan, 2009; Linden, 2008; Mann, 2010; Massias, 2009). Many nursing programs are integrating simulation into their curricula; some to address the problem of diminishing acute care clinical experiences, some to teach skill acquisition and task-training, and some to develop critical thinking skills (Dreifuerst, 2009). In the absence of actual clinical experiences, simulation has given student nurses a safe environment to practice and develop critical thinking and clinical judgment skills (Jeffries, 2007).

Simulation that includes an interactive component—giving learners feedback on their clinical judgments—offers a constructivist, contextual, experiential learning environment that fosters critical thinking (Dreifuerst, 2009; Jeffries, 2006; Overstreet, 2009). Simulation also allows students to establish priorities as they make decisions and implement nursing interventions (Jeffries, 2007). Simulation includes a variety of methods, from high- to low-technology options. While many of these methods have proved effective, each has advantages and disadvantages.

High-fidelity human patient manikins offer realistic patient care experiences with programmable signs and symptoms. Manikin responses may be manipulated to provide feedback to student actions, which are further supported by peer and faculty-student debriefing (Overstreet, 2009). The high cost of high-fidelity simulation, both of the equipment itself and the faculty time required to program and operate it, may be a barrier to the use of such technology for many nursing schools (Harlow & Sportsman, 2007; Tuoriniemi & Schott-Baer, 2008; Van Sell, Johnson-Russell, & Kindred, 2006).

While paper case studies have been used in nursing education with positive results (Bentley, 2001; DeYoung, 2003; Toomy, 2003; White, 2003), their static nature may not satisfy the learning styles of today's digital natives. Computer-based simulation, designed to be accessed independently by a single user, is a mid-level technology that falls between high-fidelity patient manikins and traditional paper case studies. Computer-based reproductions are interactive, challenging, and give feedback without requiring the educator to invest time and resources to create the feedback (Dieterle & Clark, 2007). Such programs are accessible: learners who have a computer with an internet connection can use them as often as they desire. The consideration of these features and benefits lead to the question, would computer-based simulation be a sound pedagogy to enhance critical thinking skills, and thereby help enrich clinical judgment skills in nursing education?

Statement of the Problem

The professional nurse must engage in complex cognition in order to critically examine multiple variables and make clinical judgments that promote safe and effective patient care. Critical thinking, which includes reflecting on patient care within the context of each situation, is the basis for clinical judgment (Alfaro-LeFevre, 2008; Banning, 2006; Benner, Tanner, & Chesla, 2009; Daly, 2001; Facione & Facione, 1996; Kuiper & Pesut, 2004). Clinical judgment includes situational decision making and, when used to determine a nursing intervention, combines knowledge with practical patient care experience (Jenkins, 2011; Roche, 2002). Effective clinical decision making by healthcare professionals represents one of the most important contributions these professionals make toward providing safe, effective healthcare (White, 2003). Expert clinical practice requires a nurse to accurately and efficiently evaluate a patient's condition including observing relevant data. After the data are apprehended, critical thinking skills are needed to assimilate the information and determine an intervention with the aim of achieving desired patient outcomes (Lauri & Salanterä, 2002; Roche, 2002).

Because nurses need critical thinking skills to make clinical judgments while providing care, student nurses must develop a disposition, or a tendency, to think critically. The ability to think critically is part of nursing competency and a dominant trait relating to patient safety (Institute of Medicine, 2004). Yet, many students and new graduates lack the critical thinking skills, or the disposition to use these skills, needed to produce the high levels of clinical judgment required to provide safe, quality care (Jeffries, 2005a). Results of a study by Del Bueno (2001) showed that only 30% of 760 new nursing graduates consistently demonstrated the ability to recognize and safely manage commonly occurring problems while caring for their patients. An even larger study—of 10,988 nurses with less than one year of experience—showed that 76% of these new nurses failed to meet expectations for clinical judgment (Del Bueno, 2001). In addition, an evaluation of sentinel events in acute care settings indicated that such events occurred more often in areas staffed with newly graduated nurses (Joint Commission on Accreditation of Healthcare Organizations, 2006).

This deficit in students' ability to successfully transition from nursing education to full-time practice underscores the need for pedagogy that enhances the process of critical thinking and clinical judgment. More plainly, the responsibility for preparing nurses to examine situations critically lies with nurse educators. Nurse educators also recognize that, for their students to develop and use critical thinking that supports sound clinical judgments, students must gain explicit knowledge of and experience with clinical situations similar to those confronted in practice (Daly, 2001; Myrick & Yonge, 2004). However, in an increasingly complex clinical environment, students need a safe venue to practice these skills without posing harm to actual patients. Students' critical thinking skills can be refined when they practice clinical cases as a form of experiential learning, which may occur in a variety of ways. This project proposed that electronic interactive simulation (EIS) might offer the experiential learning necessary to help students develop a disposition toward critical thinking and improve their clinical judgment as measured by the efficiency and accuracy of their decision making.

Theoretical Framework

Kolb's Experiential Learning Theory (ELT) (1984) provided the theoretical framework for this study. The ELT explains the process that learners use to move beyond data memorization, or cognitive gain, and into the critical thinking arena where they reflect upon and assimilate information to support their decision making. Kolb explains his theory by saying, "Learning… occurs through the active Extension and grounding of ideas and experiences in the external world and through internal reflection about the attributes of these experiences and ideas"

(Kolb, 1984, p. 52). Two dimensions of learning, *prehension* and *transformation*, form the basis of ELT. Both of these concepts include dialectically opposed orientations that guide the Comprehension of information (Kolb, 1984). The process of learning lies in the way the adaptive dialectics are resolved and requires both a grasp of the experience and a transformation of that experience into a logical pattern of understanding. This is an active learning process that takes place during real or simulated experiences (Kolb, 1984).

Kolb's ELT describes a learning process with four stages: apprehending a concrete experience (Apprehension), reflectively observing previous explicit and tacit knowledge (Intention), forming abstract concepts of the problem to shape understanding (Comprehension), and finally testing the Comprehension in new situations (Extension). While the stages in Kolb's ELT model indicate a sequence, the process is a cycle that may be entered at any point and proceeds in the indicated sequential pattern (see Figure 2).

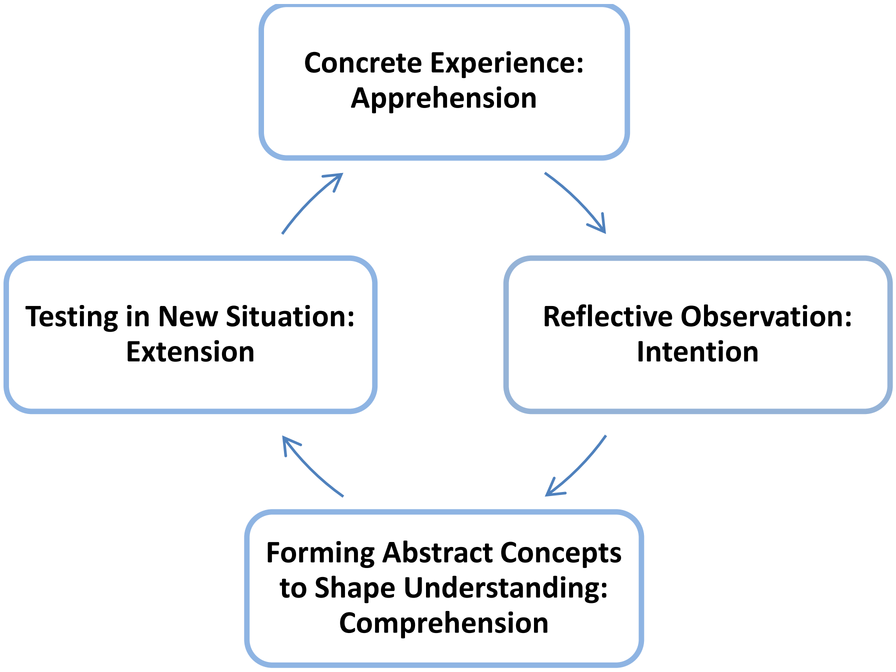

Figure 2. Kolb's Experiential Learning Cycle (adapted from Kolb, 1984)

The process continually begins again as the outcome of a previous situation is reassessed as a new concrete experience. In nursing practice, after making a clinical judgment, the nurse acts on the decision and assesses the intervention's outcome. Then, this assessment information is added to the nurse's catalog of experiences and goes on to influence future clinical judgment.

Theoretical Definitions

Prehension represents the grasp of experience through the abstract/concrete dialectic and includes the concepts of Apprehension and Comprehension.

Transformation is the active/reflective dialectic and represents two different ways of transforming the grasp of the experience (prehension), through Intention and Extension.

Apprehension is described as a way of knowing through direct experience and includes what one sees, hears, and feels. It is interaction with a concrete experience or specific event. A clinical presentation is an observable or measurable sign such as a bleeding wound, a reported symptom, or a vital sign. As an example, let's look at a triage nurse working in an emergency department (ED). This nurse apprehends that a patient reports being short of breath, appears anxious, and states having chest tightness. The nurse also apprehends that the patient is pale with vital signs within normal ranges, except for a slightly elevated pulse rate.

Intention is an internal, reflective observation that critically examines what the apprehended experience means to the experiencer. Kolb (1984) proposes that this stage includes assimilating all that is known, either tacitly or explicitly, that the individual connects to the concrete experience. This connection requires critical thinking and may be thought of as a "metaphorical bridge between information and action" (Rubenfeld & Scheffer, 2010, p. 26). Going back to the example of the triage nurse in the ED, after Apprehension, the nurse possesses several pieces of information taken from a direct external source (the patient). The nurse then combines this information with preexisting internal knowledge—including learned explicit knowledge and tacit or intuitive knowledge—through reflecting or thinking. Perhaps the nurse recalls the signs and symptoms of myocardial infarction or pneumonia and considers these scenarios as a possible source for the presenting signs. Intuitive knowledge, which may be linked to prior experiences, also may influence how a situation is interpreted. It is during intention that characteristics associated with the use of critical thinking skills, known as disposition toward critical thinking, is linked to clinical judgment.

Comprehension is the transformation of apprehended information into an abstract symbolic representation that allows a person to predict and re-create those Apprehensions. Comprehension requires assimilating the flow of information from a particular Apprehension into a coherent pattern. During the Comprehension stage, a nurse forms a theory that predicts what he or she believes will happen in the given situation. This action, the formation of maxims, statements, or ideas accepted as self-evidently true, helps the nurse understand the process in terms of prior experience and learning. This comprehension of a situation provides a framework of understanding upon which a person can make a decision based on logical, critical thinking. The clinical decision is a course of action, or as previously defined, a clinical judgment. This discussion of experience and experiential learning corresponds to Benner's work, which shows that clinical competence is guided by norms, or what is typically expected based on the given situation (Benner, 1984, 2004). Simply stated, the nurse forms an opinion of what should happen based on a logical process of critical thinking and then determines a clinical judgment regarding patient care (Comprehension). To continue the ER triage example, the nurse must decide on an acuity level that indicates how soon the patient should receive care. Based on previous knowledge of the possible signs of myocardial infarction and experience with the presentation of atypical cues, the nurse assigns the patient a priority level of 2.

Extension is the transformation of abstract conceptualization through active experimentation. It is a behavioral action that occurs after decision making. In nursing, Extension is the performance of the intervention. A nursing action or intervention based on clinical or situational decision making illustrates the stage where decision making is extended into the outside world. To complete the ER triage example, the nurse enters the acuity level (2) in the patient's record and immediately escorts the patient to an emergency room to receive treatment.

The concepts of Apprehension, Intention, Comprehension, and Extension may be adapted to describe the clinical decision-making process that nurses engage in countless times in everyday practice (see Table 1).

Table 1. Kolb's Experiential Learning Theory Applied to Clinical Judgment

Original Term in Kolb's ELT Model	**Meaning of Term when Applied to Nursing Practice**
Apprehension	Clinical presentation
Intention	Critical thinking, reflecting on knowledge and experience
Comprehension	Clinical judgment, decision making
Extension	Nursing action or intervention

Aims

The aim of this study was to identify an effective method of simulated experiential learning that could be independently accessed by senior baccalaureate student nurses (BSNs) with the goal of enhancing their critical thinking disposition and clinical judgment skills.

Purpose

The purpose of this experimental study was to compare the effects that electronic interactive simulation (EIS) and traditional paper case studies had on the clinical judgment skills of senior nursing students—enrolled in baccalaureate nursing programs in the United States—as measured by their critical thinking disposition and the accuracy and efficiency of their situational decision making,

Hypotheses

This study explored three hypotheses.

1. Senior baccalaureate nursing students who participate in EIS of real-life clinical scenarios over a period of two weeks will experience significant increases critical thinking disposition measured by the California Critical Thinking Disposition Inventory (CCTDI) (Insight Assessment, 2013) when compared to students who received traditional paper case study instruction.

2. Senior baccalaureate nursing students who participate in EIS of real-life clinical scenarios over a period of two weeks will experience significant increases in clinical judgment measured as accuracy of situational decision making by the Triage Acuity Instrument (TAI) when compared to students who received traditional paper case study instruction.

3. Senior baccalaureate nursing students who participate in EIS of real-life clinical scenarios over a period of two weeks will experience significant increases in clinical judgment measured as efficiency of situational decision making by the TAI when compared to students who received traditional paper case study instruction.

Assumptions

Several assumptions were made for this study. The first is that experience and experiential learning occur in real-life situations or through simulated scenarios. Second, that decision making is an outcome indicator for clinical judgment. Third, that accuracy in decision making is necessary to achieve expert clinical judgment. Fourth, that efficiency in decision making is necessary to achieve expert clinical judgment. Fifth, that an EIS provides at least the same level of experiential learning as other simulation methods. Sixth, that participants adhered to study protocols.

Conceptual Definitions of Terms

Critical thinking includes clinical reasoning and is “all or part of the process of questioning, analysis, synthesis, interpretation, inference, inductive and deductive reasoning, intuition, application, and creativity” (AACN, 2008, p. 36).

Critical thinking disposition is the mindset, or tendency to use critical thinking skills.

Clinical judgment is the outcome “of critical thinking in nursing practice” (AACN, 2008, p. 36).

Situational decision making is decision making in a specific clinical scenario, or a decision based on clinical judgment that determines a nursing action, which can be measured for accuracy and efficiency.

Accuracy as an outcome is a student giving the correct response to a question.

Efficiency as an outcome is the length of time a student takes to give a correct response to a question.

Experience is either the direct observation of or participation in events as a basis of knowledge, skill, or as practice derived from direct observation of or participation in events or in a particular activity (Merriam-Webster Online Dictionary, 2012).

Experiential learning is “learning… [that] occurs through the active Extension and grounding of ideas and experiences in the external world and through internal reflection about the attributes of these experiences and ideas” (Kolb, 1984, p. 52).

Simulation is a technique, activity, or device that imitates “characteristics, processes, and experiences of the real world for the purposes of teaching, acquiring, and assessing knowledge, skills, and attitudes” (Guise et al., 2012, p. 411).

Electronic interactive simulation (EIS) is a single-user, computer-based simulation software that prompts active participation and decision making from the user and provides either audio or written feedback to the user.

A *traditional paper case study* is a form of simulation, offered on paper only, that includes a written description of a clinical scenario or vignette focused on a specific problem, followed by clinical questions that require student decision making.

Limitations

Study participants were senior nursing students currently enrolled in the final academic year of baccalaureate nursing programs. Data were collected at three universities located in the Southeast United States, which may limit generalizability of the findings. Data were collected only in baccalaureate nursing programs, which may limit generalization to Associate Degree, RN-to-BSN, or Master’s programs. The study’s participant pool also may limit generalization to nursing freshmen, sophomores, or juniors. Other possible confounds were student history, student maturity level, and testing variations. The number of times and length of time that students accessed the intervention during the two-week period was not controlled and may be a study limitation. However, because the study primarily examined changes in the measures between the pretest and posttest periods, these confounds may present only a minimal concern. The primary hypotheses addressed the score changes between the two randomly created groups, not the magnitude of the pretest and posttest changes. Groups were tested two times, a strategy that can introduce the limitation of students having a history with the tests. Alternate test versions were used to reduce this limitation with the TAI instrument. The CCTDI has only one version but has established test/retest validity completed two weeks apart.

Significance to Health Sciences and Nursing

Patient safety is a primary concern for the nursing profession and a responsibility of all professional nurses. Expert clinical judgment is an important skill and an essential nursing practice component that promotes safe, accurate patient care. Healthcare problems may occur when nursing expertise is inappropriately matched to the complexity of the clinical situation (Krauskopf, 2004). Patient safety is improved when the accuracy and efficiency of clinical decisions, as outcome indicators for nursing clinical judgment, are improved. To improve a nurse’s clinical expertise in a specific situation, the nurse must have experience with a similar situation (Benner, 2004). Nurse experience may be augmented in the safe, non-threatening environment of simulation. A variety of simulation techniques replicate the essential aspects of a clinical situation so that, when the situation occurs in the real world, the nurse can apply the expert clinical judgment skills needed to act judiciously (Jeffries & Rogers, 2007). To prepare nursing students to provide safe and efficient patient care, nursing educators and researchers are always looking for new instructional strategies that expand and enhance nursing students’ critical thinking and clinical judgment skills. Simulation is one of the strategies gaining popularity in healthcare education (Aebersold et al., 2012).

Another patient safety issue important to the nursing profession is the shortage of professional nurses (AACN, 2012). While there are multiple barriers to adequate nurse staffing, increasing nursing school enrollment is a problem due to the lack of clinical opportunities for experiential learning (Bearson & Wiker, 2005; Curl, Smith, Chisholm, Hamilton, & McGee, 2007; Jeffries, McNelis, & Wheeler, 2008; MacFarlane et al., 2007; Medley & Horne, 2005). Many states are beginning to allow some percentage of simulation to replace actual direct patient care (Nehring, 2008) in their nursing programs. It is important to test the efficacy of various simulation techniques to assure that nursing students receive the experiential learning they need to attain clinical competency.

Another vital step in preparing competent, skilled nurses is teaching them the critical thinking and clinical judgment skills they need to pass the National Council Licensure Examination for Registered Nurse (NCLEX-RN). If graduate nurses do not pass this exam, they cannot enter the workforce and the shortage may continue to grow. Nursing schools and colleges have a mandate to prepare students to pass the NCLEX-RN. Both major accrediting bodies for nursing education, the AACN and the NLN, include critical thinking and clinical judgment as essential outcomes for nursing education. If simulation can be shown to provide students with skills similar to those gained during traditional clinical experience, its use in pre-licensure nursing education should be continued and possibly expanded.

Chapter Two: Review of Literature

This chapter describes the method, databases, and keywords used to search the professional literature. The findings were critiqued and organized into themes to compare and contrast current knowledge. Themes included various experiential pedagogy/teaching strategies, especially simulation and its benefits and drawbacks. Gaps in the literature were identified, as well as how this study addressed those gaps.

Literature Search Methods

A literature search was conducted of the CINAHL, PubMed, Infotrac, PsycInfo, and ERIC electronic databases using the key terms of critical thinking, critical thinking disposition, clinical reasoning, clinical judgment, and decision making. The terms *education*, *nursing education*, *teaching strategies*, *experiential learning*, *Kolb experiential learning theory* and *computer-based simulation* were added to the initial search terms. Inclusion criteria were English language, peer-reviewed, original research articles about adult populations, published between 2005 and 2012, related to the key terms. Qualitative, quantitative, and mixed-method studies were reviewed. References that provided historic information were older than the stated inclusion range. A final sample of 335 articles was retrieved and, after the abstracts were reviewed, 34 were selected for in-depth review. A variety of professional journals, including some from international sources, was included in the final group. A descendancy search of the selected articles led to additional research that met the inclusion criteria. Books and stand-alone documents published by study authors' respective organizations also were reviewed. An analysis of literature content on the concepts within the context of Kolb were evaluated and used to develop the hypotheses. A summary of each topic, including what is known and not known, is presented with recommendations for future research.

Terms in the Literature

The literature showed that experience and experiential learning are two different things. According to Kolb "learning is the process whereby knowledge is created through the transformation of experience" (1984, p. 38). When a person gives little thought to an experience, he or she is unlikely to undergo this transformation of experience or receive any experiential learning from it. In order for transformation of experience to occur, one must resolve the dialectic tensions by critically considering the information taken in and combining it with other known information and experiences through reflection. The characteristics of thinking associated with Kolb's concept of transformation of experience are often referred to as critical thinking.

The terms critical thinking, clinical reasoning, clinical judgment, and decision making often have ambiguous meanings in nursing literature. Further, critical thinking is recognized as not only a group of specific characteristics, but also as the tendency to use those characteristics. Despite such ambiguities, these terms occurred as important themes in many nursing programs (Forsberg et al., 2011) and were examined in this literature review.

