COMPARISON OF SIMULATION-BASED PERFORMANCE WITH METRICS OF CRITICAL THINKING SKILLS IN NURSING STUDENTS: A PILOT STUDY

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ABSTRACT

Alternative approaches to evaluating critical thinking skills are needed, as pencil and paper assessments may not accurately predict simulated or actual clinical performance. To ensure patient safety, it is imperative to determine how to best promote and measure critical thinking skills. Few studies have examined how these skills are related to performance in a simulated or actual clinical setting. The purpose of this study was to examine the relationship between metrics of critical thinking skills and performance in simulated clinical scenarios and identify predictors of simulation-based performance of nursing students in their last term of academic preparation.

A convenience sample of 36 student nurses prepared at the diploma (n=14), associate (n=12), and baccalaureate (n=10) level in their last term of academic preparation participated in a measurement of critical thinking skills and simulation-based performance using videotaped vignettes (VTV), high-fidelity human simulation (HFHS), and two standardized tests: the California Critical Thinking Disposition Inventory (CCTDI) and California Critical Thinking Skills Test (CCTST). Simulation-based performance on the VTV and HFHS assessment was rated as "meeting" or "not meeting" overall expectations and in six categories: problem recognition, reports essential data, initiates appropriate nursing interventions, anticipates medical

orders, provides rationale, and prioritizes the situation. Student scores on the CCTDI and CCTST were categorized as strong, average, or weak critical thinking disposition or skills.

A majority (75.0%) of students did not meet overall performance expectations when assessed using VTV and HFHS. Those not meeting expectations had difficulty recognizing the clinical problem and reporting the appropriate findings to the physician. There was no significant difference between overall performance based on the method of simulation (VTV or HFHS). However, more students met performance expectations for the category of initiating nursing interventions ($p=0.0002$) using HFHS. The relationships between VTV performance and CCTDI or CCTST scores were not significant except for the relationship between the category of problem recognition and overall CCTST scores (Cramer's $V = 0.444$, $p = 0.029$). There was a statistically significant relationship between HFHS performance and overall CCTDI scores (Cramer's $V = .413$, $p = 0.047$). Gender, educational preparation, internship/residency participation, prior nursing aide experience, and number of classes using HFHS as a teaching method were not related to overall VTV or HFHS performance or scores on the CCTDI or CCTST. However, there was a significant relationship between age and overall CCTST scores (Cramer's $V = .388$, $p = 0.029$). The CCTDI, CCTST, and level of educational preparation were not statistically significant predictors of VTV performance.

Student nurses' performance reflected difficulty meeting expectations when tested in both simulated settings. HFHS appeared to best approximate scores on a standardized metric of critical thinking. Further research is needed to determine if results of simulated performance predicts application of critical thinking skills in a clinical setting.

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PREFACE

An unknown author was once quoted as saying that the "road to success is lined with many tempting parking spaces". Over the past 3 years, I have often contemplated pulling off the road and taking a rest in one of those spaces.

Fortunately, the University Of Pittsburgh School Of Nursing has offered me both the financial and emotional support to keep moving forward. The unconditional guidance and strength of Dr. Leslie Hoffman and my dissertation committee is greatly appreciated and I only hope I will be given the chance to pay it forward. I would also like to acknowledge John O'Donnell and the Peter M. Winter Institute for Simulation, Education, and Research for their generosity and expertise. The talented faculty within the School of Nursing has also donated charitably to this project. Special thanks to Dr. Zullo, Dr. DeVito Dabbs, Dr. Kitutu, and Dr. Samosky for their expertise and willingness to support me in this endeavor.

Finally, I would like to thank my family and friends, for without them I would not have persevered. Their patience has been tremendous, and their encouragement uplifting. Through this experience, I hope my children have learned how important it is to set a goal and stick with it even through hard times. If they understand this, their success in life is unlimited.

1.0 PROPOSAL INTRODUCTION

The Institute of Medicine (IOM) recently reported that hundreds of thousands of errors occur in the health care system (Kohn, 2000). Patient safety can be directly impacted by the critical thinking ability and clinical performance of the nurse. Nurses must maintain a high level of vigilance and clinical judgment to detect early changes in patient status that signal the need for intervention (Buerhaus et al., 2005), thus patient safety is directly influenced by the critical thinking ability and clinical performance of the nurse. This ability requires advanced problem solving and expert communication skills (NACNEP, 1996). Using root cause analysis, the Joint Commission of Accreditation of Healthcare Organizational Standards (JCAHO) identified deficiencies in orientation, training, and competency assessment of healthcare providers as top factors contributing to patient safety errors in recent years (1995 to 2005) (JCAHO, 2006).

New graduate nurses practice at the novice or advanced beginner level (Benner, 1984). They are at the early stage of developing a skill set and applying critical thinking. Due to the nursing shortage and budgetary issues, the orientation period for new graduates has been condensed (AORN, 2006), a potential factor contributing to errors. Performance based evaluation is one means of determining whether new graduates posses the critical thinking and clinical performance skills necessary to promote patient safety, or require a more extended orientation.

Critical thinking is thought to be a key component of nursing practice, education and knowledge (Alfaro-LeFevre, 2004), yet it is ambiguously and inconsistently defined and applied within the profession (Duchscher, 2003). Furthermore, the relationship between critical thinking skills and simulated or actual clinical performance is unclear. Paper and pencil or multiple-choice computerized assessments of critical thinking pose significant challenges in application (Duchscher, 2003) as they represent an assessment of the nurses' proposed, rather than actual clinical performance. Simulated methods of assessing performance such as videotaped vignettes (VTV) and high-fidelity human simulation (HFHS) offer alternatives to paper and pencil or computer-based examination. VTV provide a narrative action assessment; the nurse observes an actor portraying a patient in a clinical setting and provides a written description of his/her proposed actions and rationale (Performance Management Service, Inc., 2007). HFHS provides an experiential action assessment that allows the operator to create scenarios that simulate events encountered in clinical practice; the nurse manages the simulated event facilitating translation of critical thought into action. Both performance assessment methods have the goal of identifying specific areas of deficiency and providing remediation to support safe clinical practice. However, there are notable differences. Assessment via VTV is based on reflective, passive responses elicited from watching a videotape of an actor portraying a patient in a potentially critical situation. There is no mannequin, medical equipment, or requirement to integrate both cognitive and psychomotor skills. In contrast, HFHS promotes a more active/interactive environment that encourages independence, application of knowledge, and self-direction.

To date, no studies have evaluated the relationship between metrics of critical thinking skills and simulation-based performance. Furthermore, there is limited literature about the areas

of clinical performance that are weakest. Such information is needed to direct efforts to improve nursing education and practice.

1.1 PURPOSE & SPECIFIC AIMS

The purpose of this study was to examine the relationship between metrics of critical thinking skills and performance in simulated clinical scenarios and identify predictors of simulation-based performance of nursing students in their last term of academic preparation.

1.1.1 Specific Aims

1. Compare simulation-based performance scores for videotaped vignettes (VTV) and high-fidelity human simulation (HFHS) of student nurses enrolled in their last term of academic preparation.
2. Determine the relationship between critical thinking skills scores (California Critical Thinking Skills Test [CCTST], California Critical Thinking Disposition Index [CCTDI]) and simulation-based performance scores (VTV and HFHS) of student nurses enrolled in their last term of academic preparation.
3. Identify predictors of simulation-based performance (VTV and HFHS) of student nurses enrolled in their last term of academic preparation.

1.2 OPERATIONAL DEFINITIONS

The concepts examined in this study included, simulation-based performance, videotaped vignettes, high-fidelity human simulation, student nurses, and critical thinking skills.

Simulation-Based Performance are activities meant to mimic the reality of a clinical situation (Jeffries, 2005). The ability to 1)recognize a critical patient problem, 2) report essential clinical data, 3) initiate independent nursing interventions and assessments, 4) anticipate medical orders, 5) understand decision rationale, and 6) prioritize care. Simulation-based performance was measured by scores on the VTV and HFHS assessment.

Videotaped Vignette (VTV) is a narrative action assessment method utilizing a videotaped clinical scenario. The assessment is based on reflective, passive, written responses elicited from watching a videotape of an actor portraying a patient in a potentially critical situation. It assesses the nurses' ability to determine the course of action to take in a patient situation including prioritization and explanation.