Critical Thinking

Numerous attempts to define or clarify the concept of critical thinking were found in the literature (Benner et al., 2008; Scheffer & Rubenfeld, 2000; Turner, 2005). A concept analysis by Turner (2005) offered an overview of the most frequently cited definitions as well as insight into the term's changing meaning in nursing literature over time. Rodgers' evolutionary view of concept analysis was used to present the concept in a dynamic and changing environment and clarify the concept in its existing use (Rodgers & Knafl, 2000; Turner, 2005). This review included the research from 1981 to 2002; however earlier references were provided for context relating to changes in the conceptual definition. A nursing database search for the keyword *critical thinking* yielded 646 sources that included journal articles, books, editorials, and dissertations. The sample was then narrowed by excluding editorials and dissertations and non-English publications. A random sampling method identified 49 publications for the final review.

Turner (2005) found that the most frequently cited definition is from the APA's Delphi report (N=13) stating that critical thinking is "the process of self-regulatory judgment, an interactive, reflective reasoning process" (Facione, 1990, p. 274). Turner identified the second most frequently occurring definition (N=8) as one provided by Paul. Critical thinking is "that mode of thinking… in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them" (Paul, 1992, p. 1).

As early as the 1960s, researchers Watson and Glaser offered a definition of critical thinking that was cited as the third most common definition in Turner's review (N=7). Critical thinking is the "attitude of being disposed to consider in a thoughtful way the problems and participants that come within the range of one's experiences; knowledge of the methods of logical inquiry and reasoning; and some skills in applying those methods" (Watson & Glaser, 1964, pp. 5-6). Turner's (2005) analysis arrived at the following summation of other definitions that occurred less often in the literature:

> Critical thinking in nursing is a purposeful, self-regulatory judgment associated in some way with clinical decision making, diagnostic reasoning, the nursing process, clinical

> judgment, and problem solving. It is characterized by analysis, reasoning, inference, interpretation, knowledge, and open-mindedness. It requires knowledge of the area about which one is thinking and results in safe, competent practice and improved decision-making, clinical judgments, and problem solving. (p. 276).

Turner (2005) offered the insightful conclusion that the concept of critical thinking is only partially mature in the nursing literature. While some characteristics are clear, the concept does not have clear boundaries, antecedents, or consequences. Turner (2005) further proposed that a comparative analysis of critical thinking, clinical decision making, diagnostic reasoning, and clinical judgment may help clarify the boundaries of these concepts.

Recognizing that technology has increased the amount of complex information available to students, Ramasamy (2011) asserted that undergraduates need to be extremely competent in processing information logically and systematically through critical thinking. Informal logic includes informal fallacy, a critical thinking component that leads to self-deception. The term *informal reasoning fallacy* describes arguments that are psychologically persuasive but logically incorrect (Ramasamy, p. 3). Fallacies are distracting because they appear reasonable. The ability to detect such fallacies before making a decision is a characteristic of good critical thinking (Ramasamy). Characteristics or habits associated with good critical thinking skills are termed *critical thinking disposition*. One identified area of critical thinking disposition, referred to as *truthseeking*, relates to the detection of informal fallacies (Ramasamy).

Ramasamy (2011) measured the level of critical thinking ability among Malaysian undergraduates using informal logic and critical thinking dispositions. A cross-sectional survey was conducted on a sample of 189 undergraduates from three different disciplines. The Informal

Reasoning Fallacy Instrument (IRFI) and CCTDI were used as measurement tools; each showed a high reliability . Validity was not reported other than a statement that "Both tests projected good results among Malaysian undergraduates" (Ramasamy, p. 1). Findings supported previous research that nursing students scored highest on the Inquisitiveness measure and lowest on the Truthseeking measure. Ramasamy (2011) recommends that the critical thinking disposition for detecting informal fallacy in reasoning should be nurtured in undergraduate students. In addition, Ramasamy urged further research be done to detect the association between informal reasoning ability and critical thinking dispositions.

Critical thinking in nursing is an essential component of professional accountability and quality nursing care. Critical thinkers in nursing exhibit certain habits of the mind: confidence, contextual perspective, creativity, flexibility, inquisitiveness, intellectual integrity, intuition, open-mindedness, perseverance, and reflection. Critical thinkers also practice the cognitive skills of analyzing, applying standards, discriminating, information seeking, logical reasoning, predicting, and transforming knowledge (Scheffer & Rubenfeld, 2000, p. 357).

The AACN defines critical thinking as "questioning, analysis, synthesis, interpretation, inference, inductive and deductive reasoning, intuition, application, and creativity" (AACN, 1998, p. 9). In addition, the AACN states that critical thinking underlies independent and interdependent decision making (AACN, 2008).

The NLNAC offers a definition of critical thinking: "The deliberate nonlinear process of collecting, interpreting, analyzing, drawing conclusions about, presenting, and evaluating information that is both factual and belief based. This is demonstrated in nursing by clinical judgment, which includes ethical, diagnostic, and therapeutic dimensions and research" (NLNAC, 2002, p. 8).

Clinical Reasoning

Some clinical reasoning definitions focus on cognitive processes. For example, Fonteyn and Ritter (2000) define clinical reasoning as "the cognitive processes and strategies that nurses use to understand the significance of patient data, to identify and diagnose actual or potential patient problems, to make clinical decisions to assist in problem resolution, and to achieve positive patient outcomes" (p. 107).

Other definitions focus on a holistic integration of various ways of knowing that include explicit and tacit knowledge. Michael Polanyi introduced the concepts of tacit knowledge (that which is implied or simply understood and is often associated with intuition) and explicit knowledge (that which may be articulated, organized and/or stored in books, manuals or other media to share with others) (Polanyi, 1966). Considering different types of knowledge leads to another definition of clinical reasoning, "the intellectual activity which synthesizes information obtained from the clinical situation, integrates it with previous knowledge and experience and uses it for making diagnostic and management decisions" (Huhn & Deutsch, 2011, p. 5).

The foundation of clinical reasoning is a knowledge base that is used to identify problems and determine nursing interventions. Both contextual knowledge (gained from readings or classwork) and experiential knowledge (based on experiences) are necessary for clinical reasoning. In nursing education, more student knowledge tends to be contextual, due to the disproportionate amount of time they spend learning before entering clinical practice (Baldwin, 2007). Communication, diagnosis, and decision making are described as the foundation of clinical judgment and the basis for expert medical care (Kienle & Kiene, 2011).

Clinical Judgment

Clinical judgment is used interchangeably with clinical reasoning in the literature. Benner, Tanner, and Chesla (1995) defined clinical judgment as “the ways in which nurses come to understand the problems, issues, or concerns of clients/patients, to attend to salient information, and to respond in concerned and involved ways” (p. 2). Tanner (2006) developed a model of clinical judgment in nursing practice that includes the phases of noticing, interpreting, reflecting, and responding. Tanner’s model acknowledges the influence of the nurse’s experience, which includes explicit and tacit knowledge, and its influence on clinical judgment (Lasater & Nielsen, 2009). This closely aligns with Kolb’s (1984) model of experiential learning that requires not only taking in information but assimilating it with previous knowledge and experience as a basis for decision making.

The basis for clinical judgment is the ability to group cues together in patterns that represent clinical conditions. For students, beginning clinical reasoning depends on their ability to recognize the cues from the client's presentation that match a pattern of cues typical of a clinical condition they have already learned. Novice student nurses operate on the level of recognizing and applying a cue pattern. However, extraneous cues may cause uncertainty or require unnecessary attention, thereby delaying action. More experienced nurses continue to sift quickly through ambivalent cues, recognizing what is or is not important, to support or refute their decisions. Compared to students or novice nurses, experienced nurses demonstrate a greater use of cognitive skills and reflective thinking, both of which are necessary for good clinical judgment (Baldwin, 2007; Kuiper & Pesut, 2004). Clinical judgment is an outcome of the critical thinking process that requires both experiential and contextual knowledge.

Pedagogy/Teaching Strategies

The majority of research conducted on educational methods used for improving clinical judgment has focused on the deliberative and analytic application of scientific knowledge. In the complex world of nursing, expert clinical judgment goes beyond the analytic process to include the holistic and intuitive responses gained through experiential learning (Benner, 1982). Kolb's ELT (1984) posits that Comprehension occurs when all information, tacit or explicit, is assimilated into a coherent pattern. This pattern then becomes a framework of understanding upon which one can make a decision based on logical, critical thinking. Pedagogy aimed at improving Comprehension, the framework for clinical decision making, was reviewed.

Thompson and Stapley (2011) conducted a systematic review and meta-synthesis of educational approaches aimed at improving nurses' clinical decision making. In their review, cognition and judgment are defined as integral parts of clinical decision making. Twenty-four studies were included in the synthesis and the stated purpose was "to establish the efficacy and effectiveness of educational interventions designed to improve novice (students) and experienced nurses' judgment and decision making" (Thompson & Stapley, 2011, p. 882). The study included an adequately defined sample and controlled for study type in the analysis. The results included three randomized controlled trials, 12 pretest/posttest studies with comparison groups, two historical comparison studies, and seven pretest/posttest studies without comparison groups. Studies were excluded if they did not contain pretest data, original research, or a focus on educational interventions for nursing judgment or decision making. The authors concluded that the educational interventions targeted several key elements required for quality decision making and clinical judgment: critical thinking, diagnostic reasoning, and ethical reasoning. Researchers noted that, while the interventions proved worthy for other disciplines such as medicine, the results for nursing judgment were inconclusive. It is noteworthy that only three random controlled trials were available and the review demonstrates a lack of randomization in dealing with confounding variables. A lack of research that is framed in experiential learning theory is evident in this meta-synthesis. The researchers concluded that the interventions used to develop nursing judgment and decision making are numerous and varied, and their effectiveness is inconsistent.

Case Studies

A mainstay and one of the earliest teaching methods of experiential learning is the traditional paper case study. The use of case studies in education has been documented for more than 100 years. The typical use is to apply theories and didactic content to simulations of potential real life events (Toomy, 2003). Case studies may be in-depth descriptions of an entire scenario or more detailed vignettes that focus on a specific problem. DeYoung (2003) asserts that the use of case study allows learners to apply their previous experiences to a new learning opportunity. Several scholars assert that case study learning improves problem solving, decision making, critical thinking, and self-directed learning (Bentley, 2001). Earlier studies showed that using case studies for problem-based study increased enthusiasm and motivation in nursing (White & Von Riesen, 1992).

Debriefing

The reflective thinking and feedback that occurs after an educational experience (also known as debriefing) may be the key to any experiential learning exercise. One mainstay of nursing education is the case study with verbal analysis. Several studies described a teaching methodology that included presenting the student with a scenario and then asking them to "think aloud" as they work through the clinical problem (Corcoran, 1986; Offredy & Meerabeau, 2005; Tanner, Padrick, Westfall, & Putzier, 1987). Thinking aloud allows learners to analyze how they arrive at a decision, which offers a means of practicing critical thinking. In addition to providing verbal accounts of the critical thinking process, interpretation of narrative accounts—and how such interpretation effects critical thinking skills—has been studied with positive results (Benner, et al., 1996; Kosowski & Roberts, 2003; Ritter, 2003; White, 2003).

One researcher, Overstreet (2009), conducted a qualitative study to explore and describe the current practices of debriefing after nursing clinical simulations. The researcher used a case study approach with a purposive sample of four cases. The data were analyzed and—along with the four established patterns of "structure, communication, time, and emotion"—three new patterns emerged: "accentuate the positive, higher order thinking, and experience counts" (Overstreet, 2009, p. 82). The identification of these new patterns provided a foundation for researchers and educators to expand their research and practice. Case study design is a good choice in areas where little is known about the phenomenon and multiple sources are to be studied (Yin, 2003). In order to identify communication patterns that hinder reflection and meaning making, *process* (defined as time spent in certain aspects of exchange) was operationalized to mean the amount of time the educator dominated the conversation and *content* was defined as what the educator discussed. Regarding content, Overstreet (2009) observed that students displayed decision making in the simulation and then noted that the debriefing allowed them to recall specific events that led to their decisions. Debriefing provided a second recall where students could deconstruct how they arrived at their decision, recognize and learn from the experience, and arrive at the state Kolb (1984) described as Comprehension. Overstreet discovered a limitation of the study in analyzing the debriefing process. Because the researcher's initial plan was to focus on the educator for process and content during the debriefings, the videotape did not fully capture students on film. Overstreet subsequently realized that debriefing is a process between educators and students and the study should focus on both participants. To achieve this, Overstreet analyzed students' tone of voice and posture during the debriefings using triangulation, student questionnaire answers, and research field notes. She then added this data to the findings (Overstreet, 2009). Debriefing is a process that deconstructs and reflects on an experience in order to better understand how a decision was reached and identify and refine effective strategies for future decision making.

Simulation

Games and simulation have been used successfully in childhood and adult education, military training, and numerous business applications (Peterson, 2012). The use of simulated experiences for training purposes has been documented as early as World War II when pilots trained for difficult maneuvers using flight simulators (Scherer, Bruce, Graves, & Erdley, 2003). The purpose of such simulations is to enhance, in a safe environment, pilots' skill and experience in reacting to crises (Hotchkiss & Mendoza, 2001). The practice continues today in military, private, and commercial flight training.

Simulation first appeared in the health industry in the 1960s when Laerdal developed a torso manikin to teach cardiopulmonary resuscitation skills (Bradley, 2006; Travis, 2010). During this same decade, a reactive simulator was developed to help anesthesia students gain necessary psychomotor and decision-making skills (Hotchkiss & Medoza, 2001). Spurred by the advent of technology and the World Wide Web during the 20th century, healthcare education rapidly transformed to include simulation, particularly the use of highly sophisticated human patient simulators (Jeffries & Rogers, 2007). Whether for the airline passenger or the healthcare patient, safety is a driving force behind simulation (Schiavenato, 2009).

Defining Simulation in Healthcare Education

In healthcare education, simulation is described as a technique, activity, or device that imitates "characteristics, processes, and experiences of the real world for the purposes of teaching, and acquiring and assessing knowledge, skills, and attitudes" (Guise et al., 2012, p. 411). Quite simply, simulation is an attempt to replicate some aspect of reality (Schiavenato, 2009).

Simulation has been identified as an effective teaching strategy to improve skill performance, enhance cognitive knowledge gain, and promote positive learner attitudes in nursing students (Jeffries & Rizzolo, 2006; Lasater, 2007; Radhakrishnan, Roche, & Cunningham, 2007). Typically, simulation presents a mock clinical situation and the delivery method can range from low-technology case studies to high-fidelity, realistic, and sophisticated human patient simulators (Dobbs, Sweitzer, & Jeffries, 2006). Although development of psychomotor skills is one application of simulation, the focus of this study is limited to simulation used to develop abilities associated with the critical thinking skills needed for clinical judgment. Specifically, this research is aimed at cognitive knowledge gain and positive attitudes regarding confidence in decision making.

An important moderating variable for simulation is fidelity, which refers to the degree of realism (from low to high) afforded by the simulation (Robertson, 2011). Low-fidelity simulation, such as a static anatomical model, is considered to lack authenticity. In other words, the student may look at it from various angles and even touch it, but there is no interaction, no back-and-forth exchange between the simulator and student. High-fidelity simulators have become increasingly realistic, mimicking physiologic signs and closely simulating real situations (Robertson, 2011; Schiavenato, 2009). Computerized high-fidelity models may be programmed to respond to the student's intervention by providing feedback on clinical judgment and decision making. Considering the many types of simulation and the importance of the moderating variables, one standard definition of simulation simply does not accomplish more than the global definition of an imitation of reality. Many different types of simulation are described in the nursing education literature. Following is an overview of the various types along with examples of each.

Simulation Used to Promote Critical Thinking in Nursing Students

The lack of an adequate number of clinical visits and/or sites is an identified barrier to traditional clinical experiential learning. Therefore, various forms of simulation are being used to augment healthcare providers' clinical experiences. Junior-level nursing students were the target of research conducted by Brannan, White, and Bezanson (2008). A prospective, experimental, pretest/posttest comparison group design was used with a convenience sample of 107 students. The independent variable was instructional method. Dependent variables included cognitive skill levels and confidence in treating a patient with acute myocardial infarction. The comparison group received traditional classroom instruction that included a two-hour lecture of course content. The intervention group received the exact same content in a series of five 20-minute high-fidelity simulations and then completed clinical decision-making questions. Cognitive skill was measured using two parallel measurement tools. The Acute Myocardial Infarction Questionnaire (AMIQ) and the Cognitive Skills Tests were developed by Brannan et al. (2008) to compare the two groups. Each test contained 20 multiple-choice questions, was reviewed by two education experts, and was tested in a pilot study of 16 nursing students. Reliability was established using the Pearson *r* correlation coefficient ($r = 0.59$, $p = 0.02$) and based on the split-half method to assess agreement between the parallel forms. The Spearman-Brown reliability coefficient of 0.74 indicated that the forms were internally consistent. An established tool was used to measure confidence level (CL); the internal consistency of the CL tool ranged from a Cronbach's alpha of 0.95 to 0.97 across both groups for pretesting and posttesting. Study results indicated a significant increase in the intervention group's cognitive skills but no statistical difference in confidence levels. Limitations of the study include the fact that the groups were not randomized and were considered similar.

Horan (2009) also measured the effects of high-fidelity simulation on critical thinking in undergraduate nursing students. In this study, students received a combination of pre-simulation lectures, short 20-30 minute simulations, and a post-simulation debriefing. The 57 student participants completed a survey to gauge the magnitude of their perceived growth in critical thinking skills. Ninety-one percent of students indicated that simulation had enhanced their critical thinking skills. A limitation of this study is that the subjective ratings lack the reliability and validity of alternative measurement approaches that are based on norm or criterion referencing (Horan, 2009). However, self-report of increased growth in critical thinking may reflect an increase in self-confidence.

Ravert's (2008) study focused on the relationship between participation in high-fidelity simulations and critical thinking gains. The study consisted of 64 baccalaureate nursing students randomly assigned to one of three groups: two interventional groups and one comparison group. Traditional lecture and small group discussions comprised the intervention for one group while the second intervention group received traditional lectures and high-fidelity simulation. The comparison group attended only scheduled lectures. Pre- and post-intervention tests were administered using the CCTDI and the California Critical Thinking Skills Test (CCTST). Both tests have established validity and reliability for non-discipline specific instruments. No statistical differences were identified between groups, suggesting that simulation is not superior to the other instructional strategies. Ravert (2008) cautioned that the critical thinking instruments were not designed specifically for nursing students and recommended the development of a tool to measure critical thinking skills among nursing students.

Although Ravert (2008) found no significant differences between the use of simulation and other strategies, Massias (2009) reached different findings. In a quantitative, quasi-experimental research design, Massias (2009) compared the ability of high-fidelity simulation and traditional hospital-based clinical learning experiences to develop critical thinking skills. The participants were 22 associate-degree senior nursing students, non-randomly assigned to one of two groups. The nonrandomized convenience sample was a limitation as it carries the risk of a self-selection bias. The comparison group attended a two-day, hospital-based traditional clinical assignment; the experimental group participated in a two-day, reality-based high-fidelity simulation. A pretest and posttest were completed using the Critical Thinking Process Test (CTPT). According to Massias (2009), the CTPT has a reliability coefficient of 0.75 and is used in nursing programs nationwide with “a high-degree of validity as nursing content experts construct it using national standards and guidelines outlined by the National Council of State Boards of Nursing (NCSBN) and the NLN” (p. 15). The only significant difference in the CTPT scores ($p < 0.05$) occurred in the CTPT Writing subscale. Massias (2009) proposed that the lack of significant differences in the remaining CTPT scores suggested that simulation is at least as effective as traditional clinical experience in promoting critical thinking and implies that the nursing profession should consider expanding the use of simulations as a substitution for clinical experience (Massias, 2009).

Combining clinical simulation with more traditional instructional strategies to determine the combined program’s effect on the cognitive aspects of critical thinking was the focus of Linden’s (2008) study. This quasi-experimental design randomly placed 97 associate-degree nursing students enrolled in their first clinical course into either a comparison or experimental group. Both the comparison group and experimental group received the usual pre-class assignments and attended lectures. The experimental group also participated in simulations of class material. All participants completed a posttest consisting of 23 multiple-choice items. Linden reported a significant increase ($p < .000$) in cognitive learning outcomes for the experiential group versus the comparison group. One limitation of this study was the use of the new instrument. Although Linden reported that the instrument was reviewed by three psychometric test development experts and found to have content validity, it had not been thoroughly tested for reliability and validity. Another potential limitation, not addressed by the researcher, was the lack of a control to address the extra instruction time the experimental group received during their simulation time.