High Fidelity Human Simulation (HFHS) is an observational action assessment method using a high-fidelity, lifelike computerized mannequin that can be programmed to respond to real-world inputs and thereby allow an interactive assessment of the course of action an individual takes in a critical patient situation including prioritization and explanation. HFHS promotes an active/interactive environment that encourages independence, application of knowledge, and self-direction.

Student Nurses are enrolled in their last term of academic preparation in a diploma, associate, or baccalaureate program and has not obtained licensure to practice as a registered nurse.

Critical Thinking Skill is conceptually defined as the process of purposeful, self-regulatory judgment giving reasoned consideration to evidence, context, conceptualizations, methods, and criteria. Critical thinking skills represent the ability to draw conclusions in the areas of analysis, inference, evaluation, deductive reasoning, and inductive reasoning (Facione et al., 2002a). In this study, skills are measured by scores on the California Critical Thinking Disposition Inventory (CCTDI) and California Critical Thinking Skills Test (CCTST).

2.0 BACKGROUND AND SIGNIFICANCE

Patient safety is at the center of today's healthcare system reform. According to the Institute of Medicine (IOM), more than 98,000 Americans die and more than one million patients suffer injuries each year due to preventable medical errors (Kohn, 2000). Thirty to forty percent of every dollar spent on healthcare is lost to inappropriate use, poor communication, and inefficiency (Proctor, 2005). The aims of the IOM for the 21st century healthcare system include providing safe, effective, patient-centered care that is timely, efficient, and equitable (IOM, 2001).

Nursing competency plays an important role in assuring patient safety (IOM, 2004). A majority of sentinel events, defined as an unanticipated event in the healthcare delivery system resulting in death or serious physical or psychological injury, occur in the acute care setting where new graduate nurses traditionally begin their professional careers (JCAHO, 2006). According to the Joint Commission International Center for Patient Safety, over 70% of sentinel events reported resulted in the patients' death and 10% resulted in a loss of function (JCRINC, 2007). Subsequent root cause analyses in which healthcare organizations learn from consequences, identified processes involved in orientation, training and competency assessment as contributing factors to sentinel events (JCAHO, 2006). The inability of a nurse to set priorities and work effectively and efficiently may delay patient treatment in a critical situation and result in serious life-threatening consequences (Redfern, 2002).

Currently, there is a call to transform assessment of new graduate competencies to match practice settings and patient care needs (Arnold et al., 2006; Maddox et al., 2001). Smith et al. (2007) surveyed pedagogical strategies used in member schools of the American Association of Colleges of Nursing (AACN). Most schools reported using readings (84%), lecture (83%), and clinical experience (75%) as core strategies to assess the six competencies set forth by the *Quality and Safety Education for Nurses* (QSEN) project (patient centered care, teamwork and collaboration, evidenced-based practice, quality improvement, safety, and informatics) (Cronenwett et al., 2007; Smith et al., 2007). Only 43% of schools reported the use of simulation as a core method of evaluation.

Novice nurses must begin their practice with the knowledge, skills, and attitudes to achieve the competencies set forth by the QSEN project (IOM, 2003). Potential gaps between what is being taught, expectations of the practice setting and evaluation methods need to be examined in order to ensure quality and safe new graduate practice. VTV and HFHS are tools that can potentially impact the evaluation of competent nursing care. Given the known risks to patient safety, it is imperative that the healthcare infrastructure utilize innovative teaching and evaluation methods to support the refinement of critical thinking skills and improve performance outcomes.

2.1 DEFINITION OF CRITICAL THINKING

Although critical thinking has been discussed since the time of Socrates and its dimensions have been explored by numerous scholars from Thomas Aquinas to John Dewey (Facione, 1990a), nursing did not begin to question how critical thinking relates to clinical practice or evaluate

ways to measure how effectively the educational system was achieving critical thinking competency until the late 1980's. This movement began, in part, to address the directive of the National League of Nursing (NLN) and the American Association of Colleges of Nursing (AACN) to measure critical thinking as an outcome criterion for the accreditation of nursing programs (AACN, 1998; Rubenfeld & Scheffer, 1999; Scheffer & Rubenfeld, 2000; Simpson & Courtney, 2002).

Despite considerable attention from scholars and educators, there is no widely accepted definition of critical thinking in the fields of nursing, psychology, or education (Simpson & Courtney, 2002). In the nursing literature, the term critical thinking is often used interchangeably with problem solving, clinical decision-making, and creative thinking (Simpson & Courtney, 2002). Problem solving focuses on identification and resolution whereas critical thinking goes beyond this and incorporates asking questions and critiquing solutions. Clinical decision-making facilitates attention to the clinical nature of the problem, but falls short of understanding the broader spectrum of the issue. Decision-making and critical thinking need to occur concurrently to provide reasoning, clarification, and potential solutions. Creative thinking is a combination of imagination and knowledge. It helps one to understand solutions that have failed and is certainly part of the subset of skills necessary to be an effective critical thinker (Simpson & Courtney, 2002).

Numerous scholars have also attempted to identify the essential attributes of critical thinking (Table 1). In 1988, a Delphi panel was established at the request of the American Philosophical Association to synthesize expert opinion on the concept of critical thinking and critical thinking assessment research. The panel concluded that interpretation, analysis, evaluation, inference, explanation, and self-regulation were necessary components to critical

thinking (Facione, 1990a, 1990b). Watson and Glaser's definition of critical thinking includes the ability to recognize the existence of the problem, determine evidence in support of what is asserted, and apply attitudes and knowledge to logically determine a course of action (Watson & Glaser, 1964; Watson & Glaser, 1980). Paul (1993) suggested that critical thinking is characterized by a process of analyzing, synthesizing, and evaluating information that is collected through observation, reflection, experience, or communication which may lead to a particular belief or action (Paul, 1993). Other critical thinking scholars define it as reasonable and reflective thinking focused on deciding what to believe and do (Ennis & Millman, 1985). Kataoka-Yahiro & Saylor identified the five components of critical thinking as having a specific knowledge base, experience, competencies, attitudes, and standards (Kataoka-Yahiro & Saylor, 1995). Beyer defined critical thinking as higher order thinking that transcends problem solving to include evaluation and reasoned judgment (Beyer, 1995). Landis & Michael (1981) include the ability to compare and contrast numerous decision alternatives.

Key elements appear among the definitions of critical thinking. Critical thinking implies an interaction between an individual and the received information. It is clearly associated with knowledge, reasoning, cognitive skills, problem identification, and exploration of alternative frames of reference. However, critical thinking extends beyond problem solving. It encompasses a greater understanding of the problem and the ability of the individual to self-regulate their judgment (Daly, 1998). The lack of a concise definition and unclear antecedents and consequences result in the inability to consistently define and therefore measure critical thinking in both the educational and practice setting.

Table 1 Critical Thinking Definitions

Definition of Critical Thinking	Source of the Definition
• Purposeful, self-regulatory judgment that results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. • The process of self-regulatory judgment; an interactive, reflective, reasoning process.	Facione (1990)
• A composite of attitudes, knowledge, and skills that include: attitudes of inquiry that involve the ability to recognize the existence of problems and an acceptance of the general needs for evidence in support of what is asserted to be true; knowledge of the nature of valid inferences, abstractions, and generalization in which the weight or accuracy of different kinds of evidence are logically determined; and skills in employing and applying the above attitudes and knowledge.	Watson & Glaser (1980)
• Reasonable and reflective thinking that is focused on deciding what to believe or do. It consists of three major components: mental operations, certain kinds of knowledge, and certain attitudes. It occurs only when all three of these components are engaged.	Ennis & Millman (1985)
• A domain-specific process of cognitive activity that determines actions. • A process that is reflective and reasonable thinking.	Kataoka-Yahiro & Saylor (1995)
• The intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered or generated by observation, experience, reflection, reasoning, or communication as a guide to belief and action.	Paul (1993)
• A higher order thinking activity that transcends problem solving to involve reasoned judgment and evaluation. • Judging the authenticity, worth, or accuracy of something.	Beyer (1995)
• Thinking that is purposeful, reasoned, and goal directed	Halpern (1989)
• An individual becoming aware of the demands of a given environmental circumstance and of evaluating numerous decision alternatives prior to taking an action that in many but not all instances may lead to the solution of the problem.	Landis & Michael (1981)
• Critical thinking involves certain skepticism, or suspension of assent, towards a given statement, established norm or mode of doing things. This skepticism might ultimately give way to acceptance, but it does not take truth for granted. Instead, it considers alternative hypotheses and possibilities.	McPeck (1981)

2.2 MEASUREMENT OF CRITICAL THINKING SKILLS

Although difficult to define, critical thinking is even more difficult to measure. In nursing, both qualitative and quantitative research studies have been conducted in an effort to understand critical thinking and/or its relationship to clinical performance.