Based on the assumption that critical thinking is a purposeful, goal directed thinking that uses a scientific method for making judgments, Becker's (2007) study focused on problem solving as a part of critical thinking. In a quantitative, quasi-experimental design, a sample of 128 participants was randomly assigned to either a problem-based, face-to-face *case analysis* learning group or a problem-based *patient simulator* group. The comparison (case analysis) group analyzed case studies similar to the high-fidelity simulations administered to the experimental (patient simulator) group. The research used the CCTST and the Critical Thinking Coding Form (Kamin, O'Sullivan, Younger, & Deterding, 2001) as both instruments have established validity and reliability. Results indicate that simulation produced significantly ($p < .01$) more critical thinking during the problem solving and integration phases than the face-to-face method. Limitations for this study included the fact that recruitment was voluntary and the same case studies were used repeatedly allowing for the possibility that information may have been shared between participants. Another limitation, offered by Becker (2007), was that some participants might have anticipated that something would go wrong during the simulation and this anticipation may have affected their reactions.

A recurring limitation throughout the literature on simulation was that the tools used to measure aspects of critical thinking were not specific to nursing education and may not accurately reflect changes in clinical judgment. Lasater (2007) also explored the effect of high-fidelity simulation on the development of clinical judgment in student nurses. Based on Tanner's

Clinical Judgment Model (Tanner, 2006), Lasater developed a tool to assess students' clinical judgment. A mixed-method design tested four dimensions of clinical judgment: confidence, aptitude, skill, and experience. The researcher found a positive correlation for the use of high-fidelity simulation in developing clinical judgment skills in baccalaureate nursing students. The author developed a rubric to assess clinical judgment that was used in this study.

Robertson (2011) considered the effect of simulation on nursing students' critical thinking, confidence levels, and learner satisfaction attributes. Robertson queried the AMED (Allied Health and Complementary Medicine), ProQuest, and CINAHL databases for research using simulation, nursing, and education as keywords. The search was limited to English studies published within the previous five years. Seventeen of the 36 returned research articles and dissertations were selected for review; an additional three non-research, internet-based references also were included (Robertson). Conclusions based on Robertson's review include that simulation is popular and continuing to increase within nursing education as a means to promote experiential learning. Research supporting simulation effectiveness is mixed; many studies support the use of simulation to enhance students' critical thinking and self-confidence. However, Robertson identified the lack of effective evaluation instruments as a limitation for many of the studies. Available instruments frequently focus on the cognitive domain and use student self-reporting to assess a simulation's effect on critical thinking (Farrar & Suggs, 2010; Horan, 2009; Robertson). Recommendations from this review included "the need to develop and test holistic tools to formally assess the impact of simulation on student learning" (Robertson, p. 58).

It is apparent from the research that the past decade has focused on various forms of simulation to meet a variety of student learning outcomes. In his research paper, *To Simulate or Not to Simulate: Modern Day Nursing Education's Compelling Question*, Robertson (2011) summarizes the situation well in a statement that begins "The unparalleled recognition that simulation has received in the educational literature… " (p. 53). Indeed, the predominance of recent educational research focuses on simulation as a means to provide experiential learning. The use of simulation and the technology linked to it continues to grow for healthcare education, including nursing, and ranges from low- to high-fidelity simulation (Tanner, 2006). The enthusiasm for simulation is reflected in its exponential growth in nursing curricula. As a result, the past decade has seen numerous research efforts that attempt to establish a connection between simulation and the student attributes of cognitive skills, confidence levels, critical thinking skills, and overall satisfaction. Although simulation is a hot topic for nursing education research, terminology defining specific types of simulation is vague or not addressed. In addition, its effectiveness in producing specific learning outcomes remains inconsistent. The following section explores the nursing literature for various types of simulation and their intended outcomes.

Types of Simulation Used in Nursing Education

Paper and video-based case studies/vignettes are considered the lowest technology form of simulation (Chau et al., 2001; Johannsson & Wertenberger, 1996). Anatomical models have long been used in healthcare education (Nehring & Lashley, 2009). One example is the anatomic arm, also known as a part task trainer, used to help nurses learn to give intramuscular or subcutaneous injections. Actual role-playing—with students acting out an open-ended script with simulated patients and environments—is described as a type of simulation by Zavertnik, Huff, & Munro (2010). Full human patient simulators allow students to practice skills and judgment (Nehring, Ellis, & Lashley, 2001; Nehring & Lashley, 2004). Games may also be used as simulation for training purposes and are available in low- and high-fidelity formats (Royse & Newton, 2007). While the variable of fidelity has been studied, the responsibility that accompanies the nursing role may be the variable that provides the educational value in a simulation (Campbell & Daley, 2009). One example is the board game entitled, *Friday Night in the Pediatric Emergency Department.* In the game, students play the role of a nurse responsible for the assessment, care, and treatment of the simulated patient (Baldwin, 2007). As a board game, it is considered a low-fidelity simulation, yet players report positive results for developing decision-making skills in leadership roles (Baldwin, 2007). In another study, Bremner and Brannan (2000) describe a clinical decision-making simulator as an innovative means to enhance decision-making skills. Using a gaming approach to facilitate knowledge acquisition and provide experience in synthetic environments opens the door to multiple formats and pedagogy. Yet another simulation delivery method is computer-based systems (Giddens, 2007). Computer-based learning systems range from the static presentation of knowledge to interactive systems that require the learner to apply clinical judgment in order to make clinical decisions.

Electronic gaming is not new to nursing education, though a search of games or gaming in the nursing literature yielded few results. The addition of the word *simulation* uncovers game-based applications. This oddity may represent a subliminal effort by researchers to convey more serious research intent than when the term *games* is used alone. Additional terms noted include educational gaming, e-games, and games for health. While terminology may not be consistent, the basis for computer-based simulation does have some qualifiers. Computer-based simulation is a computer -based program designed for an individual player that includes many aspects of computer-based gaming. Games provide a risk-free space to apply learned knowledge in a virtual environment. Werth and Werth (2011) describe gaming as an educational strategy that includes delivering small chunks of information with interactive, trial-and-error activities that allow risk-taking in a safe environment. A typical computer-based simulation offers a continuous feed of problems, or descriptive case studies, that invite the player to determine a course of action that prompts the program to deliver feedback about that course of action. A scoring method may be available with an option to compete with other players in the virtual world. This type of learning offers independence, self-direction, and applicability of learned knowledge in a context that is familiar to today's learner. Computer-based simulation games are interactive, challenging, and give feedback without requiring the educator to invest additional time and resources in creating the feedback responses (Dieterle & Clark, 2007).

A variety of gaming applications have been found effective including one in a study with midwifery students (Cioffi et al., 2005) and one with pediatrics students (Cowen & Tesh, 2002). Gaming simulations can present ethical dilemmas that participants must navigate (Metcalf & Yankou, 2003; Sloane & Holmes, 2009). The focus remains on finding better ways to enhance both tacit and explicit knowledge by developing higher levels of thinking.

As a motivating learning environment, gaming simulation may stimulate higher order cognitive skills and improve a learner's situational decision-making skills (Eastman, 2002). In a seminal study by Morrison, Kelly, Moore, and Hutchins, (1998) eight expert U.S. Navy tactical decision-making teams used a gaming simulation to develop expertise in applying tactical decision-making skills. Results from the study indicated that simulations increased the proficiency of novice decision-makers and facilitated the development of expert decision-making skills (Morrison et al., 1998). Problem solving precedes decision making and is a target skill for many computer-based simulations. Some nursing schools and colleges are testing curricula based on prototype programs. McMaster University's School of Nursing indicated positive results from a seven-step electronic game designed to enhance efficiency, integrate best research into problem-based learning, and promote evidence-based learning (Mohide, Matthew-Maich, & Cross, 2006).

While most computer-based simulation focuses on the development of critical thinking, clinical judgment, and decision-making skills, such simulation also is used to develop technological skills that support evidence-based practice. For example, The University of Kansas's School of Nursing partnered with Health Care Information Technology (HCIT) to develop and implement a model curriculum (Simulated E-hEalth Delivery System) with the primary objectives of developing critical thinking and problem-solving skills (Warren, Connors, & Weaver, 2002).

Computer programs that use avatars, a personalized graphic representing the computer user, place the learner in a virtual world where they interact with other avatars or environments created by other users. An example of this phenomenon is the virtual world known as Second Life© by Linden Research, Inc. Such technology is gaining acceptance as a method to interact with virtual clinical scenarios or other individuals in an anonymous space.

While the intent of these applications varies, many have the same pedagogy. The single-user format targets adult learners who are self-directed and motivated to learn a skill independently. However, experiential learning continues to be emphasized using feedback. This feedback may occur in a variety of ways including through intelligent agents, wizards, balloon help, or other pop-ups that are programmed to appear at appropriate times in the scenario to advise learners on data relationships or a need to shift attention.

Morey (2008; 2012) conducted a study to look at the impact of animated pedagogical agents—a lifelike "onscreen character who communicates with learners by providing feedback, guidance, and encouragement" (Mayer, 2005, p. 211). This mixed-method experimental study sought to determine if web-based animated pedagogical agents facilitate critical thinking in senior students in associate-degree nursing programs (Morey, 2008). An experimental, pretest/posttest, randomly-assigned comparison group design guided the study. The comparison group was given case studies and the experimental group was given a web-based program that included an animated pedagogical agent. These agents are similar to those developed for entertainment applications: they are lifelike and believable, and produce behavior that appears natural and appropriate to the user (Morey, 2008). The CTPT was used to measure critical thinking skills. Pre-think-aloud and post-think-aloud techniques were coded and analyzed by faculty using a rating tool and rubric to assess eight cognitive processes and critical thinking levels. Although some findings were not significant, there was a 79% increase in critical thinking indicators for the experimental group compared to 57% in the comparison group. Although this study provided mixed results, there appears to be some support for the use of a pedagogical agent to facilitate critical thinking in nursing.

Simulation Benefits for Teaching and Learning

Simulation has many benefits. Simulation is founded on adult learning principles and incorporates learners' critical reflection of actions and experiences (Brookfield, 1985; Galbraith, 2004; Peddle, 2011; Rutherford-Hemming, 2012; Waldner & Olsen, 2007). From a task-oriented view, human patient manikins or task trainers support skills learning by allowing student-paced practice (Ker & Bradley, 2007; Ziv, Wope, Small, & Glick, 2003). As an instructional/learning tool for critical thinking and clinical judgment, simulation offers a dynamic, active, and reflexive experience where the focus is as much on the importance of professional identity construction as skill attainment (Berragan, 2011).

Nursing scholar, Pamela Jeffries, found that her case study expertise (Jeffries, 2000) was a natural fit for expanding that pedagogy into simulation (Jeffries, 2005a, 2005b, 2006, 2007, 2008). An expansion of her critical care specialty led to her work in teaching cardiopulmonary assessment skills and preparing critical care nurses (Billings, Jeffries, Rowles, Stone, & Urden, 2002; Decker et al., 2010). The other foci of her simulation work are collaborative practice and transforming nursing education (Jeffries et al., 2008; Skiba, Connors, & Jeffries, 2008). Active learning encourages self-directed learners to connect concepts and function at higher levels of expertise (Jeffries, 2005a). Immediate feedback on performance is shown to increase self-confidence and enhance critical thinking as it helps learners recognize the consequences of their decision making (Issenberg & Scalese, 2004; Overstreet, 2009).

Perhaps one of the greatest benefits of simulation is its value as a means to promote the knowledge and skills necessary for ethical practice (Ker & Bradley 2007; Ziv et al., 2003). Through simulation, students may gain experience in complex or acute clinical care situations without risking patient care safety or quality. In this safe environment, students can test their decisions and learn from their mistakes without the fear of liability, blame, or guilt (Aggarwal et al., 2010; Ziv et al., 2003). Perhaps one of the most important benefits of simulation is that it encourages critical thinking and decision making (Campbell & Daley, 2009).

Simulation offers a rich environment to operationalize ELT and test its effectiveness for enhancing clinical judgment. Typically, simulation begins with a clinical picture, or case scenario (concrete experience) followed by transformation of the experience through self-reflection. This reflective stage includes opposing dialectical thoughts that weigh what is currently experienced (seen, heard, and touched) against what is known about similar situations from past experience, intuition, and knowledge. Finally, Comprehension of the situation occurs and a clinical judgment is made. The final step extends the judgment through the implementation of a nursing intervention. According to ELT, this step transforms the abstract stage of Comprehension by testing it in practice. Self-confidence is identified by the theory as an element that affects an individual's willingness to extend their Comprehension into an action (Kolb, 1984). During the simulation, an action defined by a clinical judgment, in the form of a decision, leads the person back to another concrete experience (what happened as a result of his or her decision).

Much of the literature on simulation in nursing education has focused on instructor-led simulations, particularly with the recent proliferations of high-fidelity patient simulation. The cost of high-fidelity patient simulators requires a substantial time and financial commitment. Although sessions should be short, the group size is typically small with assigned role-playing duties (Jeffries, 2005b). An adequate number of educators is required to facilitate the actual simulation and conduct the debriefing. Managing large classes of nursing students may require several days and allow only one care attempt by each student. Due to these constraints, educators may continue to rely on low-fidelity simulation, such as case studies, to augment experiential learning. While paper case studies do offer a patient scenario, and many offer feedback with correct answers, they may not fit the high-tech learning style of today's typical nursing student. An alternative may be a computer-based simulation that incorporates patient scenarios similar to paper case studies in an interactive gaming style format.

Durmaz, Dicle, Cakan, and Cakir (2012) conducted a study, similar to this research, to examine the effects of screen-based computer simulation (SBCS), comparable to EIS, on the clinical decision making of second-year undergraduate nursing students. In a randomized, controlled study, students were given access to the SBCS for independent use during a two-week period. While there was no significant difference in posttest knowledge scores, SBCS was found to be equivalent to case studies. Additionally, a significant difference was found in the SBCS group's complex skills and this difference was attributed to the groups' repeated use of the SBCS.

Barriers to Simulation Use

The exponential growth of simulation provides evidence that some educators are embracing it as a valid educational tool. Early barriers included a lack of knowledge about how to incorporate simulation into education and the importance of providing feedback through debriefing. Overstreet (2009) studied debriefing and found that, not only is debriefing extremely important, the way debriefing is conducted also is critical for developing reflective, critical thinking in nursing students who participate in simulated clinical experiences. Other barriers include the lack of a more comprehensive theoretical framework to support and guide the use of simulation in nursing as well as a lack of conclusive empirical evidence on its impact (Schiavenato 2009; Waldner & Olson 2007). Some simulation tools are expensive and time-consuming for faculty to implement and/or maintain (Conradi et al., 2009; Guise et al., 2012; Nehring & Lashley, 2009).

While the active learning principles that are the foundation of simulation appeal to many adult learners, some may prefer more traditional teaching methods (Peddle 2011; Royse & Newton 2007). Some scholars argued that the purposes and potential directions, goals, and outcomes of simulation are not clearly understood (Schiavenato 2009). Other scholars asserted that the provision of new examples of the use and effectiveness of simulation would overcome some of these obstacles (Brown & Adler, 2008).

Summary and Gaps in Knowledge

Kolb's Experiential Learning Theory (1984) explains that to build a framework for sound clinical judgment and decision making, the process of critical thinking must be applied to an actual or simulated experience. In nursing education, experiential learning occurs in a skills laboratory and in actual, often limited, clinical patient encounters (Overstreet, 2009). Simulation laboratories have gained great acceptance in education as a strategy to enhance clinical judgment through experiential learning. Dr. Pamela R. Jeffries has provided a sound foundation for simulation and is considered an authority in experiential nursing education, innovative teaching strategies, new pedagogies, and the use of technology in nursing (Billings et al., 2002; Decker et al., 2010; Jeffries 2000, 2005a, 2005b, 2006, 2007, 2008; Jeffries et al., 2008; Skiba et al., 2008).

Jeffries and other nurse scholars have laid a firm groundwork demonstrating that simulation is beneficial for nursing education. However, as a relatively new field of study, simulation research needs a strong theoretical base to extend research results into the design of and support for effective strategies to meet educational goals. A review of literature demonstrates a lack of research on the use of computer-based simulation, specifically EIS and its relationship to clinical judgment in the education of student nurses. Although several studies focus on simulation, no studies test experiential learning using computer-based simulation and its effects on clinical judgment skills in the senior student nurse.

In a virtual reality learning environment, educators may provide experiential learning opportunities that, through active participation, facilitate problem solving and clinical judgment in the patient's care (Kilmon, Brown, Ghosh, & Mikitiuk, 2010; Porter, 1993; Royse & Newton, 2007). The use of computer-based simulation as an educational resource—rather than simply a tool promoting a competence-based nursing role—may facilitate student nurses' ability to provide evidence-based nursing care while reflecting, synthesizing, and applying knowledge in various contexts. In addition, the simulated environment allows students to choose nursing interventions and receive immediate feedback (in the form of patient outcomes) in a safe learning environment. Computer-based simulation is convenient because it resides on any computer, making availability as simple as access to a computer with an internet connection.

The literature regarding the development of clinical judgment skills clearly underscores the nursing student's need for substantial practice with realistic patient cases. However, current educational settings and techniques do not allow for substantial exposure to realistic cases. This pedagogical void highlights the need for further study of the use of technology to enhance clinical judgment skills. An additional concern is that there is little published research on how computer or web-based simulations, particularly those that are interactive and support experiential learning, affect clinical judgment skills in the prelicensure student nurse.

Chapter Three: Methods

This study compared the effects of EIS to traditional paper case studies on the critical thinking disposition and clinical judgment skills of senior baccalaureate nursing students over a two-week period. This chapter describes the important components of the study's research design, as well as the data measurement instruments and techniques, operationalization of the variables, research questions, null hypotheses, and study procedures.

Research Design

This study used an experimental two-group randomized control trial with a level III pretest/posttest design for two dependent variables. A level III study is one that builds on previous research, uses an experimental design to test variables, and specifies the direction of the variables in relation to one another (Wood & Ross-Kerr, 2011). The hypotheses for this study proposed direction, specifically that BSN students who participated in EIS would experience significant increases in critical thinking disposition and clinical judgment skills compared to students who received traditional paper case study instruction. A randomized control trial is considered one of the highest levels of evidence for research purposes, second only to a systematic review of random control trials (Timmermans & Mauck, 2005). This design was appropriate for the study as it used a randomly assigned experimental group that completed the EIS as an experiential learning strategy and compared the findings to a comparison group. Paper case studies—an established strategy used in nursing education to develop critical thinking and clinical judgment skills—were used as the comparison intervention in this study. Both groups completed the same pretest and posttest following equal amounts of time to access the respective interventions.

Consistent with the requirements of the chosen experimental design, the researcher manipulated the independent variable, used a comparison group, and randomized participants into groups (LoBiondo-Wood, Haber, & Krainovich-Miller, 2002). The intervention was the independent variable, and the dependent variables were students' critical thinking disposition and clinical judgment measured as accuracy and efficiency of their clinical decision making. The independent variable is manipulated by presenting it in alternate formats. Both groups received the same clinical scenarios presented in alternate formats; the experimental group received a computer-based electronic interactive simulation and the comparison group received paper case studies. Both groups were able to access and use their interventions as often as they chose during a two-week period. Demographic information for gender, age, ethnicity, highest degree earned, university attending, and prior healthcare experience/knowledge was collected for correlations.

Parametric Approach for Hypothesis Testing

Anytime a parametric approach is used for hypothesis testing, such as ANOVA or ANCOVA, certain assumptions are made about the frequency distributions of the underlying raw measures of the dependent variables being analyzed (Polit & Beck, 2008). Specifically, the researcher assumed there was normality within each group, and homogeneity of variance across the groups. When the null is rejected, the assumption of normality is violated and the variances are not homogeneous. The Shapiro-Wilk test of normality is a well-respected test (Shapiro & Wilk, 1965) that was used to examine this normality assumption. The Levene test of homogeneity of variance, also a well-respected test (Levene, 1960,) was used to examine the homogeneity assumption.

As an aside, when examining repeated measures, such as comparing the pre-intervention to the post-intervention timeframes, another assumption often is made, referred to as sphericity. However, when only two repeats of a measure are made (as in this study), the sphericity assumption is not necessary.

As previously stated, the TAI has two subscales and the CCTDI has one overall and seven subscales, yielding ten dependent variables. In addition, each test was administered pre- and post-intervention for both the Case Study and EIS intervention groups. Each of these subscales, pre- and post-intervention within both groups, were examined for normality. There were two violations of normality within the pre-intervention timeframe, one in the CCTDI Analyticity subscale and one in the CCTDI Maturity of Judgment subscale (all subscale variables were $p > .05$ except for these two). Fortunately, these measures were not part of the statistically significant findings regarding the hypotheses that addressed the primary research questions. Therefore, these assumption violations are not of concern with respect to making Type I statistical errors (rejecting the null with a p value below .05 when the null should possibly not be rejected). At the post-intervention timeframe, there was only one violation of the normality assumption and it was in the CCTDI Analyticity subscale (all subscale variables were $p > .05$ except for this one). Because no statistical significance was found for this subscale when addressing the primary research questions, these results did not pose a concern. There were no other violations of normality.