2.2.1 Qualitative Analysis

Sedlak (1997) conducted a qualitative study attempting to describe and analyze the critical thinking processes of seven beginning baccalaureate nursing students. Paul's (1993) dimensions of reasoning were used as a framework to describe students' critical thinking. The students were asked to keep clinical journals reflecting their clinical experiences from the previous week. Structured interviews and observations were also conducted by the researcher. Four themes emerged regarding critical thinking development; professional self, perfectionism, caring, and self-directed learning. The descriptive nature of the study indicated that beginning students do indeed think critically. The study concluded that beginning students' critical thinking is developed and supported by providing opportunities for dialogue and a supportive environment (Sedlak, 1997). Haffer and Raingruber (1998) conducted an interpretive phenomenological investigation attempting to understand the experiences of clinical reasoning and development of critical thinking in 15 baccalaureate nursing students. Data were gathered through reflective journaling and the viewing and discussion of videotaped clinical scenarios. Confidence emerged as a significant theme in the development of critical thinking (Haffer & Raingruber, 1998). Jenkins and Turick-Gibson (1999) conducted a qualitative study to assess the development of critical thinking in nursing students. Ennis & Millman's (1985) definition of critical thinking

was used to guide the study. The students used role-playing and reflective journaling to describe their clinical experiences. Knowledge, attitudes, and dispositions were utilized as three pre-determined components in analyzing the data. The authors concluded that journaling played an integral role in developing critical thinking (Jenkins & Turick-Gibson, 1999). These studies have contributed to a deeper understanding of the benefits of using reflective methods to foster critical thinking during the educational tenure. Additionally, an environment supporting confidence and self-direction appears beneficial. However, the evaluation and measurement methods remain undefined and it is unclear if the process of reflection is beneficial in the transition to clinical practice.

2.2.2 Quantitative Analysis

Predominantly, the critical thinking skills of nursing students have been measured utilizing commercially developed survey instruments (Rane-Szostak & Robertson, 1996). Three measures, the California Critical Thinking Disposition Inventory (CCTDI), California Critical Thinking Skills Test (CCTST), and Watson-Glaser Critical Thinking Appraisal (WGCTA) are principally cited in the literature. Relevant studies are summarized in Table 2 and organized according to the instrument(s) employed.

The *California Critical Thinking Disposition Inventory (CCTDI)* is based on the conceptualization of critical thinking articulated in the Expert Consensus Statement on College Level Critical Thinking (1990) known as The Delphi Report (Facione, 1990). The 75-item instrument has been used nationally and internationally for learning outcomes assessment, academic advising, program evaluation, professional development, training, psychological research, and an element in application, admissions, and personnel evaluation processes (Facione

& Facione, 2001). It is designed to assess one's critical thinking dispositional profile and the critical thinking dispositions of groups. The CCTDI assesses internal motivation toward critical thinking, e.g., the disposition to use or not to use one's reasoning and reflective judgment when solving problems and making decisions.

The CCTDI has been used in several studies that examined critical thinking dispositions in the student nursing population. These studies focused on identifying differences at program entry and exit (Thompson & Rebeschi, 1999), students at various levels of the program (Colucciello, 1997), relationships between scores on these measures and the National Council Licensure Examination© (NCLEX-RN) pass rates (Giddens & Gloeckner, 2005; Stewart & Dempsey, 2005), level of educational preparation (Shin et al., 2006), and alternative pedagogical strategies (Tiwari et al., 2006).

Upon review of this literature, CCTDI scores appear to increase through a nursing student's academic tenure (Ip et al., 2000; McCarthy et al., 1999; Thompson & Rebeschi, 1999; Colucciello, 1997). Additionally, in two cited studies, CCTDI scores increased following curricular enhancement which included the use of problem based learning techniques and videotaped clinical vignettes (Tiwari et al, 2006; Yeh & Chen, 2005). Giddens & Gloeckner (2005) found on the exit CCTDI, the NCLEX-RN pass group had statistically significant higher mean scores on the overall CCTDI. However, Stewart & Dempsey (2005) found no progression of scores with advancing education or a relationship with NCLEX-RN pass rates. A positive relationship between CCTDI scores and clinical competency, grade point average, age, and gender appear unsupported (Ip et al., 2000; May et al., 1999; Thompson & Rebeschi, 1999).

The *California Critical Thinking Skills Test (CCTST)* originated from the work of Facione and the Delphi panel (1990). The authors define critical thinking as the process of

purposeful, self-regulatory judgment giving reasoned consideration to evidence, context, conceptualizations, methods, and criteria (Facione et al., 2002b). The CCTST consists of 34-items that measure the ability of the participant to draw conclusions in the areas of analysis, inference, evaluation, deductive reasoning, and inductive reasoning (Facione et al., 2002b). The items are not nursing specific. They are considered "neutral" because they are based on common situations, topics, or issues encountered in daily living (Adams et al., 1996).

The CCTST has been used in the examination of critical thinking ability of students enrolled in baccalaureate programs (Beckie et al., 2001; Thompson & Rebeschi, 1999), RN-BSN programs (White & Gomez, 2002), and in comparison to performance on the NCLEX-RN (Giddens & Gloeckner, 2005).

Some authors suggests that there is a significant improvement in CCTST scores as student nurses progress to their final year of schooling (Spelic et al, 2001; Thompson & Rebeschi, 1999; McCarthy et al., 1999; Colucciello, 1997). In a study designed to investigate the relationship of students' critical thinking skills and disposition to performance on the NCLEX-RN, Giddens & Gloeckner (2005) found on the exit CCTST, the NCLEX-RN pass group had statistically significant higher mean scores on the overall CCTST and all subscores. In contrast, curricular revisions and the addition of videotaped vignettes as a teaching method did not improve scores (Beckie et al., 2001; Chau et al., 2001. May et al. (1999) evaluated senior level baccalaureate students comparing the scores on the CCTST with scores on a faculty-created Likert-type scale designed to measure student clinical performance. Findings indicated no statistically significant correlation between the CCTST and clinical competence ratings. Additionally, in the literature reviewed, there appears no indication that CCTST scores are associated with age, gender, or grade point average (Thompson & Rebeschi, 1999).

The authors of both the CCTDI and CCTST have reported that there is a strong positive correlation between these two measures of critical thinking. Facione (1997) found a positive correlation between scores of 1557 students who completed the CCTST and CCTDI at the beginning ($r=0.201$, $p=<0.001$) and end of their educational program ($r=0.169$, $p< 0.001$). In the nursing literature, positive correlations have also been found (Colucciello, 1997; McCarthy et al., 1990). In contrast, more recent studies have shown no relationship between the two measures (May et al., 1999; Thompson & Rebeschi, 1999).

The Watson-Glaser Critical Thinking Appraisal (WGCTA) was developed to measure an individual's critical thinking ability. The authors define critical thinking as an amalgamation of an individual's attitudes, knowledge, and skills (Watson & Glaser, 1980). The instrument measures five subsets of ability; inference, recognition and assumptions, deduction, interpretation, and evaluation of arguments. The WGCTA consists of 80 items and is based on daily life situations similar to those encountered at work, school, or topics found in the media. Items are not specific to nursing and considered neutral in nature. The reliability of the instrument has been assessed using split-half reliability coefficient according to academic level, major, career, and geographic region (Watson & Glaser, 1980). The WGCTA has been shown to correlate highly with the Stanford Achievement Tests, Otis and Otis-Lennon Mental Ability Tests, Miller Analogy Test, the Scholastic Aptitude Test, and the American College Test (Adams et al., 1996; Watson & Glaser, 1980).