The second assumption made during parametric hypothesis testing is homogeneity of variance. This assumption is made when independent groups, such as the Case Study and EIS groups, are compared. As stated above, the Levene test was used to examine the homogeneity assumption. The homogeneity of variance assumption appears to be violated in three instances. The CCTDI Open-mindedness subscale fails to show homogeneity of variance in both the pre-intervention and post-intervention, and the CCTDI Maturity of Judgment subscale fails to meet the assumption in the post-intervention (all subscale measures were $p > .05$ except in these three cases). Parametric hypothesis testing approaches are not terribly robust for detecting violations of the homogeneity of variance assumption and tend to produce *p* values that are smaller than they should be (Wilcox, 1987). However, alternative mathematical approaches have been developed for calculating *p* values that do not make the homogeneity of variance assumption. These alternative approaches stay in the parametric hypothesis testing tradition. The only downside to these alternative approaches is that they have not been fully developed to be applied to mixed-model ANOVAs or mixed-model ANCOVAs. In other words, they are more appropriate for straightforward study designs such as independent group *t* tests.

In cases where the null hypothesis is rejected when examining one of the dependent variables that address the primary research questions due to violations of the homogeneity of variance assumption, these alternative approaches are employed to double-check the results. To do this, change scores (differences between the pre-intervention period and post-intervention period) are calculated, and *t* tests are performed using these alternative approaches. The Satterthwaite approach, the most accepted of these alternative approaches, was used for this analysis (Satterthwaite, 1946).

Theoretical Structure

Kolb’s Experiential Learning Theory (ELT) provided the theoretical framework that guided the study. According to Kolb, the learning process follows a cyclical arrangement of four major concepts: (1) Apprehension, (2) Intention, (3) Comprehension, and (4) Extension. The theory explains that the process of learning lies in the way adaptive dialectics are resolved and requires both a grasp of an experience and a transformation of that experience into a resulting knowledge form. This is an active learning process requiring the participant to access a real or simulated experience (Kolb, 1984). A diagram of this study's substruction and operationalization is provided in Figure 3.

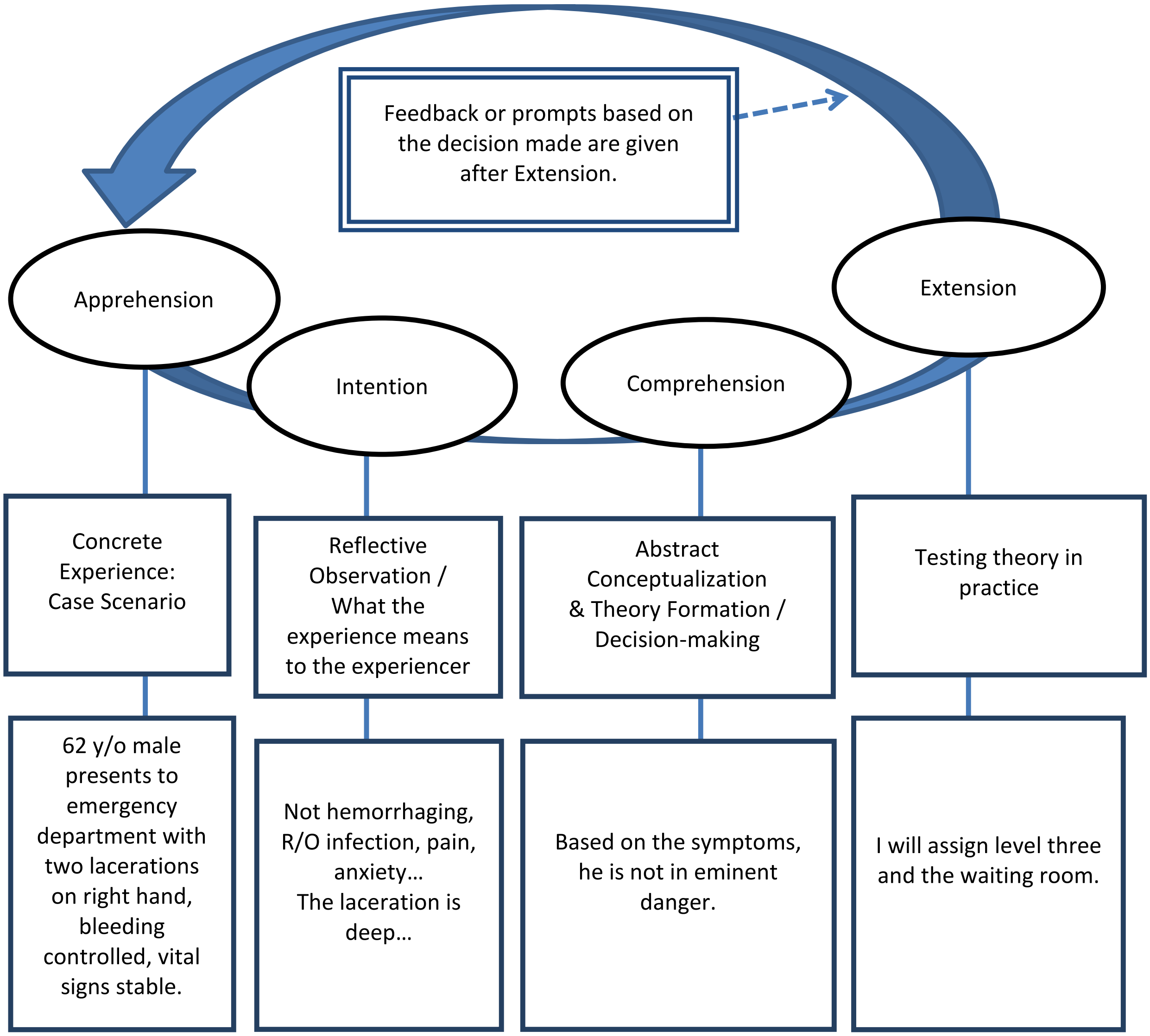

Figure 3. *Kolb's ELT Model Applied to Computer Simulation of Emergency Triage*
EIS allows learners to interact with a case study (in the form of an act or concrete experience), then reflect upon, and conceptualize what they expect to happen. The learners can then apply their comprehension by indicating a treatment decision. When learners make an incorrect or poor decision, the program gives feedback to guide them toward a better choice. The program continues to give learners opportunities to make different clinical decisions until mastery is obtained, at which time the program offers a new descriptor. Once the case study is completed, the outcomes of the learners' decisions become new concrete experiences added to their catalog of experiences

Sample

The convenience sample consisted of senior BSN students enrolled in a college or school of nursing in the United States. A power analysis was performed to determine the sample size needed to reduce the potential for a statistical Type II error. This is an a priori one-tail analysis based on predicted means for a medium effect size of .25, alpha 0.05, and statistical power of .80 (Munro, 2001). A statistical program known as G*Power 3.1.3 (G*Power, 2011) was used to calculate the estimated sample size. Based on this calculation, a minimum of 102 total participants, or 51 participants per group, was required.

Setting

To assure an adequate sample size, three universities were used for recruitment: Middle Tennessee State University (MTSU), Murray State University (MSU), and Bethel University (BU). MTSU is classified as a large four-year, primarily nonresidential public university (L4/NR); MSU as a medium four-year, primarily residential public university (M4/R); and Bethel University as a small four-year, primarily nonresidential private university (S4/NR) (Carnegie Foundation for the Advancement of Teaching, 2010).

The participants were recruited from senior baccalaureate nursing students aged 18 or older. Demographics for the selected schools of nursing indicated that students are primarily non-degree holding females under age 25 (Naber, 2011; Tune, 2010). All participants had completed their general education courses and were enrolled (full-time) in the last two semesters of their nursing curriculum. The sampling included those who graduated in the same semester as data collection and the semester following data collection.

During the senior semesters of the selected baccalaureate nursing programs, the didactic material is complex, tests require an in-depth synthesis of material, and students are expected to demonstrate safe and at least minimally effective clinical decision making. Because the study's aim was to enhance clinical judgment, recruiting students in these semesters was appropriate because they had already mastered basic information and were ready to learn to apply higher order critical thinking skills to support clinical judgment. Applying the intervention to students with beginning levels of clinical judgment—and the potential for enhancement in this ability—allowed for the possibility of achieving maximum results.

Data were collected at the MTSU, MSU, and BU campuses. On the designated date and time, the participants assembled in a classroom in each of the respective nursing buildings. Classrooms at each site had heat, air conditioning, enough desks and chairs to accommodate participants, and a quiet environment for testing or study. The computer laboratories at MTSU and MSU were used to introduce students to the experimental educational intervention and provide instructions for downloading the software. Rather than moving BU students to a computer laboratory, they used personal laptop computers, issued by the university. Restroom facilities were available in all of the buildings.

Recruitment and Consent Procedures

Following a regularly scheduled class, the instructor introduced the primary investigator or a research assistant. After the instructor left the room, the investigator/assistant described the study, how and when it was to take place, and that participation was voluntary. After potential participants' questions about the research study were solicited and answered, the students were given a written consent form that they could voluntarily complete or discard. Along with the consent form, students received printed information regarding the date, time, and place of the study. Consenting participants were reminded of this information via two email messages, one sent prior to the pretest and one prior to the posttest. The participants brought their signed consent forms on first day of the research study. For students who lost their forms but still wished to participate, additional blank forms were available immediately prior to the research study.

Demographics Questionnaire

On the first day of data collection, following collection and verification of consent forms, all participants completed a demographic questionnaire. A question that asked about specific experience, measured in months, was used as a covariate during analysis. The questionnaire was designed to identify participants who had prior triage education or healthcare experience. The questionnaire also recognized that some participants might have been exposed to triage nursing when healthcare providers related stories of clinical presentations and the actions they had taken. As an additional measure to identify and control for participants with a higher level of triage knowledge, three knowledge-based questions were included. Following completion of the questionnaire, all participants viewed a DVD containing a standardized recorded lecture about triage that explained the *Emergency Severity Index, Version 4* (Gilboy, 2012). The lecture explained why triage is important and described the algorithm used to prioritize patient care. Use of this DVD ensured that the same lecture was provided to all students.

Random Assignment to Comparison and Experimental Groups

After viewing the instructional DVD, the participants at each site were randomized into two groups. One half of the participants were randomly assigned to the experimental group and the other half to the comparison group. Randomization was achieved by having each student draw a tongue blade that was colored and numbered on one end. For example, a blade with a blue tip indicated that the participant was assigned to the experimental group and a blade with the green tip indicated that the participant was assigned to the comparison group. The numbers also indicated a group: numbers beginning with a “1” were for the experimental group and numbers beginning with “2” were for the comparison group. For example, a blue tip with the number 101 indicated the experimental group and a green tip with the number 201 indicated comparison group. Because two semesters of seniors were sampled at each site, the randomization included coding the semesters separately. Therefore, two groups at MTSU and two groups at MSU were randomized into either the comparison or experimental group, yielding eight coded groups. BU only admits students once per calendar year and only had one group of seniors. There were an equal number of blades for each of the two research groups, with a total that equaled the total number of participants. The coded blades were placed in a container that concealed the colors and numbers from the researcher, research assistant, and participants.

Students were not informed of the meaning of the colored tip or number, but were told that it was a code to provide anonymity. The student’s name and code were recorded on a participant list that was secured in a location separate from the other data. The list was used only when a student lost or forgot the code. Students were advised about the reason for the reference list and the steps taken to protect everyone’s identity. In addition, students were instructed to use the written number on their test answer sheets and not to include their name or any other identification number on the tests. If students included identifying information, the data were discarded and not included in the study. All participants were instructed not to discuss any aspect of this study or their intervention with other participants. Because students were told about this instruction during the consent process and it was included on the consent form, participants knew they were signing an agreement not to discuss any aspects of the study with anyone other than the researcher or the research assistants.

Pretest

Following consent verification and randomization of groups, the researcher administered the pretest to all participants at the same time. Students were reminded to use the code number from their tongue blade to identify their pretest. The pretest used two instruments: the CCTDI and the TAI. There are two versions of the TAI and half of the experimental group and half of the comparison group completed the test Version 1 while the other halves of each group completed test Version 2. The TAI exam had a time limit of 20 minutes. Time was called at the 20-minute mark and students were instructed to stop taking the test. The CCTDI had a time limit of 30 minutes. Following completion of the pretests, the experimental group was relocated to the computer lab or another classroom. Either a research assistant or the primary investigator accompanied each group.

Educational Interventions

The intervention and data collection occurred over a two-week period during the first third of the spring 2013 semester. The experimental group received an intervention of a single-player computer-based EIS, which places the participant in the role of a triage nurse in a virtual emergency room. The simulation, *Triage in the Emergency Department* (2012) begins with a basic description of how to play. Participants received only basic information on how to download the software on other computers. Each student was assigned a login code required for his or her personal access. This code was recorded with their initial participant code and stored securely. The access code allowed a student to download the simulation on any computer or on multiple computers.

The intervention included descriptive case studies that required the participant to assign an acuity level, an emergency room (standard or trauma room), and an appropriately trained nurse (higher acuity levels require a more experienced nurse than lower acuity levels). When incorrect decisions were made, the simulation prompted the player with pop up messages, e.g. “You failed to admit a higher acuity patient first.” The game does not have an unfolding scenario: the presentation of options is static, ensuring that each student has the same experience. See Figure 4 for a screenshot of the EIS.

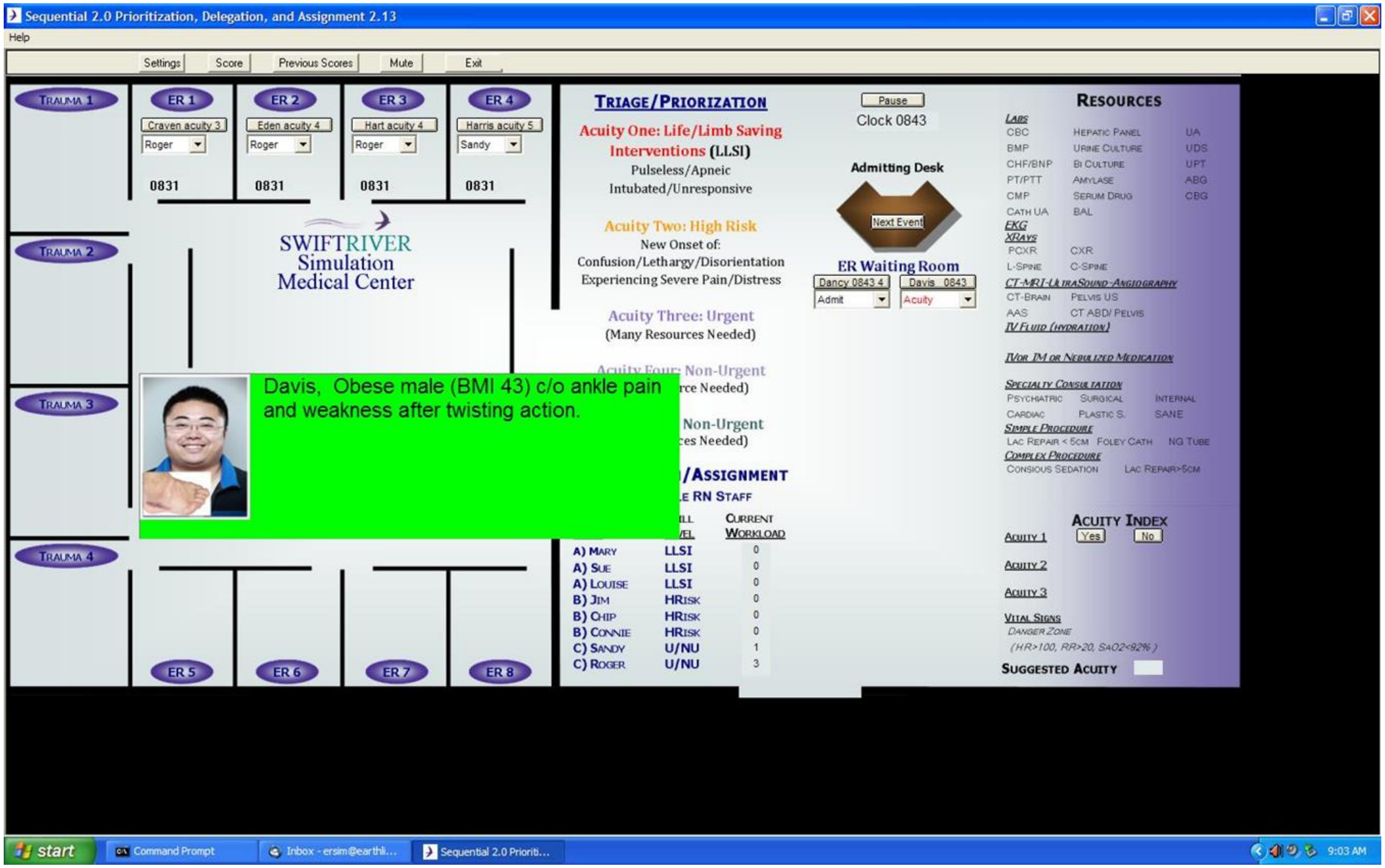

Figure 4. Screenshot of Triage in the Emergency Department (2012)

The simulation was available to each student for two weeks. All students received the same scenarios but in an order that was randomized by the computer. Therefore, although the situations were the same for decision-making purposes, they were presented in different orders.

During the same period, the comparison group participants remained in the classroom and received a paper case study booklet that contained the same content and scenarios as the EIS. The test booklet was constructed from scenarios provided by the simulation software developers. The order of the case scenarios was randomized to simulate the randomized order of scenarios in the EIS. Following the initial distribution and instructions, the students in both the comparison and the experimental groups received no further instruction.

Debriefing One

Students were notified of the day and time of the final data collection, which was scheduled exactly two weeks after the initial data collection. Students were instructed that they could continue to use the provided case studies or EIS as often as they chose until the next assessment. The case study booklet included a tally sheet and students were asked to note the number of times they used the case studies. The simulation software monitored login information to record the number of times each student used the intervention, however, once the program is downloaded to a computer, all information remained on that individual computer. Therefore, there was no mechanism for a direct report from the company. Students in the experimental group were asked to note the number of times they used the simulation in the same fashion as the comparison group. Students were again reminded not to talk about or share their instructional materials during this period. They were informed that, following the study, all instructional materials would be available to all participants and they may share at that time.

Posttest

On the designated date and time, all participants assembled in the designated classrooms. The researcher administered the posttests (TAI and CCTDI) in exactly the same way as the pretests. The participants that had previously completed TAI Version 1 now completed Version 2. The participants who had previously completed TAI Version 2 now completed Version 1. In the same manner as the pretest, the TAI exam had a time limit of 20 minutes and the CCTDI had a time limit of 30 minutes.

Debriefing Two

Following the posttests, the researcher completed a final debriefing by reading a script informing participants that the project’s data collection was complete. Any student interested in receiving the alternate educational intervention was given either a copy of the case study booklet or an access number for the simulation. Participants were thanked and given business cards with contact information in case they wanted to receive a completed manuscript or study results.

Table 2 gives a blueprint of the study plan

Table 2. Study Plan

Initial Contact	Recruitment and Consent	
Day One	Randomization and assignment of blinded code Demographic survey Lecture on triage DVD Complete pretests (TAI and CCTDI)	
	Experimental Group	Comparison Group
	Orientation to EIS Assignment of access code	Orientation to case study booklet
	Debriefing for day one	
Two Week Interval	Independent use of intervention by participants (EIS or CS) Students may use intervention as often as they like and are asked to note each time they use it.	
Day Two	Complete posttest (TAI and CCTDI) Debriefing and alternate intervention distributed	

Measurement

This study used two instruments: The California Critical Thinking Dispositions Inventory (CCTDI) and the Triage Acuity Instrument (TAI). The CCTDI is a critical thinking disposition assessment, written specifically for nursing students, that stresses terminology and critical thinking process skills within a nursing environment. While the pencil and paper version was used for this study, the CCTDI also can be administered via computer software or online. The TAI is a paper and pencil instrument that I developed based on the *Emergency Severity Index, Version 4: Implementation Handbook* (Gilboy, Tanabe, Travers, & Rosenau, 2012).

In addition to the overall CCTDI disposition score, CCTDI subscale scores were used for each dependent variable. The TAI measured clinical judgment, operationalized as accuracy and efficiency of decision making. The dependent variable of decision making was measured as accuracy and efficiency by a pretest TAI and then two weeks later by the posttest TAI. A high score on the TAI reflected high levels of clinical judgment. High scores on the CCTDI indicate a disposition toward using critical thinking skills. Each dependent variable was measured two times, as both a pretest and a posttest two weeks later. During the two-week interval, both the educational interventions were available for participant use. Precautions were taken to assure an optimum testing environment. The TAI was administered in a comfortable classroom and participants submitted their completed TAI by placing it in an envelope at the front of the room. All tests, including the TAI and CCTDI pretests and posttests, were given in a pencil and paper format.