The WGCTA has been widely used in the evaluation of nurses' critical thinking ability. These studies focused on identifying differences at varying levels of the program (Adams et al., 1999; Daly, 2001; Vaughan-Wrobel, O'Sullivan, & Smith, 1997), perception of decision-making

related to level of experience (Girot, 2000), critical thinking skills and alternative educational pathways (Brown et al., 2001), and level of educational preparation (Shin, 1998).

Inconsistent evidence exists to support a progression of critical thinking skills through the educational tenure. Brown et al. (2001) found a significant difference in WGTCA scores prior to and exiting the nursing program in both the traditional and RN-BSN cohorts. However, no significant difference was found in subsequent studies (Daly, 2001; Girot, 2000; Adams et al. 1999; Vaughan-Wrobel et al., 1997). Girot (2000) evaluated differences in critical thinking ability and perception of decision-making ability in practice. Findings indicated no statistically significant difference across the groups tested. In a study completed in Korea, Shin (1998) compared nursing students entered into the associate degree program with those at the baccalaureate level. The study concluded that baccalaureate students had significantly higher scores than the associate degree students in both critical thinking and clinical decision making as measured by the Nursing Performance Simulation Instrument (NPSI). These findings were comparable to those in a similar study completed in the United States (Brooks & Shepherd, 1990). However, these two study results are not congruent with others which found inconsistency in the relationship between critical thinking and decision-making skills (Girot, 2000; Holzemer & McLaughlin, 1988; Gordon, 1980; Tanner, 1977). Only one study assessed the relationship between WGCTA scores and age, prior degree preparation, and previous nursing experience. A positive relationship was seen with age and prior degree. However, previous nursing experience was not a factor (Vaughan-Wrobel et al., 1997)

In summary, there is inconsistent evidence of a progression of critical thinking skills in the student nursing population based on studies utilizing the CCTST and the WGCTA. There is also limited confirmation that levels of academic preparation, age, or experience are influential

factors. Based on the studies reviewed, nursing students appear to experience an upward trend in overall critical thinking disposition (CCTDI) throughout their educational tenure; however not all subscales contribute. Many of the studies have the limitation of a small sample size and relatively homogenous population. Only two studies sampled diploma and associate prepared nursing students. Therefore, generalizability of the results is limited. Furthermore, it remains unclear whether critical thinking skills are related to simulated or actual clinical performance and/or if ones' critical thinking disposition plays a substantial role in the relationship. Only one study was identified that compared critical thinking skills (CCTST) with subjectively rated clinical performance. No significant relationship was found (May et al., 1999). Further study is needed to understand if objective, quantitatively driven measures of critical thinking skills are related to or can predict actual live or simulated clinical performance.

Of the three measures, the CCTDI and CCTST are predominantly used in the nursing literature. Both instruments have undergone extensive psychometric testing with reported alpha coefficients ranging from 0.71 to 0.90. Additionally, both have been shown to significantly correlate with grade point average, SAT math and verbal scores (Facione et al., 2002a; Facione & Facione, 2001) and NCLEX-RN pass rates (Giddens & Gloeckner, 2005). Therefore, these instruments were selected for use in the present study.

Table 2 Summary of Studies Measuring Critical Thinking in Nursing Students

Critical Thinking Measure & Author(s)	Design	Sample	Reported Reliability	Findings
CCTDI **Tiwari et al. (2006)**	Randomized controlled trial -compare the effects of problem based learning and lecturing approaches on the development of student's critical thinking	N = 79 First year undergraduate nursing students	Alpha coefficient of 0.91, with range of 0.71 to 0.80 for the 7 subscales	Significantly higher CCTDI scores for those students assigned to the problem-based learning group (p=0.0013)
Stewart, S., & Dempsey, L. (2005)	Longitudinal descriptive design -examine nursing students' disposition toward critical thinking as they progressed from sophomore to senior year	N = 55 Sophomore level baccalaureate students agreeing to be followed through their senior year	Alpha coefficient ranging between 0.67 and 0.77	No significant difference between sophomore and senior CCTDI scores, no relationship found between passing the NCLEX-RN and CCTDI scores
Yeh, M., & Chen, H. (2005)	Pre- and post-test quasi-experimental design -examine the effects of an education program using an interactive videodisc in improving dispositions toward critical thinking	N = 126 Students taking a medical-surgical course in a 2-year RN-BSN program	Alpha coefficient of 0.82	Significant difference in CCTDI scores before and after use of the interactive videodisc program (p=<0.001)
Ip et al. (2000)	Cross-sectional descriptive design -examine nursing students' disposition toward critical thinking based on stages of program completion	N = 122 Undergraduate nursing students Year 1 = 51 Year 2 = 50 Year 3 = 21	Alpha coefficient of 0.90, with range of 0.60 to 0.78 for the 7 subscales	Significant differences in CCTDI scores among the groups (F ratio=12.7), year 3 students scored the lowest, significant correlation between CCTDI and GPA (p=<.05)

Table 2 Continued

Critical Thinking Measure & Author(s)	Design	Sample	Reported Reliability	Findings
CCTST **Beckie et al. (2001)**	Pretest-posttest, nonequivalent control group design -evaluate the attainment of critical thinking skills before and after curriculum revision	N = 183 Junior level BSN students Cohort 1 = 55 Pre-curriculum revision Cohort 2 = 55 revised curriculum Cohort 3 = 73 revised curriculum	Kuder Richardson 20 ranging from 0.68-0.70	Cohort 2 achieved significantly higher CCTST scores than Cohort 1 (p=<0.001) while Cohort 3 did not score significantly higher than Cohort 1
Chau et al. (2001)	Pre-test/post-test design -determine the effects of using videotaped vignettes in promoting nurses' critical thinking abilities	N = 83 First and second year BSN students Year 1 = 38 Year 2 = 45	Kuder Richardson 20 of 0.74 and subscales ranged from 0.30 to 0.61	No statistically significant difference in pre and post videotaped vignette CCTST scores
Spelic et al. (2001)	Descriptive, longitudinal study -assess changes in students' critical thinking skills between entry and exit to the program	N = 136 BSN students Accelerated = 68 RN-BSN = 17 Traditional = 51	Kuder Richardson 20 ranging from 0.62-0.75	Students in each of the three tracks demonstrated significant improvement in CCTST scores (p=<0.05)
CCTDI vs CCTST **Shin et al. (2006)**	Comparative study -investigate the critical thinking dispositions and skills of senior nursing students	N = 305 Senior level students BSN = 102 Associate = 137 RN-BSN = 66	CCTDI - α coefficient 0.7847 CCTST - Kuder Richardson 20 ranging from 0.68-0.70	Significant difference between students by program on both the CCTDI (p=0.017) and CCTST (p=0.0001). BSN students scored significantly higher. Significant relationship between scores on the CCTDI and CCTST (r=0.305, p=0.000)

Table 2 Continued

Critical Thinking Measure & Author(s)	Design	Sample	Reported Reliability	Findings
Giddens, J., & Gloeckner, G.W. (2005)	Non-experimental ex-post-facto -investigate the relationship of student's critical thinking skills and dispositions	N = 218 BSN students	Not reported	Students passing the NCLEX-RN had significantly higher exit CCTDI (p=0.010) and CCTST (p=0.015) scores. No significant change in CCTDI or CCTST scores upon entry and exit to the program
May et al. (1999)	Non-experimental, descriptive, exploratory design -test the relationship between critical thinking skills and clinical competency	N = 143 Senior level BSN students	CCTDI - α coefficient of 0.88, with range of 0.55 to 0.76 for the 7 subscales	No significant relationship between CCTDI, CCTST, and clinical competency scores
McCarthy et al., (1999)	Cross-sectional design -compare and contrast critical thinking abilities in beginning and graduating nursing students	N = 241 BSN students Sophomore = 156 Seniors = 85	CCTDI -α coefficient of 0.90, with range of 0.60 to 0.78 for the 7 subscales	Senior students scored significantly higher on the CCTDI (p=<0.001) and the CCTST (p=<0.001), significant correlation between scores on the CCTDI and CCTST (p=<0.001)
Thompson, C., & Rebeschi, L. (1999)	Descriptive, longitudinal study -compare and contrast critical thinking abilities in beginning and graduating nursing students	N = 38 BSN students	CCTDI- α coefficient of 0.90, with range of 0.60 to 0.78 for the 7 subscales CCTST -Kuder Richardson 20 ranging from 0.68-0.70	Senior students scored significantly higher on the CCTDI (p=0.015) and the CCTST (p=0.006), no significant correlations between scores on the CCTDI and CCTST with age, gender or GPA

Table 2 Continued

Critical Thinking Measure & Author(s)	Design	Sample	Reported Reliability	Findings
Colucciello, M.L. (1997)	Cross-sectional, descriptive, comparative, correlational design -examine critical thinking skills and dispositions of nursing students	N =328 BSN students Sophomore = 94 Junior = 65 Senior = 123	Alpha coefficient of 0.90, with range of 0.60 to 0.78 for the 7 subscales Kuder Richardson 20 of 0.70	Junior and senior students scored significantly higher on the CCTDI ($p=0.000$) and the CCTST ($p=<0.05$), a significant positive correlation existed between scores on the CCTDI and CCTST ($p=<0.01$)
WGCTA **Brown et al. (2001)**	Quasi-experimental -measure changes in critical thinking ability of those nursing students enrolled in various educational pathways during the curriculum	N = 123 Traditional = 45 RN-BSN = 35 Accelerated N=43	Split-half reliability coefficients ranging from 0.68 to 0.85	Significant difference between the pre- and post-WGCTA scores of traditional students ($p=0.007$) and RN-BSN students ($p=0.029$), but not of accelerated students ($p=0.107$)
Daly, W.M. (2001)	Longitudinal multi-method descriptive design -explore and develop alternative domain-specific method for identifying critical thinking in student nurses' reasoning processes	N = 43 Undergraduate nursing students Female = 38 Male = 5	Not reported	No significant difference between pre- and post-WGCTA scores, no significant relationship between WGCTA scores and age, gender, or entry qualifications
Girot, E.A. (2000)	Quasi-experimental, between subjects design -evaluate the development of critical thinking in individuals at different stages of the academic process	N = 82 Undergraduate nursing students First year = 32 Fourth year = 19 Graduate = 17 Returning = 15	Not reported	No significant difference in WGCTA scores across groups, no relationship existed between WGCTA scores and decision-making in practice

Table 2 Continued

Critical Thinking Measure & Author(s)	Design	Sample	Reported Reliability	Findings
Adams et al., (1999)	Longitudinal -measure critical thinking ability in a baccalaureate nursing program as students progressed from sophomore to senior year	N = 203 Sophomore level baccalaureate students agreeing to be followed through their senior year	Not reported	No significant difference in WCTA scores between the sophomore and senior level. No significant relationship between scores and age.
Shin, K.R. (1998)	Quasi-experimental -measure the critical thinking ability and clinical decision-making skills of two types of nursing educational programs	N = 234 Associate = 119 BSN = 115	Test-retest reliability of 0.73	BSN students scored significantly higher on the WGCTA (p=<0.001) and clinical decision-making (p=<0.001), the relationship between WGCTA scores and decision-making was significant (p=<0.001)
Vaughan-Wrobel et al. (1997)	Longitudinal descriptive study -assess the critical thinking ability of successive cohorts of nursing students	N = 391 Junior and senior level BSN students	Split-half reliability coefficients ranging from 0.68 to 0.85	Positive correlation found between higher WGCTA scores and older students (p=<0.001) and those prepared with another educational degree (p=0.003), students with previous nursing experience scored lower on the WGCTA (p=0.03), no significant difference in WGCTA scores among class cohorts or times of administration

2.3 SIMULATION-BASED PERFORMANCE ASSESSMENT

Critical thinking skills are believed to be an essential element in the development of problem solving, decision-making, and procedural knowledge necessary to provide safe clinical care (Chau et al., 2001). However, few studies have examined how critical thinking skills are related to performance in a simulated or actual clinical setting. Several methods are currently being explored in an attempt to bridge this knowledge gap. These methods include VTV which requires the nurse to provide a narrative action assessment based on his/her observations, and HFHS which requires the nurse to actively manage critical situations frequently found in clinical practice. Each method is unique in its approach to determine how a nurse will perform in a simulated clinical situation.

2.3.1 Videotaped Vignettes (VTV)

Limited studies have evaluated the use of VTV to enhance critical thinking skills and clinical performance. Examples of studies focused on nursing students include, Neill et al. (1997) who used videotaped case studies and group discussions to enhance student's critical thinking. This teaching strategy resulted in positive learning experiences for both the faculty and nursing student (Neill et al., 1997). The ability of VTV to enhance critical thinking ability was also examined by Chau et al. (2001). Eighty-three first and second year baccalaureate nursing students completed the CCTST and an investigator-developed nursing knowledge test prior to and after viewing eight video-taped vignettes depicting various clinical situations. Results indicated that CCTST scores increased slightly, however the difference was not significant

($p>0.05$). The mean score of the nursing knowledge test did increase ($p=0.01$) indicating that VTV increase knowledge regarding the management of clinical situations (Chau et al., 2001).

More commonly, VTV has been used to assess the competency of new graduates. The most widely published performance assessment tool designed for this purpose is the Performance Based Development System (PBDS). The PBDS is an attempt to move beyond a strictly quantitative assessment of critical thinking and performance. It is designed to provide a narrative action assessment based on observing video vignettes with subsequent written description of nursing actions and rationale (Performance Management Service, 2007). The developers of the instrument defined critical thinking as the ability to recognize a clinical problem, identify the risks and manage the problem, differentiate priority and urgency, apply the knowledge, and understand decision rationale (Performance Management Service, 2007). This definition of critical thinking was based on staff nurse job analyses in more than 35 hospitals (del Bueno et al., 1987).

The PBDS consists of 10 videotaped vignettes in which an actor portraying a patient depicts common clinical situations such as respiratory, cardiovascular, urinary, and neurological problems. Respondents are asked to view each vignette and state, in writing, actions they would take in response and their rationale. The PBDS is designed to identify areas of weakness, provide guidance during the orientation process, and better prepare nurses for safe clinical practice. The assessment has been in use since 1985 and implemented in over 500 healthcare organizations (Performance Management Service, 2007). Reliability and validity of the PBDS assessment components have been reported in several previous publications (del Bueno, 1990, 1994, 2001, 2005; del Bueno & Beay, 1995; Laurent & Johnston, 1995), Expert nurses established content validity and tested the videotaped scenarios in numerous healthcare organizations (del Bueno,

1990). However, although reliability and validity have been reported, it has not been established based on an actual comparison to clinical performance.

In 2001, del Bueno reported that only 30% of new nursing graduates completing the PBDS assessment were consistently able to recognize and safely manage acute care patients with commonly occurring problems or complications. They were not able to recognize classic symptoms of myocardial infarction (50%) or safely manage postoperative respiratory distress caused by a pulmonary emboli or pneumothorax (75%). del Bueno concluded that nursing curricula needed to change its focus from content methods to application of knowledge through the use of more clinical practicum time (del Bueno, 2001). In a subsequent study, aggregate data collected between 1995 and 2005 showed that between 65 and 74 percent of inexperienced nurses (< 1 year experience) failed to meet expectations on the PBDS assessment. Areas of most concern were the inability for approximately 50% of those taking the exam to recognize that a 24-hour post splenectomy patient with acute, sudden onset of right chest pain accompanied by shortness of breath and laboratory results showing respiratory alkalosis had problems in addition to "respiratory distress". Most respondents chose to treat the patient with "hyperventilation into a paper bag" and ignored the implications of the other clinical symptoms. Twenty-five to 35 percent of the new graduates could not differentiate between a decrease in mental status, bradycardia, and widened pulse pressure in a post-head trauma patient. A majority concluded that the patient was suffering from hypovolemic shock with management relevant to systemic blood loss (del Bueno, 2005).