The California Critical Thinking Dispositions Inventory

The CCTDI (2007 Edition)—an instrument developed by Facione, Sánchez, Facione, & Gainen (1995)—was used to measure the Intention, Comprehension, and Extension processes of the ELT. The CCTDI is a 75-item test designed for use with the general adult population, including college-aged students (Giancarlo & Facione, 2001). The instrument is based on the work of John Dewey (1933) and it uses the APA Delphi Report's (1990) definition of critical thinking as the theoretical basis to describe characteristics of one who is a good critical thinker. The CCTDI is specifically designed to measure the disposition to engage problems and make decisions using critical thinking. Attributes associated with a disposition toward critical thinking are used to identify ideal critical thinkers.

Building on findings from the APA Delphi discussion data, seven factors were identified as constructs to measure critical thinking disposition. The seven constructs that the instrument measures as subscales are Truthseeking, Analyticity, Open-mindedness, Systematicity, Confidence in Reasoning, Inquisitiveness, and Maturity in Judgment (Facione & Facione, 1996;

Facione, Facione, & Sánchez, 1994,). The instrument uses a 6-point Likert-type response format, ranging from 1 (strongly agree) to 6 (strongly disagree). It assesses test takers' consistent internal motivations to engage in critical thinking skills by obtaining the participants' indication of the extent to which they agree or disagree with the statements expressing beliefs, values, attitudes, and intentions that relate to reflective formation of reasoned judgments (Insight Assessment, 2013). For each of the seven subscales, the participants may score from a minimum of 10 points to a maximum of 60 points. The interpretive guidelines indicate that a score of >40 indicates a positive inclination toward the characteristic, a score of 31–39 indicates ambivalence toward the characteristic, and a score of <30 indicates an opposition to or lack of interest in the characteristic (Giancarlo & Facione, 2001). An overall CCTDI score was computed as a sum of the seven subscale scores and ranged from 70 points to a maximum of 420 points. The researcher used the following guidelines for interpreting the cumulative scores: scores of 280 and above indicated a positive disposition, scores between 211 and 279 indicated ambivalence, and scores less than 210 indicated a negative disposition (Tiwari, Lai, So, & Yuen, 2006).

CCTDI reliability and validity

Instrument development included reports of face and content validity through multiple screenings by college-level educators. Falcione and colleagues (1994) pilot tested 150 items at comprehensive universities, and the factor analysis indicated seven nonorthogonal and nondiscrete factors with several items loading on multiple scales. Item loadings ranged from .03 to .69 and were used to determine the retention of 75 Likert type items in the final instrument.

CCTDI reliability includes a Cronbach's alpha coefficient of .91 and subscale alpha values in a range of .71 to .80, suggesting internal consistency in the subscales. Item-to-total correlations ranged from .17 to .63. A small item correlation provides empirical evidence that one item is not measuring the same construct measured by the other items. A correlation value less than 0.2 or 0.3 indicates that the corresponding item does not correlate well with the scale overall and, thus, may be dropped. Internal studies of test retest reliability result in coefficients for the CCTDI that are at or exceeding .80. Loading specifics are available in the test instruction booklet (Facione & Facione, 1996).

Triage Acuity Instrument

The TAI was developed by the primary investigator and was previously tested in a pilot study. The aim of the instrument was to compare the accuracy and efficiency of decision making between the two groups on the pretest and posttest scores. While the pilot study used a TAI based on an earlier version of the *Emergency Severity Index, Version 4: A Triage Tool for Emergency Department Care*, for this study, the TAI was updated using the new *Emergency Severity Index (ESI): A Triage Tool for Emergency Department Care, Version 4* (Gilboy et al., 2012). The TAI consists of three questions for each of the 33 short vignettes, or case studies, that describe a patient presenting to the hospital emergency department (N=99 questions). The instrument is designed to test clinical judgment skills by measuring the student's ability to make decisions—assign patient acuity scores, select an appropriately skilled nurse, and designate an suitable physical space—in accordance with the Emergency Severity Index (Gilboy et al., 2012).

TAI reliability and validity.

A pilot study was conducted and assessment score reliability, pretest and posttest, was indicated by means, standard error of means, normality of score distributions, and 95% confidence intervals for groups, time, and groups by time. The small magnitudes of the standard errors and their relative consistency in each of the comparisons (group, time, groups by time) indicated the reliability and validity of TAI scores for assessing intervention effects. Three Certified Nursing Educators (CNEs) established TAI face validity by agreeing that the assessment's results satisfy Nitko's (2001) validity criteria. These criteria included content representativeness and relevance; representation of thinking skills and processes; reliability and objectivity; fairness to different types of students; and economy, efficiency, practicality, and instructional features. Content validity indicates that the test measured what it was intended to measure, as established by an expert in the field.

As previously described, the TAI is a new instrument developed for this study and tested in a pilot study as well as in this study. To examine reliability of the TAI instrument, split half correlations were performed based on comparing even numbered questions to odd numbered questions. Using this even versus odd, it was possible to calculate both the accuracy and the efficiency subscale for each of the subject's responses. Both the pre-intervention and post-intervention timeframes of the TAI were examined for reliability. Pearson's product moment correlation coefficient was used as an indicator of reliability, comparing the even versus odd split halves. It is recognized that two different versions of the TAI instrument were used, with 58 participants receiving version one at the pre-intervention timeframe and 59 participants receiving version two at the pre-intervention. This was reversed at the post-intervention, recognizing that those participants receiving version one at pre-intervention received version two at post-intervention, and vice-versa. Reliability was examined for both of the TAI versions combined and then again for each of the TAI versions separately. Table 3 presents the correlation coefficients.

Table 3. Pearson Correlations Comparing Even versus Odd Questions of the TAI

Version & Subscale	Pre-Intervention		Post-Intervention	
	r value	*p* value	*r* value	*p* value
Versions Combined				
Accuracy	.669	<.001	.861	<.001
Efficiency	.822	<.001	.817	<.001
Version One				
Accuracy	.699	<.001	.883	<.001
Efficiency	.867	<.001	.773	<.001
Versions Two				
Accuracy	.643	<.001	.593	<.001
Efficiency	.780	<.001	.852	<.001

As can be seen, all the correlation coefficients were statistically significant. However, this is to be expected with a relatively large dataset. When examining an instrument for reliability it is the magnitude of the coefficient in which we are interested. All of the coefficients were above .59. Jacob Cohen (1992) suggests that correlation coefficients in the .2 range are small, in the point 5. range are medium, and in the .8 range are large. We can see that the TAI consistently provides reliability coefficients above the medium range, approaching the high range in some cases. For a newly developed instrument, this was felt to be quite adequate support for the reliability of the instrument.

In addition to examining Pearson correlation coefficients, Kuder-Richardson 20 coefficients (KR20) were calculated on the individual items of the TAI. This was performed for both version and for the pre-intervention and post-intervention timeframes. Since this TAI instrument was timed, only the number of responses that were actually answered could be analyzed. For pre-intervention TAI version one, 20 questions was the minimum answered. However, with the two lowest removed, the minimum jumped to 39. Therefore, only 56 of the 58 subject responses were examined for the pre-intervention version one. For pre-intervention version two 39 questions was the minimum answered. At the post-intervention timeframe, the minimum answered for version one was 45. For version two it was 36.

At the pre-intervention timeframe, for version one, the KR20 = .700 ($p < .001$), and for version two, the KR20 = .545 ($p < .001$). At the post-intervention timeframe, for version one, the KR20 = .525 ($p < .001$), and for version two, the KR20 = .537 ($p < .001$). When comparing these to the Pearson correlations, we see that they are not quite as strong. However, these KR20 coefficients are examining the overall correlations of the individual items of the TAI, whereas the Pearson correlations are examining the reliability of an overall (split half) test score. Given the different nursing experiences of the study participants, it might be expected that different participants would have more expertise in some areas than others, causing various specific items to not be well correlated, even while the overall reliability of the TAI may be quite good. These KR20 values were felt to be adequate toward demonstrating a reasonable degree of reliability for the TAI.

Validity of the TAI is another issue entirely. Given that the questions are directly related to nursing situations, it is felt that the face validity of the TAI was quite strong. It must be admitted that convergent and discriminant validity were not examined. This would take administering an instrument measuring a similar construct to a group of participants, and this was not performed in this study. A further examination of the validity of the TAI must be deferred to a possible future study.

To minimize the potential for participant history or maturation level to interfere with results, two versions of the TAI were used; these were identical except that they included different case studies. Half of each experimental and comparison group completed Version 1 as a pretest and half completed Version 2 as a pretest. Each participant completed the alternate version on posttest. This protected the study from any subtle differences between TAI Versions 1 and 2.

TAI accuracy and efficiency.

Intervention effects were evaluated by comparing the pretest to posttest changes in accuracy and efficiency of subject TAI responses. For this study, *accuracy* was defined as the raw number of correct decisions made by each subject divided by the number attempted. *Efficiency* was defined as the total number of correct answers divided by the total number of decisions possible on the test. Efficiency takes into account the number of correct decisions relative to the number of decisions available as a function of the time allotted for taking the TAI.

The accuracy score, therefore, was calculated as the number of correct answers selected divided by the number attempted. A measure of efficiency was calculated as the total number of correct answers divided by the total number of decisions possible on the test within 20 minutes.

Operationalizing the Variables

Intention

Kolb's stage of Intention was measured using several of the CCTDI subscales. The Open-mindedness subscale measures the traits of being tolerant of others opinions and treating others in a fair and responsible manner (Facione et al., 1995). True reflective thinking includes considering all facets of information related to the experience and setting aside personal bias in order to assimilate meaning. Attitudes of fairness, discipline, and integrity in caring for patients are measured with the Open-mindedness subscale. Dispositional intolerance may preclude effective clinical judgment (Facione et al., 1995). An example of this would be a clinician not fairly judging symptoms when assessing pain in an individual known to abuse narcotics. A clinician having a disposition toward the bias that the patient is seeking medication and not truly in pain without accurately assessing all information would score low on the Open-mindedness scale. The CCTDI construct and subscale of Inquisitiveness is intellectual curiosity. It is the tendency to want to know things, of being curious and eager to acquire new knowledge, and to understand the explanations and applications of that new knowledge. The opposite of inquisitiveness is indifference.

An analytical person, as measured by the CCTDI Analyticity subscale, is alert to possible consequences. Another word used to describe this subscale is foresightfulness, which reflects the habit of anticipating both the good and bad potential outcomes of a decision. During Intention, all that is perceived and known is considered, or reflected upon, while weighing the effects of any one variable on the whole situation. The opposite of analyticity is failing to think critically about the potential outcomes and consequences of a decision before making it (Insight Assessment, 2013).

The systematic person, as measured by the Systematicity subscale, is orderly, focused, and diligent in problem solving. A lack of systematicity results in disorganization. Although a person who shows strong systematicity may or may not demonstrate a specific pattern or strategy for problem solving and decision making, he or she approaches issues in an organized manner (Insight Assessment, 2013). Self-confidence in critical thinking, or Confidence in Reasoning, is the habitual tendency to trust reflective thinking to solve problems and make decisions. The opposite of this habit of mind is to consistently devalue or reject careful reason and reflection for problem solving and decision making (Insight Assessment, 2013).

Comprehension

The CCTDI Maturity of Judgment scale measures the ability to be judicious in decision making and is particularly important when faced with ill-structured problems that preclude certainty (Facione et al., 1995; Ramasamy, 2011). Maturity in nursing expertise is demonstrated as an ability to look beyond the immediate flow of information to sort out the most important cues needed to complete comprehension of a situation (Benner, 2001). It is the habit of making a timely judgment, without avoiding premature closure on issues or jumping to inaccurate conclusions. Cognitive immaturity is the opposite of maturity and is exemplified by imprudence, black and white thinking, and refusing to recognize and change a point of view when presented with evidence. It also may represent a tendency to change one's mind or revise opinions without any careful thought or substantiation (Insight Assessment, 2013).

Comprehension was also tested more discretely through the assessment of accuracy in decision making. The TAI measured the number of correct triage acuity answers for the presenting case scenarios. Administering the TAI as both a pretest and posttest allowed the researcher to assess the knowledge gained from the experimental or comparison intervention.

The theoretical concept of Comprehension was operationalized as decision making and measured by the TAI. Specific cognitive knowledge gain related to triage nursing skills was measured by the TAI. The knowledge-based questions measured accuracy and efficiency of patient acuity assignment during emergency room triage.

Research Hypotheses

1. Senior baccalaureate nursing students who participate in EIS of real-life clinical scenarios over a period of two weeks will experience significant increases critical thinking

disposition by the CCTDI when compared to students who received traditional paper case study instruction.

2. Senior baccalaureate nursing students who participate in EIS of real-life clinical scenarios over a period of two weeks will experience significant increases in clinical judgment measured as accuracy of situational decision making by the TAI when compared to students who received traditional paper case study instruction.

3. Senior baccalaureate nursing students who participate in EIS of real-life clinical scenarios over a period of two weeks will experience significant increases in clinical judgment measured as efficiency of situational decision making by the TAI when compared to students who received traditional paper case study instruction.

Data Analysis

All statistical analyses were performed using IBM SPSS software version 20.0 (IBM Corp.). Statistical significance was set at $p < 0.05$. All hypothesis tests were performed as two-tailed. When reported in the text, the SD abbreviation represents the standard deviation. There are several instances where the chi-square test-of-independence is utilized and *p* values are calculated in the following ways. When a two-by-two contingency table is being analyzed, Fisher's exact test was used to produce the *p* value. In circumstances with a larger contingency table, exact tests were used to produce *p* values.

Chapter Four: Results

In this chapter, I present findings from the study. A restatement of the research hypotheses is followed by the sample description. Next is an analysis of potentially confounding variables. A description of the dependent variables is then presented. The chapter concludes with a discussion of the differences in changes in the dependent variables between the experimental and comparison groups for each hypothesis.

Research Hypotheses

1. H_1: Posttest scores compared to pretest scores on measures of disposition toward critical thinking assessed by the CCTDI will be higher for the experimental group than for the comparison group.

2. H_2: Posttest scores compared to pretest scores on measures of accuracy for decision making assessed by the TAI will be higher for the experimental group than for the comparison group.

3. H_3: Posttest scores compared to pretest scores on measures of efficiency for decision making assessed by the TAI will be higher for the experimental group than for the comparison group.

Study Participants

Participants were randomly assigned to either the experimental or comparison group. The experimental group received the electronic interactive simulation intervention and the comparison group received the traditional pencil and paper case studies. The study started with 121 participants. However, four participants withdrew before completing the study protocol. Three participants who withdrew were in the Case Study intervention group, and one participant was lost from the EIS intervention group. I considered this attrition rate was quite low and did not feel that the loss of these four participants would affect the study results in any material way. The remaining 117 participants made up the dataset that was used to test the hypotheses and address the research questions (see Figure 5).

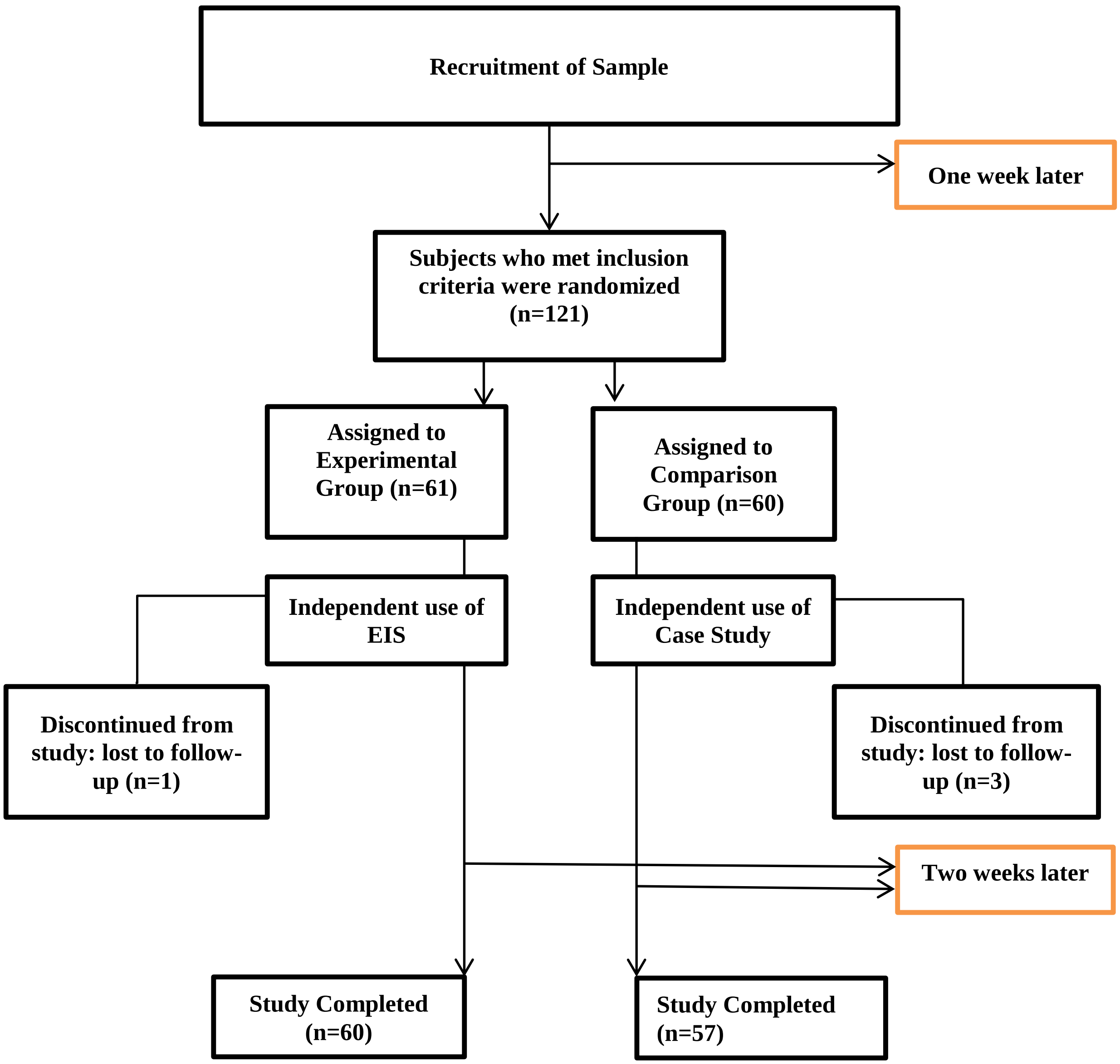

Figure 5. Sampling and Flow of Subjects through Study

The power analysis showed that only 102 participants were needed (51 per group) to maintain 80% power. Therefore, the study's 117 participants, divided between two groups, were adequate to maintain the desired 80% statistical power.

Participants self-reported the number of times they accessed the educational intervention, see Table 4. A chi-square test-of-independence revealed a relationship between subject group and the number of times the intervention was accessed, χ^2_3 = 12.353, p = .003. The overall means and standard deviation for accessing the intervention was 2.01 ±0.59. While the Case Study group mean was 2.19 with a standard deviation of ± 0.69, the EIS group mean was 2.01 with a standard deviation of ±0.42. Statistical analysis indicates that the Case Study group accessed the intervention more frequently than the EIS group.

Table 4. *Frequency Distribution of Number of Times Intervention Was Accessed*

Measurement	Combined Groups	Case Study Group	EIS Group
Accessed once	16 (13.7%)	5 (8.8%)	11 (18.3%)
Accessed twice	88 (75.2%)	40 (70.2)	48 (80.0%)
Accessed three times	9 (7.7%)	8 (14.0%)	1 (1.7%)
Accessed four times	4 (3.4%)	4 (7.0%)	0 (0.0%)

Several descriptive variables were measured as potential confounds to interpreting the results. First, I determined each variable's frequency distribution. Age and months of prior experience are certainly continuous variables, but producing grouped frequency distributions of continuous variables is certainly acceptable. In addition, these two continuous variables are highly positively skewed and could cause problems if analyzed as continuous covariates. The variables then were examined to determine their distribution within the Case Study and EIS groups in order to identify any significant differences. In addition, when a variable was found to have statistical significance for the primary research questions, it was included in a secondary ANCOVA analysis to make sure it did not confound the primary interpretation.

Overall Demographic and Assessment Descriptives

Among the 117 participants, there were 20 males (17.1%) and 97 females (82.9%). The ages ranged from 21 to 50 years, with the mean age for all participants of 25.5 years, SD = 6.3 years. A group frequency distribution of subject ages (in five-year intervals) is shown in Table 5.