In summary, findings suggest that there may be serious deficiencies in the critical thinking ability of new graduate nurses and a need for more extended orientation. del Bueno suggests that the focus should be on the clinical coach or preceptor asking critical questions

rather than simply imparting information (del Bueno, 2005). However, limited information is offered on the procedures for rating the assessment and the qualifications of the evaluators. Descriptive analysis is restricted to two categories; experienced (> 1 year) and inexperienced (≤ 1 year). Age, gender, prior healthcare experience in addition to nursing, employment location, and employment tenure were not reported. Although the sample size was large, the authors do not offer information on academic preparation, therefore the results are difficult to generalize. Another concern is that the PBDS is based on simulated vignettes. It is possible that actual clinical decision-making may differ from the stated actions. Although reliability and validity has been reported in previous publications (del Bueno, 1990 , 1994 , 2001 , 2005), no studies were identified comparing performance on the PBDS assessment with actual clinical performance. Further study should identify areas of needed remediation and explore the congruence between PBDS testing results and actual or simulated clinical performance.

2.3.2 High-Fidelity Human Simulation (HFHS)

It is difficult for educators to insure that students experience a broad variety of learning activities as these depend on access to clinical sites, patient diagnoses and experiences. Consequently, multiple authors recommend using simulation methods to create scenarios that require critical thinking (Henrich et al., 2002; Nehring et al., 2002; Parr & Sweeney, 2006). HFHS attempts to enhance critical thinking and performance in a controlled environment that allows the participant to exercise basic decision-making skills. It allows safe learning without patient risk (Schwid et al., 2002). HFHS contains numerous features that facilitate a realistic environment including the ability to change the room layout and vary equipment, measure blood pressure, palpable pulses, heart sounds, spontaneous ventilation, breath sounds, hemodynamic monitoring, oxygenation

status, and a pharmacologic system enabling the user to understand medication delivery and physiological action (Euliano, 2001; Kozlowski, 2004; Lupien & George-Gay, 2001). Additionally, simulation offers the potential to implement distracters and interactions through the use of equipment and actors that mimic real clinical situations. HFHS has been used to educate healthcare professionals in a variety of disciplines including anesthesiology (Hotchkiss & Mendoza, 2001; Murray et al., 2005; O'Donnell et al., 1998; Yee et al., 2005), emergency medicine (DeVita et al., 2005; Holzemer & McLaughlin, 1988; Rosenthal et al., 2006), pediatrics (Eppich et al., 2006), nursing (Alinier et al., 2006; Ferrario, 2003; Henneman & Cunningham, 2005; Larew et al., 2006; Long, 2005; Morgan & Cleave-Hogg, 2005; Plunkett & Olivieri, 1989; Rauen, 2004; Yaeger et al., 2004), the military (Vardi et al., 2002), medical emergency team training (DeVita et al., 2005) and disaster management (Cowan & Cloutier, 1988; Giovachino & Carey, 2001; Nguyen et al., 2005). Applications vary from training in a specific skill (e.g., endotracheal intubation) to competency training and assessment (e.g., management of cardiogenic shock).

HFHS is designed as an observational action assessment method. It allows for the creation of critical situations frequently found in clinical practice. When accompanied by debriefing, it provides students with the opportunity to explore implications of their actions, learn from their choices, and transfer knowledge to the clinical setting. Prior studies have shown that HFHS can have a positive impact on the ability to learn technical skills (Gallagher & Cates, 2004a, , 2004b; Seymour et al., 2002). It has been most frequently utilized in the training and evaluation of nurse anesthetists, medical students, and anesthesiologists. Chopra et al. (1994) studied 28 anesthesiologists and trainees using two simulated scenarios; anaphylactic shock and malignant hyperthermia. During phase 1, all participants were videotaped and their performance

was scored for the anaphylactic scenario. In phase 2 the group was randomized into anaphylactic or malignant hyperthermia simulator training. Phase 3 consisted of scoring their simulated performance in the malignant hyperthermia scenario. The researchers concluded that those trained in malignant hyperthermia via the simulator responded and performed much quicker (Chopra et al., 1994). In a similar prospective, randomized trial Stedman et al. sought to determine whether full-scale HFHS was superior to problem-based learning in the training of fourth-year medical students in acute care assessment and management skills. The simulation group performed significantly better ($p<.0001$) in the simulated assessment of dyspnea leading the authors to conclude that the use of HFHS in the training of medical students in critical assessment is superior to problem-based learning (Schwid et al., 2002). Simulated anaphylaxis scenarios have been shown to increase critical thinking and crisis management ability in nurse anesthetist students and anesthesiology residents (Berkenstadt et al., 2005; Gaba et al., 1994; Schwid et al., 2002). Additional research has been conducted on simulation use in difficult airway management, fiberoptic endotracheal intubation, and crisis/trauma management (Howard et al., 1992; Marshall et al., 2001; Naik et al., 2001; Owen & Plummer, 2002; Runciman & Merry, 2005).

Recently, a number of randomized clinical trials have been conducted investigating the transfer of skills acquired on virtual reality simulators to clinical performance. All unequivocally demonstrate the effectiveness of simulation-based training in improving actual clinical performance on procedures, including laporascopic cholesystectomy (Cossman et al., 2007; Grantcharov et al., 2004; Seymour et al., 2002), colonoscopy (Ahlberg et al., 2005), and catheter-based endovascular procedures (Chaer et al., 2006).

Few studies have evaluated outcomes of using HFHS training for nurses (Alinier et al., 2006) and only one study was identified that focused on new graduates. Trossman (2005) described the use of HFHS in the orientation of new graduates in a large medical center. The author concluded that HFHS was helpful in recreating low occurrence, high risk situations and can potentially remedy a new graduate's fear of being assertive because it allows the new graduate to practice difficult skills in a safe environment (Trossman, 2005). A second study evaluated student and faculty perception of the use of HFHS in teaching baccalaureate nursing students. The realism of the scenario, ability to transfer skills into real practice, and perceived value of simulation was assessed. Nearly half the students felt that HFHS increased their confidence, competency, and perceived ability to practice in a real-world setting. All faculty members felt that the HFHS experience would be transferable to the clinical environment (Feingold et al., 2004). A third study evaluated HFHS as an alternative clinical experience with two groups of students and instructors. The scenarios were designed to promote medication skill acquisition. A 4-point Likert-type scale survey was administered to assess student's perceived increase in knowledge regarding medication administration principals, patient responses, and confidence in skills. Findings indicated a positive learning experience. However, the students did not suggest HFHS replace the experience at the patient bedside (Bearnson & Wiker, 2005). Bond, Kostenbader, and McCarthy (2001) investigated the satisfaction level of pre and post acute care healthcare providers in using HFHS to enhance training methods. Findings revealed a high level of HFHS acceptance (Bond et al., 2001).

Three unpublished dissertations were identified that investigated the use of HFHS as a teaching strategy and its effect on critical thinking ability in nursing students (Howard, 2007; Schumacher, 2004; Wortock, 2002) . Each study used commercially prepared critical thinking

tools as an outcome measure. Wortock (2002) designed a study to examine different strategies for increasing critical thinking necessary for code response proficiency in 54 nursing students. Group 1 received standard cardiac code response instruction included in the college curriculum, group 2 received the HFHS code scenario, group 3 received a web-based cardiac code response course, and group 4 received a combination of the web-based course and HFHS. The students were tested pre and post intervention using the CCTST and the Critical Thinking Process Test (CTPT). There were no significant differences in scores. However, the author suggested that the web-based instruction combined with the HFHS experience increased critical thinking, improved skills sets, and therefore improved patient outcomes (Wortock, 2002). Schumacher (2004) conducted a descriptive, quasi-experimental study comparing critical thinking abilities and learning outcomes of three groups of students utilizing three instructional strategies. A 60-item customized Health Education Systems, Inc. (HESI) exam, which is a test designed to assist in identifying learning needs in nursing students, was administered as a pretest to all study participants and used to randomize the subjects into three groups (classroom instruction, HFHS, and a combination of both). Myocardial infarction, deep vein thrombosis leading to pulmonary embolism, and shock (anaphylactic and hypovolemic) were used as the three clinical scenarios. Each group rotated through the three learning activities. After each activity, critical thinking abilities and learning outcomes were measured thorough the administration of a 20-item customized HESI exam which served as the posttest. There were no statistically significant differences between critical thinking abilities ($p>0.08$) or learning outcomes ($p>0.12$) of nursing students when classroom instruction was utilized. However, statistically significant differences were detected between critical thinking abilities ($p<.0.002$) and learning outcomes ($p<0.001$) when simulation or a combination of classroom and simulation was utilized (Schumacher, 2004).