Table 5. *Frequency Distribution of Demographic Variables*

Variable Category	Characteristic	Frequency	Percent
Gender	Male	20	17.1
	Female	97	82.9
Age Group	20–24	80	68.4
	25–29	10	13.7
	30–34	16	8.5
	35–39	3	2.6
	40–44	5	4.3
	45–49	2	1.7
	50–54	1	0.9
Ethnicity	Caucasian	102	87.2
	African descent	9	7.7
	Filipino	1	0.9
	Hispanic	3	2.6
	East Indian	2	1.7
Highest Degree Earned	None	91	77.8
	Diploma	2	1.7
	Associates	6	5.4
	Bachelors	18	15.4
University from which Recruited for Study	BU	15	12.8
	MSU	37	31.6
	MTSU	65	55.6
Months of Previous Healthcare Experience	0–9	81	69.2
	10–19	13	11.1
	20–29	4	3.4
	30–39	8	6.8
	40–49	3	2.6
	50–59	1	0.9
	60–69	1	0.9
	70–79	2	1.7
	80–89	1	0.9
	90–99	0	0.0
	≥100	3	2.6
Previous Knowledge based on ENA Recommendation	Correct Responses	47	40.2
	Incorrect Responses	70	59.8
Previous Knowledge based on Patient Acuity	Correct Responses	35	29.9
	Incorrect Responses	82	70.1
Previous Knowledge based on Physical Space Assignment	Correct Responses	98	83.8
	Incorrect Responses	19	16.2

The age distribution was positively skewed, with the majority of participants being in the 20 to 24 year age group. For this reason, for further analyses, age was converted into a dichotomous measure with one condition representing the 20 to 24 year age group and another condition representing participants age 25 and older. When grouped in this way, there were 80 participants (68.4%) in the younger group and 37 participants (31.6%) in the older group.

Five ethnicities were represented among the 117 participants. A frequency distribution of these ethnicities is presented in Table 5. The majority of the participants were Caucasian. Similar to the way age was handled, the researcher decided that two groups, Caucasian and Other, would be most appropriate for subsequent examinations of how ethnicity may have affected the results. When the non-Caucasian groups were combined, the distribution was 102 Caucasians (87.2%) and 15 Other ethnicities (12.8%).

Another demographic measured as a potential factor/confound in the observed results was prior degrees earned. The three possibilities were diploma, associate's degree, or bachelor's degree. Table 5 provides the breakdown of these degrees for all study participants. Yet again, this measure was skewed in its distribution, with the majority of participants not having a degree. To provide reasonable groups for analysis, the participants were combined into two groups, those without a previous degree (91 participants, 77.8%) and those with a previous degree (26 participants, 22.2%).

Participants were recruited from Middle Tennessee State University (MTSU), Bethel University (BU), and Murray State University (MSU). The university at which the participants were attending also was tracked and examined as a possible confound (see Table 5).

Prior healthcare experience was another factor that could affect the results. This factor was measured in months and grouped in the frequency distribution in ten-month intervals (see Table 5). Yet again, a positively skewed distribution was noted. The first group (0 to 9 months) contained over two-thirds of the participants. To provide a reasonable measure for checking this potential confound, the participants were combined into two groups: those with nine or fewer months of prior experience (81 participants, 69.2%) and those with ten or more months of prior experience (36 participants, 30.8%).

Participants' prior knowledge about healthcare was assessed when they answered three multiple-choice questions in which they were asked to assign a patient acuity level, select a nurse with the appropriate skill level, and designate a suitable physical space assignment. Subject answers were categorized as correct or incorrect responses. The frequencies and percentages of correct and incorrect responses for all three questions are noted in Table 5.

Analysis of Potentially Confounding Variables

The study's primary independent variable was whether a subject was in the Case Study or EIS group. After the attrition of four participants, 57 participants (48.7%) remained in the Case Study group and 60 participants (51.3%) in the EIS group. The subscales of the TAI and the CCTDI served as the study's dependent variables.

The participants were assessed twice, once before the interventions and once after. Two equivalent TAI versions were used so that participants would not be exposed to the same version twice. The TAI version given to the participants at the pre-intervention time was randomized. However, this practice could still be a potential confound to interpreting the results. Therefore, the distribution of the TAI versions was examined for the pre-intervention timeframe (see Table 6).

Table 6. *Frequencies and Percentages of the TAI Versions Used at Pre-intervention*

TAI Version	Case Study Group		EIS Group	
	Frequency	Percent	Frequency	Percent
TAI Version 1	29	50.9	28	46.7
TAI Version 2	28	49.1	32	53.3

A chi-square test-of-independence between the Case Study and EIS groups and the assignment of TAI Version one or two at this pre-intervention period was performed, $\chi_1^2 = 0.207$, $p = .713$. Differences in the assignment of TAI versions between the two experimental groups were not statistically significant. Therefore, the different but equivalent TAI versions should not be considered a confounding variable between the two experimental groups.

There were five demographic measures—reduced to dichotomous categories—that may have been potential confounds: gender, age group, ethnicity, degree, months of prior experience, and prior knowledge. Table 7 illustrates the distribution of each of these potential confounds within the two experimental groups, along with the *p* value from a chi-square test-of-independence. The results showed that the chi-square test-of-independence was not statistically significant for any of the measures. Therefore, it was safe to conclude that the distribution of these potential confounds was approximately even between the two experimental groups, and there was no reason to suspect that any of these factors confounded the interpretation of subsequent results.

Table 7. *Frequencies and Percentages of Demographics in Experimental Groups*

Measures		Case Study group		EIS Group		χ2 Value	p Value
		Frequency	Percent	Frequency	Percent		
Gender	Male	11	19	9	15	= 0.381	*p* = .626
	Female	46	80	51	85		
Age	24 or Younger	35	61	45	75	= 2.499	*p* = .163
	25 or Older	22	38	15	25		
Ethnicity	Caucasian	50	87	52	86	= 0.029	*p* > .999
	Other	7	12	8	13		
Degree	No Degree	43	75	48	80	= 0.352	*p* = .658
	Degree	14	24	12	20		
University	BU	8	14	7	11.7	= 0.987	*p* = .610
	MSU	20	35.1	17	28.3		
	MTSU	29	50.9	36	60		
Months of Experience	9 or less	38	66	43	71	= 0.343	*p* = .689
	10 or more	19	33	17	28		
Prior Know. ENA Recom.	Correct Resp.	27	47	20	33	= 2.396	*p* = .135
	Incorrect Resp.	30	52	40	66		
Prior Know. Patient Acuity	Correct Resp.	19	33	16	26	= 0.620	*p* = .545
	Incorrect Resp.	38	66	44	73		
Prior Know. Space Assign.	Correct Resp.	47	82	51	85	= 0.139	*p* = .804
	Incorrect Resp.	10	17	9	15		

The university at which the participants attended had the potential to confound the findings. This factor was also examined for a difference in distribution between the two experimental groups and, again was not found to be statistically significant, χ^2_2 = 0.987, p = .610. The actual frequencies and percentages in each group by university are shown in Table 7.

In addition to those above, three questions about prior knowledge also were measured as potential confounds. The breakdown of the correct and incorrect responses for each of the two experimental groups is presented in Table 7 along with p values for a chi-square test-of-independence for each question. Results of the chi-square test were not statistically significant for any of the three questions. Therefore, it was safe to assume that prior knowledge was relatively evenly distributed between the two experimental groups did not confound interpretation of the results.

Overall Descriptives of the Dependent Variables

Before examining the dependent variables with respect to the actual research questions, they were examined in overall fashion (without dividing the participants into the Case Study and EIS groups). All measures were taken both pre-intervention and post-intervention. Means and standard deviations were calculated at both of these timeframes for all measures and examined with a repeated measures *t* test to detect statistically significant changes. These calculations are presented in Table 8.

Table 8. *Means and Standard Deviations of Dependent Variables at Pre-intervention and Post-intervention, with Tests for Statistically Significant Differences*

Instrument and Subscale	Pre-intervention		Post-intervention		Repeated Measures *t* Test	
	Mean	SD	Mean	SD	t_{116} value	*p* value
TAI						
Accuracy	48.4	9.3	52.3	9.7	-3.773	<.001
Efficiency	37.0		45.1	12.1	-6.654	<.001
CCTDI						
Overall	303.1	31.6	303.5	32.7	-0.204	.838
Truthseeking	38.0	6.6	38.9	5.7	-2.143	.034
Open-mindedness	42.0	6.4	41.7	6.5	0.830	.408
Inquisitiveness	46.6	6.4	46.4	7.1	0.404	.687
Analyticity	45.3	5.8	44.7	6.2	1.491	.139
Systematicity	42.4	6.1	42.5	6.4	-0.089	.929
Conf. in Reasoning	43.9	6.2	44.0	6.3	-0.205	.838
Maturity of Judgment	45.0	7.1	45.3	6.6	-0.608	.544

There were two violations of normality within the pre-intervention timeframe, one in the CCTDI Analyticity subscale and one in the CCTDI Maturity of Judgment subscale (all subscales were $p > .05$ except for these two). At the post-intervention timeframe, there was only one violation of normality, in the CCTDI Analyticity subscale (all subscales were $p > .05$ except for this one). Because no statistical significance was found for this subscale when addressing the primary research questions, these results did not pose a concern.

The homogeneity of variance assumption appears to be violated in three instances. The CCTDI Open-mindedness subscale fails to show homogeneity of variance in both the pre-intervention and post-intervention timeframes, and the CCTDI Maturity of Judgment subscale fails to meet the assumption in the post-intervention timeframe (all measures were $p > .05$ except for these three cases). Change scores (differences between the pre-intervention period and post-intervention period) were calculated, and *t* tests were performed as alternative approaches. There were no other violations of variance.

Differences in Changes in the Dependent Variables between Experimental Groups

This section covers changes in the measures from pre- to post-intervention. Of particular interest was whether these changes are different for the Case Study and EIS groups. This *difference in changes* was examined via an interaction effect in a mixed-model ANOVA. This ANOVA was considered mixed because it included the repeated measures factor (pre- to post-intervention) and the independent groups factor (Case Study versus EIS).

Hypothesis 1

Hypothesis 1 was that posttest scores compared to pretest scores on measures of disposition toward critical thinking assessed by the CCTDI would be higher for the experimental group than for the comparison group.

The first task was to examine the difference in changes (differences in the pre- to post-intervention changes between the two experimental groups) on each of the eight CCTDI subscales. These results are provided in Table 9.

Table 9. *Means, Standard Deviations, and Pre-intervention to Post-intervention Changes in CCTDI Subscales between Experimental Groups*

Subscale, Timeframe, & Pre/post Change	Case Study Group		EIS Group	
	Mean	SD	Mean	SD
Overall CCTDI				
Pre-intervention	305.0	34.3	301.4	28.9
Post-intervention	301.2	35.2	305.6	30.3
Pre/post Change	-3.8		4.2	
Truthseeking				
Pre-intervention	38.6	6.9	37.5	6.3
Post-intervention	38.3	6.3	39.5	5.1
Pre/post Change	-0.3		2.0	
Open-mindedness				
Pre-intervention	41.7	7.4	42.3	5.3
Post-intervention	40.3	7.8	43.0	4.8
Pre/post Change	-1.4		0.7	
Inquisitiveness				
Pre-intervention	46.1	6.7	47.2	6.1
Post-intervention	45.9	7.6	46.9	6.7
Pre/post Change	-0.2		-0.3	
Analyticity				
Pre-intervention	46.1	6.4	44.6	5.1
Post-intervention	45.1	6.3	44.3	6.1
Pre/post Change	-1.0		-0.3	
Systematicity				
Pre-intervention	42.9	6.7	42.0	5.6
Post-intervention	42.7	6.8	42.3	6.0
Pre/post Change	-0.2		0.3	
Confidence in Reasoning				
Pre-intervention	43.7	6.7	44.1	5.6
Post-intervention	42.9	6.8	44.9	5.7
Pre/post Change	-0.8		0.8	
Maturity of Judgment				
Pre-intervention	46.1	6.3	44.0	7.7
Post-intervention	46.0	7.3	44.7	5.8
Pre/post Change	-0.1		0.7	

Table 10 outlines a mixed-model ANOVA analysis of each of the CCTDI subscales with between-subject, within-subject, and interaction effects. When examining these results, four statistically significant interactions became apparent. For the CCTDI subscales of Overall, Truthseeking, Open-mindedness, and Confidence in Reasoning, there are statistically significant differences in the pre- to post-intervention changes between the Case Study and EIS groups. Furthermore, in all four cases, EIS group scores improved while the Case Study group's scores went down. These four findings directly support the research hypothesis that the EIS will show greater improvements on the CCTDI subscales than the Case Study group.

Table 10. Mixed-model ANOVA Analysis of CCTDI Subscales

Subscale & ANOVA Effect Source	Type III Sum of Squares	Degrees of Freedom	Mean Square	*F*	*p* value
CCTDI Overall					
Case Study versus EIS Groups	7.599	1	7.599	0.004	.950
Pre- versus Post-intervention	2.902	1	2.902	0.021	.886
Groups × Pre/post Interaction	924.75	1	924.75	6.561	.012
Within-subjects Error Term	16208.1	115	140.94		
Between-subjects Error Term	222639	115	1936.0		
Truthseeking					
Case Study versus EIS Groups	0.360	1	0.360	0.005	.942
Pre- versus Post-intervention	41.41	1	41.41	4.571	.035
Groups × Pre/post Interaction	80.71	1	80.71	8.909	.003
Within-subjects Error Term	1041.8	115	9.059		
Between-subjects Error Term	7728.9	115	67.21		
Open-mindedness					
Case Study versus EIS Groups	159.08	1	159.08	2.128	.147
Pre- versus Post-intervention	6.513	1	6.513	0.859	.356
Groups × Pre/post Interaction	60.479	1	60.479	7.976	.006
Within-subjects Error Term	871.98	115	7.582		
Between-subjects Error Term	8596.0	115	74.748		
Inquisitiveness					
Case Study versus EIS Groups	63.435	1	63.435	0.789	.376
Pre- versus Post-intervention	1.845	1	1.845	0.158	.691
Groups × Pre/post Interaction	0.306	1	0.306	0.026	.872
Within-subjects Error Term	1340.3	115	11.655		
Between-subjects Error Term	9244.3	115	80.385		
Analyticity					
Case Study versus EIS Groups	80.292	1	80.292	1.286	.259
Pre- versus Post-intervention	19.774	1	19.774	2.287	.133
Groups × Pre/post Interaction	7.090	1	7.090	0.820	.367
Within-subjects Error Term	994.23	115	8.645		
Between-subjects Error Term	7182.2	115	62.454		
Systematicity					
Case Study versus EIS Groups	26.464	1	26.464	0.375	.542
Pre- versus Post-intervention	0.046	1	0.046	0.005	.942
Groups × Pre/post Interaction	3.328	1	3.328	0.386	.536
Within-subjects Error Term	992.60	115			
Between-subjects Error Term	8123.31	115			
Confidence in Reasoning					
Case Study versus EIS Groups	80.774	1	80.774	1.168	.282
Pre- versus Post-intervention	0.184	1	0.184	0.023	.879
Groups × Pre/post Interaction	38.406	1	38.406	4.818	.030
Within-subjects Error Term	916.75	115	7.972		
Between-subjects Error Term	7951.49	115	69.143		
Maturity of Judgment					
Case Study versus EIS Groups	176.27	1	176.27	2.320	.130
Pre- versus Post-intervention	5.781	1	5.781	0.345	.558
Groups × Pre/post Interaction	9.457	1	9.457	0.564	.454
Within-subjects Error Term	1927.37	115	16.760		
Between-subjects Error Term	8735.90	115	75.964		

As stated previously, when statistical significance supporting the research hypotheses was found, the statistical assumptions were revisited and ANCOVA analyses were performed to ensure that the potential confounds did not produce the observed results. No problems with the normality assumptions were found during the examination of the statistical assumptions regarding these statistically significant findings. However, the homogeneity of variance assumption for the Open-mindedness subscale was violated in both the pre- and post-intervention timeframes. Therefore, pre-to-post change scores were calculated for each subject on the Open-mindedness subscale, and these change scores were subjected to a Satterthwaite *t* test. The results of this test continued to show that the two experimental groups were different on changes to the CCTDI Open-mindedness subscale, $t_{115} = 2.826$, $p = .006$.

Referring back to the potential confounds measured in Table 7, each was analyzed and found to be relatively equally distributed between the two experimental groups (and not of concern as a confound). However, to confirm the significant findings that support the research hypothesis, each of these potential confounds was included in an ANCOVA analysis to examine whether or not it changed the findings observed in Table 9. Table 11 provides the results for the four CCTDI subscales—Overall, Truthseeking, Open-mindedness, and Confidence in Reasoning—while reexamining the interaction effect via ANCOVA for each potential confound

Table 11. *A Re-examination of the Statistically Significant Interaction Effects Including an ANCOVA Analysis of Potential Confounds*

Potential Confounding Variables	Statistically Significant CCTDI Subscales							
	Overall		Truthseeking		Open-mindedness		Confidence in Reasoning	
	$F_{1,114}$	*p*	$F_{1,114}$	*p*	$F_{1,114}$	*p*	$F_{1,114}$	*p*
Gender	6.460	.012	8.575	.004	7.749	.006	4.816	.030
Age Group	7.140	.009	9.257	.003	8.649	.004	4.304	.040
Ethnicity Group	6.625	.011	9.153	.003	7.905	.006	4.848	.030
Degree Group	6.563	.012	8.924	.003	8.219	.005	4.633	.033
University	5.516	.021	7.955	.006	7.015	.009	4.139	.044
Months Experience Gr.	6.550	.012	9.034	.003	7.771	.006	4.858	.030
Previous Knowledge:								
ENA Recommend.	5.514	.021	8.283	.005	6.774	.010	4.293	.041
Patient Acuity	6.869	.010	9.136	.003	8.115	.005	4.470	.037
Space Assignment	6.625	.011	8.922	.003	8.137	.005	4.674	.033

An examination of the results in Table 11 shows that the statistically significant CCTDI subscales maintain their statistical significance even while controlling for each of the potentially confounding variables. Therefore, it was appropriate to conclude that these possible confounds do not contribute to the findings. A graphic representation of these findings was useful, but an examination of the main effects from the mixed-model ANOVA analyses, shown in Table 10, was also needed. The main effect for changes from pre- to post-intervention was examined in Table 8, but not in the context of the mixed-model ANOVA. In Table 8, only the CCTDI's Truthseeking subscale was found to be statistically significant. In the context of the mixed-model ANOVA analysis, the same result was found. None of the CCTDI subscales showed statistical significance (all $p > .05$) except the Truthseeking subscale ($F_{1,115} = 4.571$, $p = .035$).

This mixed-model ANOVA analysis showed a main effect between the two experimental groups (Case Study and EIS) while effectively averaging the pre-treatment and post-treatment measures. None of these between-group main effects was found to be statistically significant (all $p > .05$).

To return to the four statistically significant interaction effects, graphs of the means for each of these effects are shown in Figures 6 through 9.

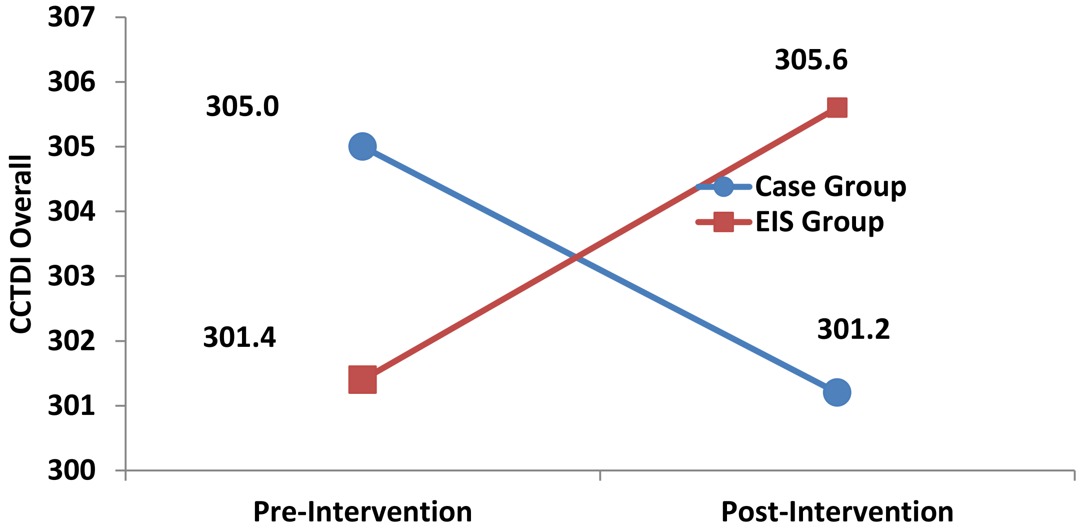

Figure 6. *Plots of the mean values for the pre- and post-intervention CCTDI Overall subscale for both experimental groups.*

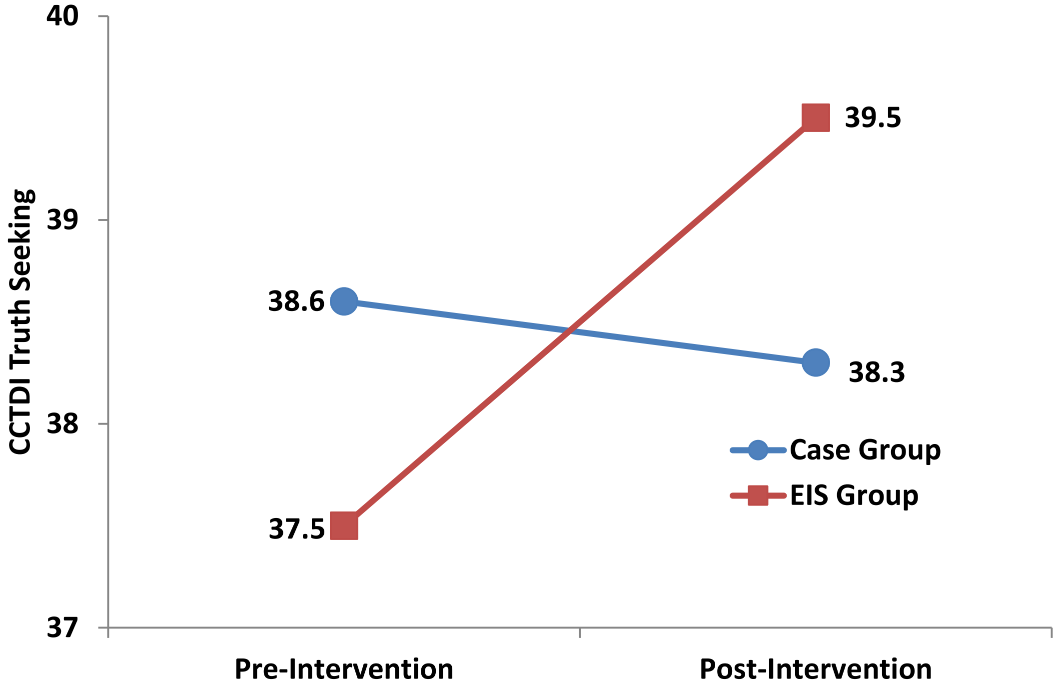

Figure 7. *Plots of the mean values for the pre- and post-intervention CCTDI Truthseeking subscale for both experimental groups.*

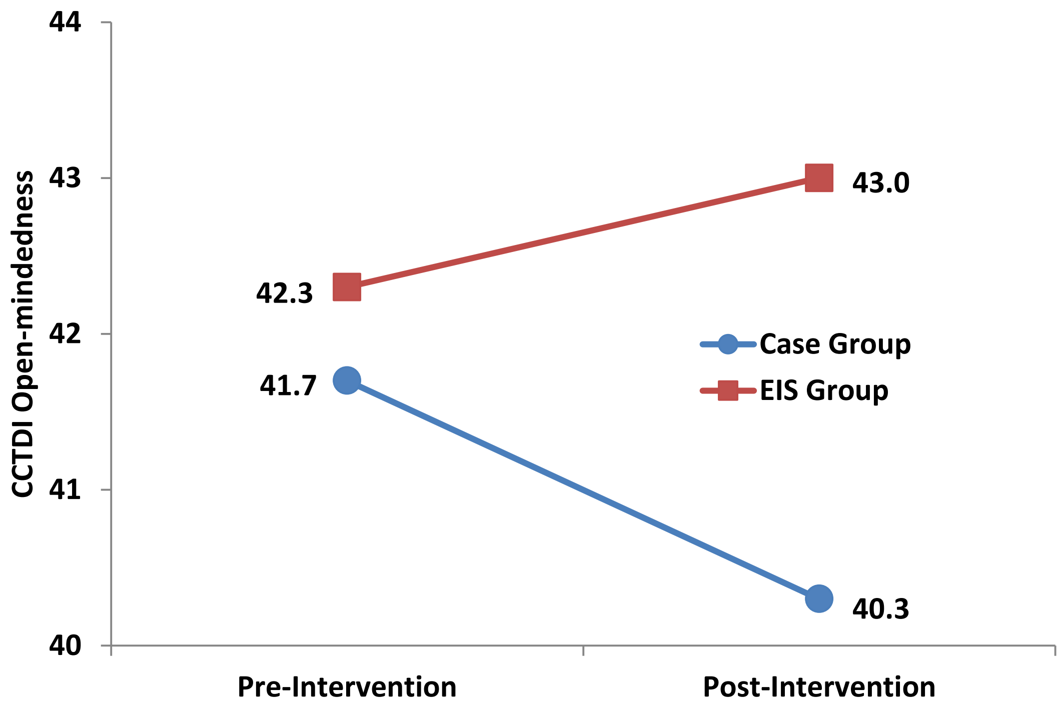

Figure 8. *Plots of the mean values for the pre- and post-intervention CCTDI Open-mindedness subscale for both experimental groups.*

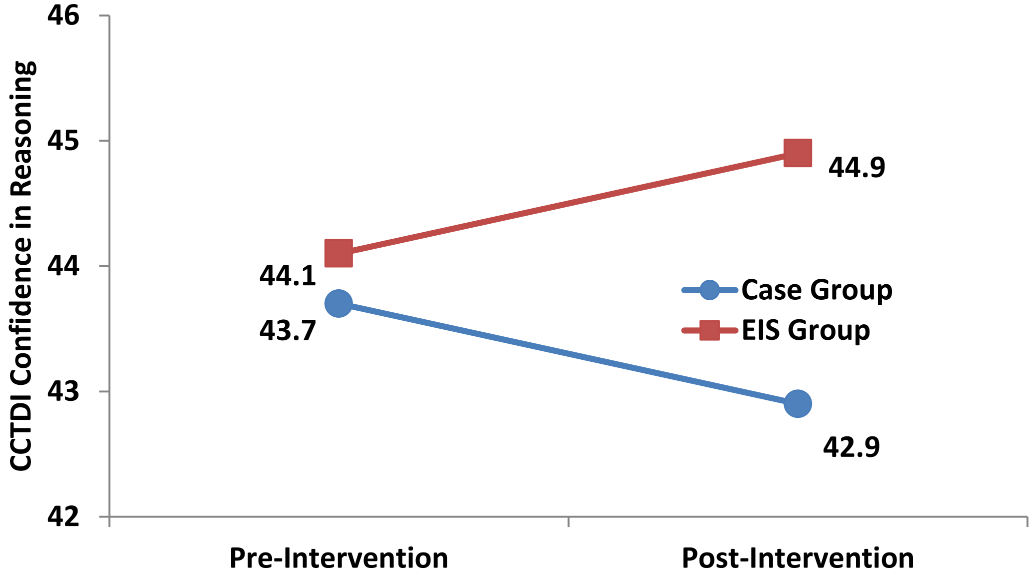

Figure 9. *Plots of the mean values for the pre- and post-intervention CCTDI Confidence in Reasoning subscale for both experimental groups.*

Figures 6 through 9 depict the easily noted pre- to post-intervention EIS group (red line) increases in the four CCTDI subscales, in contrast to the Case Study group (blue line) decreases. While it was interesting that the Case Study group started with better scores than the EIS group on the CCTDI Overall and Truthseeking subscales, this fact does not explain the decrease in the group's post-intervention scores. If the subscale had a ceiling effect (Polit & Beck, 2008), one might expect the higher starting value to stay higher, but that effect still does not explain why the Case Study group's scores decreased while the EIS group's scores increased. The CCTDI Open-mindedness and Confidence in Reasoning subscales present an even more stark comparison.

While the Case Study group scores started below those of the EIS group and then decreased at post-intervention, the EIS group scores started higher and continued to improve.

Hypothesis 2

The second hypothesis was that posttest scores compared to pretest scores on measures of accuracy for decision making assessed by the TAI would be higher for the experimental group than for the comparison group.

An analysis of TAI Accuracy subscale using a mixed-model ANOVA is shown in Table 12. The interaction was not statistically significant in this case. Therefore, the researcher concluded that the pre- to post-intervention change was approximately the same within the two experimental groups, and the observed differences in this sample (3.6 versus 4.4) are due to nothing more than a sampling error. The research hypothesis that the EIS intervention will cause greater change scores than the Case study intervention on the TAI Accuracy subscale was not supported by these findings.

Table 12. *Means, Standard Deviations, Pre-intervention to Post-intervention Changes, and Tests of Interactions between Experimental Groups for the Accuracy TAI Subscale*

Timeframe and	Case Study group		EIS Group	
Pre/post Change	Mean	SD	Mean	SD
Pre-intervention	48.0	9.8	48.7	8.9
Post-intervention	51.6	9.9	53.1	9.5
Pre/post Change	3.6		4.4	

The mixed-model ANOVA (shown in Table 13) produced *p* values for the pre- to post-intervention main effect, as well as the overall difference between the Case Study and EIS group. The main effects for the pre- to post-intervention were found to be statistically significant for the TAI Accuracy subscale, $F_{1,115} = 14.048$, $p < .001$. However, this effect was already examined in a slightly different way in Table 8. The main effect between the two experimental groups averages the pre- and post-intervention values, and examines whether these averages are different for the two groups. The main effect for the TAI Accuracy subscale of was not found to be statistically significant, $F_{1,115} = 0.557$, $p < .457$.

Table 13. *Mixed-model ANOVA Analysis of the TAI Accuracy Subscale with Between-subject, Within-subject, and Interaction Effects*

ANOVA Effect Source	Type III Sum of Squares	Degrees of Freedom	Mean Square	*F*	*p* value
Case Study versus EIS Groups	64.615	1	64.615	0.557	.457
Pre- versus Post-Intervention	926.59	1	926.59	14.048	<.001
Groups × Pre/post Interaction	9.457	1	9.457	0.143	.706
Within-subjects Error Term	7585.04	115	65.957		
Between-subjects Error Term	13347.8	115	116.07		

Hypothesis 3

The third hypothesis was that posttest scores compared to pretest scores on measures of efficiency for decision making assessed by the TAI would be higher for the experimental group than for the comparison group.

An analysis of the TAI Efficiency subscale of using a mixed-model ANOVA is shown in Table 14. The interaction was not statistically significant in this instance. Therefore, the researcher concluded that the pre- to post-intervention change was approximately the same within the two experimental groups, and that the observed difference in this sample (6.7 versus 9.4) was due to nothing more than a sampling error. The research hypothesis that the EIS intervention will cause greater change scores than the Case Study intervention on the TAI Efficiency subscale was not supported by these findings.

Table 14. *Means, Standard Deviations, Pre-intervention to Post-intervention Changes, and Tests of Interactions between Experimental Groups for the Efficiency TAI Subscale*

Timeframe and Pre/post Change	Case Study group		EIS Group	
	Mean	SD	Mean	SD
Pre-Intervention	37.0	10.1	36.9	11.0
Post-Intervention	43.7	12.4	46.3	11.8
Pre/post Change	6.7		9.4	

Performing the mixed-model ANOVA (shown in Table 14) produced *p* values for the pre- to post-intervention main effect, as well as the overall difference between the Case Study and EIS groups. The main effects for the pre- to post-intervention were found to be statistically significant for the TAI Efficiency subscale, $F_{1,115} = 43.967$, $p < .001$. However, this effect was already examined in a slightly different way in Table 8. The main effect between the two experimental groups averages the pre- and post-intervention values, and examines whether these averages are different for the two groups. The main effects for the TAI Efficiency subscale was not found to be statistically significant, $F_{1,115} = 0.516$, $p < .474$.

Table 15. *Mixed-model ANOVA Analysis of the TAI Efficiency Subscale with Between-subject, Within-subject, and Interaction Effects*

ANOVA Effect Source	Type III Sum of Squares	Degrees of Freedom	Mean Square	*F*	*p* value
Case Study versus EIS Groups	88.547	1	88.547	0.516	.474
Pre- versus Post-intervention	3804.99	1	3804.99	43.967	<.001
Groups × Pre/post Interaction	109.053	1	109.053	1.260	.264
Within-subjects Error Term	9952.33	115			
Between-subjects Error Term	19753.4	115			

Parametric approaches, such as Student *t* tests, Student repeated measures *t* test, ANOVA, ANCOVA, and Satterthwaite analyses were used in other situations. These approaches have a normality assumption as well as a homogeneity of variance assumption regarding the dependent variable. The normality assumption states that the groups have a Gaussian-shaped frequency distribution in the population on the dependent variable within each of the groups being studied. However, this normality assumption is only a “soft” assumption in that the sampling distribution of ANOVA and ANCOVA hypothesis tests has been shown to be relatively normally distributed even when the raw measures are not (Bartlett, 1935; Geary, 1947; Pearson & Please, 1975). In any event, this “soft” assumption was examined via the Shapiro-

Wilk test. The homogeneity of variance assumption states that the variance of the groups being compared will be the same in the population and that any observed differences in variances of the sample groups is nothing but sampling error. The Levene test was used to examine the homogeneity of variance assumption.

Chapter Five: Discussion

This randomized controlled trial examined the effectiveness of electronic interactive simulation (EIS) compared to traditional paper case studies on the critical thinking disposition and clinical judgment skills of senior nursing students utilizing Kolb's experiential learning as a theoretical framework. In addition to a summary of the key findings, this chapter presents conclusions, recommendations for further research, and study implications.

Sample Demographics and Participant Attrition

Demographic characteristics for the comparison (Case Study) and experimental (EIS) groups showed no significant difference at baseline. Initially, 121 participants entered the study and four withdrew before completing the study protocol. It is not known why the participants left the study; they attended the recruitment and first day of data collection but not the final day of data collection. Of the four, three were in the comparison Case Study group and one was in the experimental EIS group. Three were from MSU and one was from MTSU. The loss of four participants was considered a low attrition rate that did not limit the study. All data from these participants was destroyed and was not included in the study analysis. The distribution of total participants was 12.8% from BU, 31.6% from MSU, and 55.6% from MTSU. The participation rate was consistent across the sampling pool for all seniors at BU, MSU, and MTSU. Recruitment exceeded the necessary power analysis and was considered adequate to detect an effect.

Study participants were primarily 18–24 year old (68.4%) Caucasian (87.2%) females (82.9%) who had not earned a post high school academic degree (77.8%). Mean age for the study population was 25.5 years. While males and minorities were underrepresented in this study, the sample was consistent with the demographic composition of the target population. Males comprised 17.1% of the sample and those who self-identified as African descent, Filipino, Hispanic, and East Indian represented 12.8% of the sample. Underrepresentation of males and minorities in the sample was a limitation of this study and limits generalizability of findings to men, those of non-Caucasian ethnicity, and people older than 24 years of age.

Previous healthcare experience, or previous exposure to discussions of healthcare experiences, was considered a potential confounding variable for this study. A majority of participants (69.2%) self-reported having fewer than 10 months of healthcare experience, excluding school-related clinical experiences. The remaining 30.8% reported having no previous healthcare experience. All senior nursing student participants were assumed to have an equivalent amount of school-related clinical practice, and therefore were not asked about such experience in the demographic survey. The potential for participants to have secondary knowledge gain also was identified as a concern for this study. Three questions were included on the demographic survey to control for any pre-existing knowledge about triage nursing. The questions required basic healthcare knowledge and an understanding of the triage categories. While it was assumed that all senior BSN students have a basic understanding of many healthcare issues, not all students have previous knowledge of the triage system. The difference between the experimental and comparison groups was not statistically significant for any of the three questions. Therefore, it was appropriate to assume that prior triage knowledge was relatively evenly distributed between the two experimental, and should not act as a confound to interpreting subsequent results.

All of the demographic variables were considered potential confounds and analyzed separately for both the experimental groups. A comparison of these variables—gender, age, ethnicity, highest degree earned, university, previous healthcare experience, as well as accuracy in assigning patient acuity, an appropriately skilled nurse, or physical space—indicated no statistically significance differences between the groups. Based on this analysis, these variables were not considered limitations to the study.

Study participants were senior nursing students currently enrolled in the final academic year of a baccalaureate nursing program at three universities located in the Southeast United States. Although registered nurse licensure is granted by state governments, accreditation for nursing programs in the United States is governed by two national organizations, the CCNE or the NLNAC. Further, all registered nurses have passed a version of the national certification exam, known as the NCLEX-RN©. It was assumed that all senior nursing students in the United States are equivalent regardless of geographic region. Therefore, there is no limitation for generalizability of the findings within the United States. However, generalizability to areas outside the U.S. may be limited. Data were collected only in baccalaureate nursing programs, which limits generalization to Associate Degree, RN-to-BSN, or Master's nursing programs, and possibly to freshmen, sophomore, or junior nursing students.

Instruments

This study used two instruments, the TAI and the CCTDI.

TAI

This instrument was designed to test decision making, which was operationalized as accuracy and efficiency for this study. Two versions of the TAI were used for each group in both the pretest and posttest to avoid weaknesses of history or maturation of testing. If a participant completed Version 1 as a pretest, he or she completed Version 2 as a posttest. This two-test strategy controlled for history so that participants did not see the same scenarios more than once.

As previously described, the TAI is a new instrument developed for this study and tested in a pilot study as well as in this study. Both the pre-intervention and post-intervention timeframes of the TAI were examined for reliability. Pearson's product moment correlation coefficient was used as an indicator of reliability, comparing the even versus odd split halves. All the correlation coefficients were statistically significant and all were above .59. The TAI consistently provides reliability coefficients above the medium range, approaching the high range in some cases. For a newly developed instrument, this was felt to be quite adequate support for the reliability of the instrument.

Kuder-Richardson 20 coefficients (KR20) were calculated on the individual items of the TAI for both versions and for the pre-intervention and post-intervention timeframes. At the pre-intervention timeframe, for version one, the KR20 = .700 ($p < .001$), and for version two, the KR20 = .545 ($p < .001$). At the post-intervention timeframe, for version one, the KR20 = .525 ($p < .001$), and for version two, the KR20 = .537 ($p < .001$). When comparing these to the Pearson correlations, we see that they are not quite as strong. However, these KR20 coefficients are examining the overall correlations of the individual items of the TAI, whereas the Pearson correlations are examining the reliability of an overall (split half) test score. Given the different nursing experiences of the study participants, it might be expected that different participants would have more expertise in some areas than others, causing various specific items to not be well correlated, even while the overall reliability of the TAI may be quite good. These KR20 values were felt to be adequate toward demonstrating a reasonable degree of reliability for the TAI.

Given that the questions are directly related to nursing situations, it is felt that the face validity of the TAI was quite strong. It must be admitted that convergent and discriminant validity were not examined. This would take administering an instrument measuring a similar construct to a group of participants, and this was not performed in this study. A further examination of the validity of the TAI must be deferred to a possible future study.

CCTDI

This well-established instrument is proven for empirical and conceptual studies of human reasoning behavior (Facione & Facione, 1996) and specifically designed to measure the disposition to engage problems and make decisions using critical thinking. There is only one version of the CCTDI and groups were tested two times, which presented a potential limitation of history or maturation. The CCTDI uses a six-point Likert format—with responses ranging from "strongly agree" to "strongly disagree"—and is proven reliable as a pre- and post-test to measure critical thinking disposition (Godzyk, 2008). Test/retest reliability results in CCTDI coefficients that are equal to or exceed .80 when the Time 2 administration is given two weeks after the Time 1 administration. This criterion was met in this study design. Based on previous empirical evidence and the format of the study's primary hypotheses—that address change score differences between two randomly created groups and not the actual magnitude of the pretest and posttest changes—test history or maturation was not believed to be a limitation for this study. The CCTDI's composite, or overall, score and seven subscale scores, yield eight dependent variables that can be examined for change. Scores on each of the subscales range from 10 to 60 and were analyzed on a continuum to provide statistical support.

Hypothesis 1

It was hypothesized that posttest scores compared to pretest scores on measures of disposition toward critical thinking assessed by the CCTDI would be higher for the experimental group (EIS) than for the comparison group. Disposition toward critical thinking, or a tendency to use critical thinking, is a concept that relates to Kolb's ELT stage of Intention. During this stage, the learner must use critical thinking skills to move from Apprehension of concrete information to an understanding of complex situations in ELT's stage of Comprehension. Application of the ELT theory led to a research question that asked if there would be an increase in critical thinking disposition associated with the use of EIS compared to paper case studies. The group CCTDI scores were analyzed to determine if there was an increase in the use of critical thinking skills from the pretest to the posttest.

The findings indicated that there was a significant change in three of the CCTDI subscale scores and the overall score. On the overall CCTDI score, the Case Study group began at a higher mean (M=305.0) than the EIS group (M=301.4). The EIS group scored higher on the post-intervention (M= 305.6), demonstrating a significant change (M=4.2) and indicating that the EIS intervention did improve critical thinking disposition. Another notable finding was that the post-intervention Case Study group mean actually went down (M=301.2) leaving a finding of M= -3.8. In light of this result, it appears that not only was the EIS more effective, the case method may have diminished the tendency to use critical thinking skills. It is unknown why this phenomenon occurred, however, considering the ELT framework, the linear process of a static problem presentation seen in the case study intervention might have reinforced rule-oriented thinking that does not encourage reflection on previous experience. Such reliance on abstract principles for decision making is consistent with Benner's description of the novice nurse and her assertion that experience is necessary to move beyond this type of thinking (Benner, 1982). Another consideration was that the multiple stimuli within the EIS—such as the background noises of a busy emergency room, visual pictures, and written text—creates a sense of immersion in the situation that was lacking in the paper case studies.