Howard (2007) conducted a study to determine whether the use of HFHS as an educational intervention with nursing students was more effective than the use of interactive case studies with respect to critical thinking ability. A quasi-experimental, two group, pre-post test design was utilized with a sample of 49 nursing students from two different nursing programs. The students were pre-tested with a custom-designed HESI exam. Two clinical scenarios were developed for the study; acute coronary syndrome and acute ischemic stroke. Participants were randomly assigned to each of the two groups, received the educational intervention, and then were post-tested using another HESI exam based on similar content. A significant difference was found with respect to knowledge gain using the HESI conversion score (p=.018) and the HESI score (p=0.037), and a significant difference with respect to critical thinking ability using the critical thinking HESI sub score (p=0.051), with the HFHS group scoring significantly better than the interactive case study group on the post-test (Howard, 2007).

There have been a number of other studies published on the inclusion of HFHS in traditional nursing curriculum and the evaluation of both faculty and student satisfaction with the implementation process and outcome objectives (Beyea, 2004; Jeffries, 2005; Larew et al., 2006; Rauen, 2004). Qualitative studies have suggested that simulation helps students to acquire skills, build confidence, and work through difficult clinical problems (O'Donnell et al., 2005). Some have reported perceived improvement in problem solving, decision-making, and critical thinking (Henrichs et al., 2002). Overall, most investigators find the use of HFHS to be beneficial in the nursing curriculum and emphasize the potential for skills acquired in a simulated environment to be transferred into clinical practice.

In summary, previous studies utilizing HFHS have shown an improvement in performance time, crisis management ability, medical emergency team management, critical

thinking, and learning outcomes (Chopra et al., 1994; Schwid et al., 2002; DeVita et al., 2005). Additionally, it appears that the use of HFHS facilitates assertiveness and perception of confidence and competency (Feingold et al., 2004; Trossman, 2005). However, there is an absence of systematic study regarding the authenticity of simulation experience except for "participant perception" assessments that are highly prone to bias (Hotchkiss et al., 2002). Furthermore, most studies address the issue of performance improvement with repeated simulation exposure and have focused on knowledge and technical skill ability. Although researchers are beginning to address HFHS as a surrogate to clinical care, it still remains unclear of simulated performance transitions into "real" demonstration in the clinical setting. Limited research has been conducted on the evaluation of non-technical skills (Yee et al., 2005). Published studies evaluating HFHS are restricted by sample size due to time constraints, availability of participants, and cost therefore limiting generalizability of results. Evaluation in the student or new graduate nursing population is limited. The literature is lacking in quantitative evidence which encompass the full use of the simulation evaluation including critical thinking concepts required of new graduate nurses such as problem recognition, rationale, and prioritization. The use of simulation methods are very time intensive and costly. Therefore, further study is needed to determine if quantitatively measured critical thinking ability is related to performance in a simulated environment and if performance in a simulated environment translates into actual clinical practice.

No studies were identified that explored the relationship between traditional assessment of critical thinking measures and simulation-based performance. Furthermore, no studies were identified that attempted to determine if differences in performance exist based on level of response (narrative vs. observational) or level of academic preparation (diploma, associate, or

baccalaureate). VTV and HFHS are two alternative evaluation methods currently being studied. Both assessment methods provide insight into areas of deficiency and allow the participant to examine their clinical performance and decision-making processes. Therefore, these two evaluation methods were used to determine if a relationship existed between the performance measures and to determine predictors of simulation-based performance (VTV and HFHS) of student nurses enrolled in their last term of academic preparation.

2.4 CONCEPTUAL FRAMEWORK

Numerous conceptual frameworks of critical thinking have been developed and considered for this study. The Transactional Model of Critical Thinking (TMCT) reflects the effects of specific personal antecedent characteristics, attributes, and environmental conditions upon critical thinking outcomes (Gendrop, S.C., & Eisenhauer, L.A., 1996). It emphasizes influences such as age, cognitive style, culture, attitudes, and values as contributing factors. The Critical Thinking Model for Nursing Judgment (Kataoka-Yahiro, M. & Saylor, C.A., 1995) recognizes three levels of critical thinking in nursing: basic, complex, and commitment. The higher the level, the greater expertise needed for making sound clinical judgments. It is divided into specific knowledge, experience, and attitudes. Donabedian's Quality of Care Model encompasses structure, process, and outcomes. It incorporates the course of action and the consequence of the care given (Fesler-Birch, D.M., 2005). All three of these conceptual frameworks emphasize the evaluation of structure and process of care. However, there is little agreement on the relationship between improving clinical practice and patient outcomes. Since these frameworks were limited in their ability to guide research regarding assessment of potential differences in performance

under hypothetical conditions (what is expressed or intended) compared to assessments of performance when faced with actual clinical situations (what is actually done), they were deemed inadequate for guiding this study.

Argyris and Schon (Argyris, C., & Schon, D., 1974) built on the work of Freud and Jung and suggested that there is a theory consistent with what people say they will do and a theory consistent with what they actually do (Argyris, C., 1980) i.e. an Espoused Theory (what is expressed) and a Theory-in-Use (what is done). The theoretical framework for this study is based on Argyris and Schon's Theories of Action Espoused and Theory-in-Use. This theory has three elements; governing values, action strategies, and outcomes. Governing values are those dimensions or values that people try to keep within acceptable limits. Action strategies are the plans or assessments used by people to keep their governing values acceptable. Outcomes are the end result of the action and can be intended or unintended (Anderson, 1997; Argyris, C., & Schon, D. , 1974).

Espoused Theory represents the views and values people believe their behavior is based on. Theory-in-Use represents the views and values implied by their behavior (Argyris, C., Putnam, R., & McLain-Smith, D. , 1985). Argyris suggests that although people design the action, they are often unaware of the design or that this action differs from their espoused theory. Effectiveness or intended outcomes result from attaining congruence between Espoused Theory and Theory-in-Use (Argyris, C., 1987). If there is a disconnection between what is expressed (Espoused Theory) and done (Theory-in-Use), the mismatch may result in an unintended outcome. The discovery of this mismatch then leads to a learning process which incorporates the invention of new meaning and production of new action. The theorists hypothesize that this subsequent learning process results in increased effectiveness in decision-making and better

acceptance of failures and mistakes (Argyris, C., & Schon, D. , 1974). There are inconsistencies and weaknesses in this theory. Decisions based on espoused theory can always have exceptions and be reconsidered. Action-decisions, on the other hand, are very concrete because they immediately trigger an action. It is unclear if the authors have considered the emotional aspect and potential fear of embarrassment that may influence the decision-making process. Although Argyris & Schon's work has illuminated important inconsistencies between theorizing and pedagogical interventions through the use of reflective exercises, there is an absence of empirical data comparing theoretical to simulated or actual performance.

The proposed study applied the three elements of the theory as well as the concepts of Espoused Theory and Theory-in-Use in determining the relationship between critical thinking skills and simulation-based performance evaluated using VTV and HFHS, in student nurses prepared at the diploma, associate, and baccalaureate level. In this conceptualization (Figure 1), the governing value in the study is critical thinking. The action strategy is the assessment used to keep the governing value acceptable, operationalized using a traditional critical thinking evaluation method (CCTST); VTV in which written text is used to assess the ability of the student nurse to determine the course of action to take; and HFHS in which direct observation is used to assess the course of action taken by the student nurse. Both the VTV and HFHS assessment characterizes the nurses' ability to recognize the clinical problem, report essential clinical data, initiate independent nursing interventions and assessments, anticipate medical orders, understand decision rationale, and prioritize care. The written answers (VTV) will represent the Espoused Theory and HFHS will represent the Theory-in-Use or the observable action that the student takes. For both assessments, the same patient scenario was used and the actions taken by the student nurse to manage the problem were evaluated in the same manner.

Outcomes are the end result of the action and can be intended or unintended. An intended outcome of the CCTST is a score reflecting strong critical thinking skills. An intended outcome of both the VTV and HFHS assessment is successful simulation-based performance as measured by the students' ability to recognize the clinical problem, report essential clinical data, initiate nursing interventions, and prioritize the care of the patient. Additionally, an intended outcome will be represented by a relationship between strong critical thinking skills and successful simulation-based performance (VTV and HFHS) (Figure 1**)**.