The CCTDI's Truthseeking, Open-mindedness, and Confidence in Reasoning subscales showed significant increases in the EIS group compared to the Case Study group. The Truthseeking subscale is described as the habit of always desiring the best possible understanding of any given situation even if the information is not congruent with pre-existing beliefs. Truthseeking is associated with an ability to detect what are known as informal fallacies, which are psychologically persuasive but logically incorrect arguments. Higher scores on this subscale indicate that the person will avoid bias that ignores good reasons and relevant evidence in order to avoid difficult ideas. In the Truthseeking subscale, the beginning mean (M=37.5.7) increased in the post-intervention (M=39.5) for the EIS group while the Case Study group's pre-intervention score (M=38.6) went down slightly in the post-intervention score (M=38.3). Individual subscale scores for the CCTDI are grouped into categories with a description of the characteristics associated with each range. Scores that fall into the 30 to 40 range are indicative of ambivalent or inconsistent endorsement of the attitude or attribute being measured. Individual test takers are frequently seen to move from this score category to a higher range score as a result of completing an educational or training program aimed at the scale construct and there is upward movement in the EIS group, though there is not a large enough increase to consider a meaningful clinical significance. A slight decrease is seen in the Case Study group and also does not indicate meaningful clinical significance.

Open-mindedness is the tendency to consider views other than those held by the individual; the opposite of open-mindedness is intolerance of other's ideas. A lack of open-mindedness may block consideration of important information and impair processing during the ELT stage of Intention. This study showed a decrease in this subscale for the comparison Case Study group. It is noted that a negative change in scores from pre-intervention to post-intervention may indicate non-reflective strategies to address life and work problems (Insight Assessment, 2013). A lack in the critical thinking disposition construct of Open-mindedness may lead to false conclusions, as not all information may be processed. The Case Study group began with a pre-intervention score (M=41.7) and decreased to (M=40.3), showing a negative change (M= -1.4). The EIS group began with M=42.3 and ended with M=43.0, a statistically significant change. The established boundaries for interpretation of clinical significance show that the EIS group remains solidly in the 40-50 range. This indicates consistent endorsement and valuation of the attitude or attributes being measured. The Case Study group began on the low end of the range and dropped further; this may indicate a move toward ambivalent or inconsistent use of this attribute.

Confidence in Reasoning is the habitual tendency to trust reflective thinking to solve problems and to make decisions while rejecting the practice of doubting one's judgment. Confidence in Reasoning may be used in several of the ELT stages for understanding, thereby demonstrating how this construct affects learning. Reflective thinking occurs during the Intention stage and requires the thinker to assimilate information from a particular Apprehension into a coherent pattern during Comprehension. A lack of confidence in reasoning may inhibit or slow the thinking process when the tendency to doubt oneself and one's decisions arises. Once a decision is made, a lack of confidence in reasoning may impede the experiential learning process as the thinker lacks the self-assurance required to extend a behavioral action into the outside world. The theoretical model states that transformation, or grasp, of an experience, occurs through "Extension and grounding of ideas and experiences in the external world and through internal reflection about the attributes of these experiences and ideas" (Kolb, 1984, p. 52). It is apparent that a lack of confidence in one's reasoning ability might lead to hesitation in following through with the action that demonstrates clinical judgment. Findings from the study indicate that the EIS group improved from pre-intervention (M=44.1) to post-intervention (M=44.9) for a positive change (M=0.8) for the Confidence in Reasoning construct. The Case Study group began slightly lower than the EIS group (M=43.7) and decreased even further (M= 42.9) with a negative change (M= -0.8). The findings for these three subscales are statistically significant to support the hypothesis that that posttest scores compared to pretest scores on measures of disposition toward critical thinking assessed by the CCTDI would be higher for the experimental (EIS) group than for the comparison (Case Study) group. Although statistical significance is seen for the CCTDI's Truthseeking, Open-mindedness, and Confidence in Reasoning subscales only the Open-mindedness subscale may be presented as a possible meaningful clinical significance.

While measures of the other four CCTDI subscales—Inquisitiveness, Analyticity, Systematicity, and Maturity of Judgment—did not reach statistical significance, some demonstrated a trend that helped support the hypothesis. Inquisitiveness is intellectual curiosity or an eagerness to acquire new knowledge, even knowledge that may not be useful now. The opposite of inquisitiveness is indifference. Pre-intervention Inquisitiveness scores for the Case Study group (M=46.1) decreased post-intervention (M=45.9), for a net loss of -0.2. The EIS group pre-intervention score (M=47.2) also decreased post-intervention (M=46.9) for a loss of -0.3. There is no statistical significance for this change.

The Analyticity construct was defined as the tendency to be alert to and striving to anticipate both the good and bad potential consequences of situations and decisions. A lack of analyticity might indicate that the person accepts ideas uncritically. A definite trend was seen in the results of this subscale. The Case Study group pre-intervention score (M=46.1) decreased post-intervention (M=45.1) for net loss of -1.0. The EIS group pre-intervention score (M=44.6) also decreased post-intervention (M=44.3) for a loss of -0.3. It is unknown why both groups would decrease in this area. Although there was a decrease in each group for this construct, the decrease was much greater for the Case Study group than the EIS group.

A person who exhibits a strong tendency for critical thinking will score higher on the Systematicity subscale than someone who typically does not sort or group his or her thoughts into a coherent pattern. A tendency toward systematicity is seen in someone who approaches problems in a disciplined, orderly, and systematic way. A lack of systematicity may occur if no specific problem-solving strategy is used. A systematic approach to examining all that one knows about a phenomenon and reflecting on this knowledge occurs during the Intention phase. Study results indicated that the Case Study group (M=42.9) started slightly higher than the EIS group (M=42.0) on this subscale. However, the score for the Case Study group decreased to (M=42.7) while the EIS group increased slightly (M= 42.3). This represents a negative change for the Case Study group (M=-0.2) and a positive change for the EIS group (M=0.3). Although these numbers did not meet the threshold for statistical significance, they do show a mild trend that helps support the hypothesis.

The final construct examined for critical thinking disposition was Maturity of Judgment or the habit of seeing the complexity of issues while appreciating the need to reach a decision in a timely manner, even in the absence of complete knowledge. Characteristics that are the opposite of this construct are being imprudent, having black-and-white thinking, failing to make timely decisions, or stubbornly refusing to change when confronted with contrary evidence. ELT's Intention stage requires active reflection on "all that one knows" or has experienced regarding the phenomenon or concrete experience. This reflection on complex issues leads to assimilating, or transforming the knowledge into a coherent pattern (Comprehension). Conversely, lack of Maturity of Judgment suggests either the inability to make a timely decision or the failure to consider all evidence, perhaps ignoring some evidence deemed unworthy of consideration. The EIS group showed a gain of 0.7 (pre-intervention M=44.0 and post intervention M= 44.7) while the Case Study group showed a loss of -0.1 (pre-intervention M=46.1 and post intervention M= 46.0). Although there was no statistical significance in these changes, they seem to suggest a trend that EIS enhances this characteristic.

Results showed statistically significant differences in the degree of change between the Case and EIS groups in overall CCTDI scores as well as in the Truthseeking, Open-mindedness, and Confidence in Reasoning subscales. In every category, the EIS group showed a greater positive change than the Case Study group. In two of the four CCTDI subscales that did not reach statistical significance, the Case Study group showed a negative change while the EIS group showed a positive change. This finding suggests that the traditional paper case study approach may actually decrease a disposition toward critical thinking, or diminish these attributes.

Hypothesis 2

It was hypothesized that posttest scores compared to pretest scores on measures of Accuracy (H_2) for decision making, assessed by the TAI would be higher for the experimental EIS group than for the comparison Case Study group. As a baseline, both EIS and Case Study groups' scores were combined and the results demonstrated that all participants improved from pretest to posttest for accuracy. Examining the dependent variable of Accuracy, both EIS (M=48.7) and comparison (M=48.0) groups started with similar pretest scores. Following the two week intervention period, the posttest scores increased for the EIS group (M=53.1) and for the comparison group (to M=51.6).

Considering that both the experimental and the comparison group scores on the TAI increased from pre-test to posttest, the hypothesis is not supported. However, the TAI is designed to test cognitive knowledge gain for clinical judgment skills of decision making at the application level. The instructional DVD video teaches an algorithm that assists in decision making for assigning acuity levels and both groups viewed the DVD. This type of decision-making is associated with beginning levels of experience that depends on rules and rarely considers a holistic picture. The fact that both group's scores increased suggests that both educational methods, the EIS and the paper case studies combined with the standardized recorded lecture video, are effective for increasing the knowledge base needed for beginning clinical judgment skills for acuity level assignment. It is noted that although there was no statistical difference, the trend for enhanced clinical judgment skills, measured by the TAI was greater for the EIS group than the Case Study group. This small difference between groups may represent the effect of increased critical thinking disposition rather than an increase in cognitive knowledge gain.

Hypothesis 3

This hypothesis proposed that posttest scores compared to pretest scores on measures of Efficiency for decision-making, assessed by the TAI, would be higher for the experimental group than for the comparison group. It was noted earlier that a student's lack of confidence might lead to hesitation in following through with a clinical judgment. This phenomenon may be part of the reason for the following findings. The EIS efficiency pretest score (M= 36.9) and the posttest score (46.3) indicated a positive change in the mean score. The Case Study group began with a pretest score similar to the experimental group (M=37.0) then increased to a smaller degree on the posttest score (M=43.7). Similar to the results on accuracy, statistical significance is not reached, however a higher trend is seen in the experimental group compared to the comparison group.

Theoretical Framework Implications

Findings generated from this study have important implications for the use of Kolb's ELT (1984) in guiding future research of critical thinking disposition and clinical judgment skills. Study findings supported the usefulness of ELT for understanding how clinical judgment skills are developed and for testing pedagogy aimed at enhancing the critical thinking disposition constructs that support clinical judgment. Senior pre-licensure BSN students enrolled in the experimental EIS group demonstrated improvement in three of the seven Critical Thinking

Disposition subscales. In addition, a trend in the remaining subscales suggested improvement compared to the Case study comparison group. The position of each of the seven constructs can be plotted within the ELT's learning cycle. Advocates of experiential learning tend to draw heavily on Kolb's work and multiple studies, in an array of disciplines, have tested or used ELT to guide pedagogy. However, additional studies are needed to develop a middle-range theory specific to nursing and EIS.

Clinical Educational Implications

Patient safety is a priority issue in nursing research and health policy. Higher patient acuity levels and a shortage of nurses combine to form a perfect storm where inexperienced nurses are more likely to commit clinical judgment. While nursing educators agree that there is a need for experiential learning, it has become increasingly difficult to secure the amount of direct patient care and clinical experience necessary to prepare new graduate nurses. High-fidelity simulation has been embraced as a safe and effective method for experiential learning and instruction in nursing education; however, the high cost of equipment and limited experiences per student reduces the practicality of this teaching/learning strategy. This study's findings support EIS, a computer-based interactive simulation, as a viable option for providing experiential learning to enhance clinical judgment skills. This study focused on BSN students; however, it has implications for other populations as well.

Implications for Future Research

Additional studies are needed to test this study's findings on other student populations, such as associate degree and RN-BSN nursing students, and those in graduate degree programs to become nurse practitioners, midwives, or nurse anesthetists. Similar research that applies the hypotheses to registered nurses for continuing education or in support of clinical specialty certification also is recommended.

While this study compared the teaching strategy of EIS to traditional paper case studies, research is needed to compare EIS to other methods, such as high-fidelity simulation. Terminology within this field is inconsistent and concept analysis and adoption of standardized language is needed. Outcome studies that focus on clinical judgment, patient safety, and student perception of competence following EIS use also are needed. Many state Boards of Nursing are allowing simulation to replace some percentage of required direct patient care. Would EIS meet the criteria for this requirement? Additional research is needed to support the effectiveness of EIS, as an adjunctive tool and as a primary pedagogy, for nursing education.

Future EIS research offers the opportunity for collaboration among multiple healthcare disciplines, such as medicine, occupational or physical therapy and others. Although computer-based simulation is not new, EIS—especially in its emerging forms—is quite different from simulations developed even a few years ago. Nursing students are typically younger than 25 years of age and future research should include the educational gaming technology industry that targets young adult learners. Alternate platforms should be explored; handheld devices such as smartphones or iPads are increasingly common among nursing students and offer a portable and easily accessible EIS delivery platform.

In addition to quantitative outcome studies, there is a need for qualitative inquiry into the use of EIS for teaching and learning. As an emerging pedagogy, the use of EIS will have a learning curve among educators and students. In this study, the Case Study group (M=2.19) accessed the intervention more than the EIS group (M=1.83). It is not known why this phenomenon occurred. A mixed-method approach that identifies student and faculty perceptions of EIS is recommended for future inquiry. Through interpretive dialogue, researchers may be able to uncover barriers to the use of EIS and propose future research to test strategies to overcome such barriers.

Conclusions

This study examined the effects of EIS, as compared to paper case studies, on the critical thinking disposition and clinical judgment skills of senior nursing students. Results show that participants who used EIS over a two-week period increased their scores for critical thinking disposition overall and on three of the CCTDI subscales. Results also indicated a positive trend, greater than that of the comparison group, on the remaining four subscales. It was noted that many Case Study group scores decreased suggesting that traditional paper case studies may have a stifling effect on the development of critical thinking disposition.

Retention and application of learned information was apparent for both groups, however, there was a trend for a greater change in the EIS group compared to the Case Study group. Additional research is needed to explore the effectiveness of this emerging pedagogy to add to what is known about the effects of experiential learning in healthcare professions.

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Appendices

Appendix A – Institutional Review Board Approval Letter, UTK

THE UNIVERSITY of TENNESSEE
KNOXVILLE

Institutional Review Board
Office of Research
1534 White Ave.
Knoxville, TN 37996-1529
Phone: 865-974-7697
FAX: 865-974-7400

January 8, 2013

IRB#: 9048 B

TITLE: Enhancing Critical Thinking Disposition and Clinical Judgment Skills in Senior BSN Students via Electronic Interactive Simulation

Weatherspoon, Deborah
Nursing
[redacted]

Phillips, Kenneth
Nursing
1200 Volunteer Blvd
Campus-4180

Your project listed above has been reviewed and granted IRB approval under expedited review.

This approval is for a period ending one year from the date of this letter. Please make timely submission of renewal or prompt notification of project termination (see item #3 below).

Responsibilities of the investigator during the conduct of this project include the following:

1. To obtain prior approval from the Committee before instituting any changes in the project.

2. If signed consent forms are being obtained from subjects, they must be stored for at least three years following completion of the project

3. To submit a Form D to report changes in the project or to report termination at 12-month or less intervals.

The Committee wishes you every success in your research endeavor. This office will send you a renewal notice (Form R) on the anniversary of your approval date.

[redacted]

Brenda Lawson
Compliances

Enclosure

Appendix B – Institutional Review Board Approval Letter, MTSU

Institutional Review Board
P.O. Box 134
Middle Tennessee State University
Murfreesboro, Tennessee 37132
Office: (615) 898-5005

MIDDLE TENNESSEE STATE UNIVERSITY

January 7, 2013

Deborah Weatherspoon
School of Nursing
Deborah.Weatherspoon@mtsu.edu

Protocol Title: **Enhancing Critical Thinking Disposition and Clinical Judgment Skills in Senior BSN Students via Electronic Interactive Simulation**
Protocol Number: **13-168**

Dear Investigator(s),

The MTSU Institutional Review Board (IRB), or a representative of the IRB, has reviewed the research proposal identified above and determined that the study poses minimal risk to participants. The proposal qualifies for an expedited review under 45 CFR 46.110 Category 4.

Approval is granted for one (1) year from the date of this letter using potential participants from nursing programs at Middle Tennessee State University, Murray State University and, Bethel University.

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to provide a certificate of training to the Office of Compliance. **If you add researchers to an approved project, please forward an updated list of researchers and their certificates of training to the Office of Compliance (Box 134) before they begin work on the project.** Any change to the protocol must be submitted to the IRB before implementation.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at [redacted]

Upon completion of the study you will need to submit an end-of-project report to the Office of Compliance. The report form can be found on the IRB website. Complete research means that you have finished collecting and analyzing data. **Should you not finish your research within the one (1) year period, you must submit a Progress Report and request a continuation prior to the expiration date.** Please allow time for review and requested revisions. Your study expires **January 6, 2014**.

Also, all research materials must be retained by the PI or faculty advisor (if the PI is a student) for at least three (3) years after study completion. Should you have any questions or need additional information, please do not hesitate to contact me [redacted]

Sincerely,

[redacted]

Andrew Owusu Ph.D.
Associate Professor
Department of Health and Human Performance
Middle Tennessee State University
P.O. Box 96
Murfreesboro, TN 37132

A Tennessee Board of Regents University
MTSU is an equal opportunity, non-racially identifiable, educational institution that does not discriminate against individuals with disabilities.

Appendix C – Institutional Review Board Approval Letter, MSU

IRB Authorization Agreement

Name of Institution or Organization Providing IRB Review (Institution A): University of Tennessee, Knoxville

IRB Registration #:00000103 Federalwide Assurance (FWA) #:00006629

Name of Institution Relying on the Designated IRB (Institution B):
Murray State University (MSU)
OHRP Federalwide Assurance (FWA)#: 000001496

The Officials signing below agree that Murray State University may rely on the designated IRB for review and continuing oversight of its human subject research described below:

This agreement is limited to the following specific protocol(s):

Name of Research Project: Enhancing Critical Thinking Disposition and Clinical Judgment skills in Senior BSN Students via Electronic Interactive Stimulation

IRB Protocol Numbers for both institutions: UTK #9048B / MSU #13-068

Name of Principal Investigator: Deborah Weatherspoon

Sponsor or Funding Agency:______________________**Award Number, if any:**______________

(___) Other (describe):

The review and continuing oversight performed by the designated IRB will meet the human subjects protection requirements of Institution B's OHRP-approved FWA. The IRB at Institution A will follow written procedures for reporting its findings and actions to appropriate officials at Institution B. Relevant minutes of IRB meetings will be made available to Institution B upon request. Institution B remains responsible for ensuring compliance with the IRB's determinations and with the terms of its OHRP-approved Assurance. This document must be kept on file at both institutions and provided to OHRP upon request.

Signatures:

Authorized Official of (A): [redacted]	Authorized Official of (B): Murray State University
[redacted]	[redacted]
signature *date*	*signature* *date*
Brenda Lawson Compliance Officer/IRB Administrator University of Tennessee Knoxville 1534 White Avenue Knoxville, TN 37996-1529	Paula J. Waddill, Ph.D. Chair, Murray State University IRB Murray State University 202 Wells Hall Murray, KY 42071
[redacted] blawson@utk.edu	[redacted] (email) pwaddill@murraystate.edu

Appendix C – Institutional Review Board Approval Letter, BU

College of Health Sciences
325 Cherry Avenue
McKenzie, TN38201

BETHEL UNIVERSITY
COLLEGE OF HEALTH SCIENCES

Phone: 731-352-6757
Fax: 731-352-2771
www.bethelu.edu

January 14, 2013

Authorization for the identified principal investigator to perform the identified research project following University of Knoxville IRB Review.

Principal Investigator: Deborah Weatherspoon

Name of Research Project: Enhancing Critical Thinking Disposition and Clinical Judgment Skills in Senior BSN Students via Electronic Interactive Stimulation

IRB Protocol number for UTK: UTK #9048B

Bethel University does not currently have a constituted IRB but is in the process of developing this board.

Members of the IRB have been identified and are working to formalize the Board.
Ms. Weatherspoon's IRB proposal that was submitted to and approved by the University of Tennessee Knoxville IRB was reviewed by the sitting members of the Bethel IRB development committee members. A unanimous vote was registered to accept the IRB review and oversight provided by the University of Tennessee Knoxville for Bethel University.

Ms. Weatherspoon is given permission to conduct research at Bethel University limited to the protocol agreed upon between Ms. Weatherspoon and UTK IRB.

Sincerely,

[redacted]

Mary Bess Griffith
Vice-Chairperson – Bethel IRB Development Committee
325 Cherry Ave
McKenzie, TN 38201

[redacted]

griffithmb@bethelu.edu

Vita

Deborah L. Weatherspoon attended the University of Memphis, where she received an Associate Degree in Nursing and began a career as a registered nurse in 1978. She completed studies at the Middle Tennessee School of Anesthesia and has held a national certification as a certified registered nurse anesthetist (CRNA) since 1982. Following a diverse career providing anesthesia services, primarily in underserved rural areas in the United States, she completed her BSN at Excelsior College, NY (2005) and a MSN with a focus of nursing education from Middle Tennessee State University, Murfreesboro, TN (2009). Currently, Deborah is a PhD candidate at the University of Tennessee, Knoxville and will complete her degree requirements in May 2013.