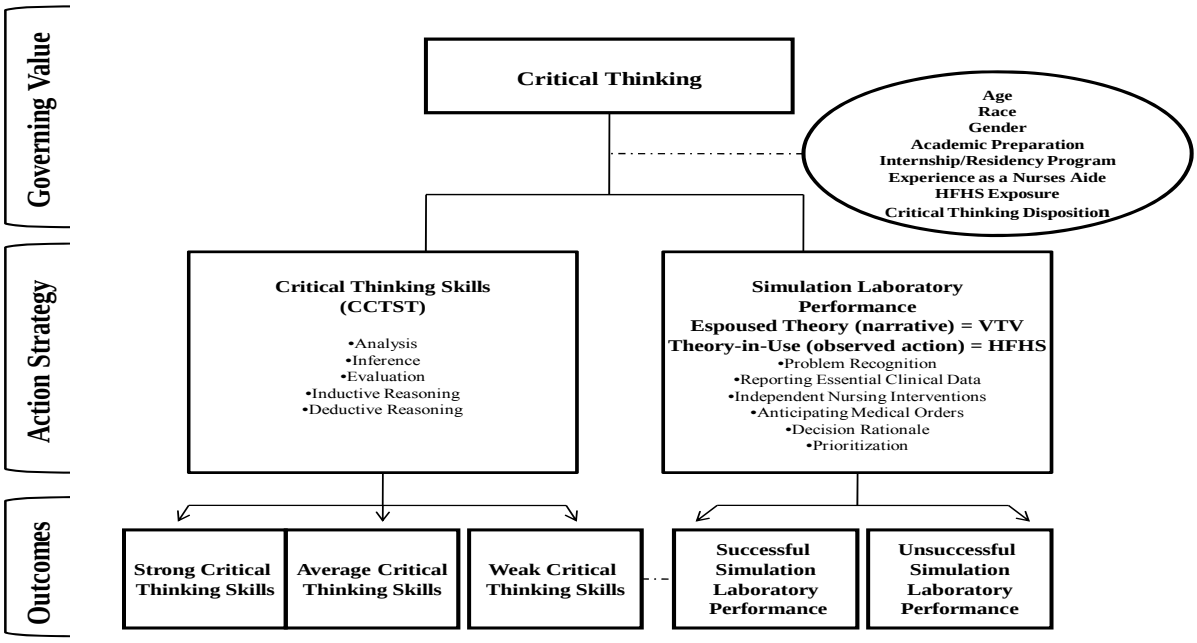

Figure 1 Conceptual Framework

2.5 SIGNIFICANCE & INNOVATION

Commonly used critical thinking evaluation methods consist of paper and pencil or multiple-choice computerized instruments (Duchscher, 2003) that may not accurately rate the clinical ability of practitioners faced with a simulated or actual situation. Although use of VTV and HFHS have been advocated as a means to move beyond a paper and pencil or computer-based examination, few studies have examined the relationship between traditional critical thinking scores and narrative and observational action when a nurse is faced with the management of a critical situation. Furthermore, there is a lack of reported studies determining predictors of performance on these tests. If congruency occurs between the VTV and HFHS performance in the simulated setting, the least expensive method would be preferable to assess a nursing students' or new graduate's readiness for clinical practice. Many institutions are grappling with the financial justification to build and develop HFHS simulation centers. Therefore, it is important to determine which form of simulation testing (VTV or HFHS) best reflects critical thinking skills. If a mismatch is identified between what is being said (VTV) and what is being done (HFHS), a preferential evaluation method may be suggested that can possibly facilitate a learning process which will allow the student or new graduate nurse to incorporate new meaning, produce new actions, and potentially avoid unintended outcomes in patient care. This study used a quasi-experimental, cross-over design to examine the relationship between metrics of critical thinking skills and performance in simulated clinical scenarios and identify predictors of simulation-based performance of nursing students in their last term of academic preparation.

3.0 PRELIMINARY STUDY

Limited research has been conducted to assess critical thinking ability in the new and experienced nurse. In order to advance practice, it is necessary to develop and evaluate strategies to help nurses develop essential skills. In order to most effectively transition a new graduate to the responsibilities inherent in clinical practice, new approaches are needed. Optimally, these approaches will be objectively evaluated to determine their effectiveness prior to implementation.

Purpose: The aim of this post hoc retrospective analysis was to assess ability of a commonly used VTV assessment, the Problem Based Development System assessment (PBDS), to identify common patterns in critical thinking learning needs of newly graduated and experienced nurses by 1) describing the overall rate at which nurses met expectations on the PBDS assessment; 2) examining the relationship between meeting PBDS expectations and years of nursing experience controlling for preparation level; and 3) examining the relationship between meeting PBDS expectations and nurses' preparation level (diploma, associate, baccalaureate) controlling for years of nursing experience.

Sample: The sample included 2144 nurses prepared at the diploma (n=674), associate (n=880), or baccalaureate level (n=590). Of these, 56.5% were new graduates, 9.2% had > 1 but less than 5 years of experience, 9.8% had ≥ 5 but less than 10 years of experience, and 24.5% had ≥ 10 years of experience. The healthcare system which provided the de-identified data

included 19 acute care, specialty, community and regional hospitals located in southwestern PA. All newly hired nurses were assessed using the PBDS in order to customize their orientation at the beginning of their employment tenure. The sample size achieved 98% power to detect an effect size of 0.10 using a 2 and 3 degrees of freedom Chi-Square Test with a significance level (alpha) of 0.05.

Method: Approval to conduct the study was obtained from the University of Pittsburgh Institutional Review Board. Descriptive statistics were calculated using SPSS, version 14.0. Of the 539 subjects who did not meet expectations, 103 (19.1%) did not have complete subcategory scores. Descriptive data were analyzed for the entire sample and failure results for those with complete data. The Chi-square test for independence likelihood ratio was used to analyze differences in years of experience and level of preparation. The likelihood ratio was used due to the large sample size. The level of significance was set *a priori* at .05.

Results: Overall, 74.9% of the sample was rated as meeting expectations on the PBDS. Learning needs identified for nurses not meeting expectations related to the following areas: initiating independent nursing interventions (97.2%), differentiation of urgency (67%), reporting essential clinical data (65.4%), anticipating relevant medical orders (62.8%), providing relevant rationale to support decisions (62.6%), and problem recognition (57.1%). Controlling for level of preparation, associate ($p=.007$) and baccalaureate ($p <.0001$) nurses were more likely to meet expectations on the PBDS as years of experience increased; a similar trend was not seen for diploma nurses ($p=.10$). Controlling for years of experience, new graduates were less likely to meet PBDS expectations compared to nurses with ≥ 10 years experience ($p=.046$).

Conclusion: Patient safety may be compromised if a nurse cannot provide clinically competent care. Assessments such as the PBDS can provide information about learning needs and facilitate individualized orientation targeted to increase performance level.

4.0 RESEARCH DESIGN AND METHODS

4.1 DESIGN

This study employed a quasi-experimental, cross-over design to examine the relationship between metrics of critical thinking skills and performance in simulated clinical scenarios and identify predictors of simulation-based performance of nursing students in their last term of academic preparation. Forty-eight student nurses prepared at the diploma (n=26), associate (n=12), and baccalaureate (n=10) level participated in the protocol within their last term of academic preparation from accredited nursing schools. In Phase I, each member of the cohort completed a demographic profile, the California Critical Thinking Disposition Index (CCTDI), and the California Critical Thinking Skills Test (CCTST) (Figure 2). In Phase II, participants were randomized into two groups. A two-group cross-over design was used in an attempt to control for an order effect. Group A participated in VTV orientation and a simulation-based performance evaluation utilizing a pulmonary embolism case scenario via VTV. Group B participated in HFHS orientation and the same simulation-based performance evaluation and case scenario via HFHS. In Phase III, testing for the two groups alternated with Group A tested using HFHS and Group B using VTV. A limited debriefing session also occurred following testing to discuss the experience of being tested in the VTV and HFHS environments. Potential moderating variables were age, race, gender, academic preparation, participation in an

internship/residency program, experience as an acute care nurses aide, number of courses where high-fidelity human simulation was used as a teaching tool, and critical thinking disposition (CCTDI). The within-subject method provided greater study power and a reduction in error variance associated with individual differences (Hulley et al., 2001).

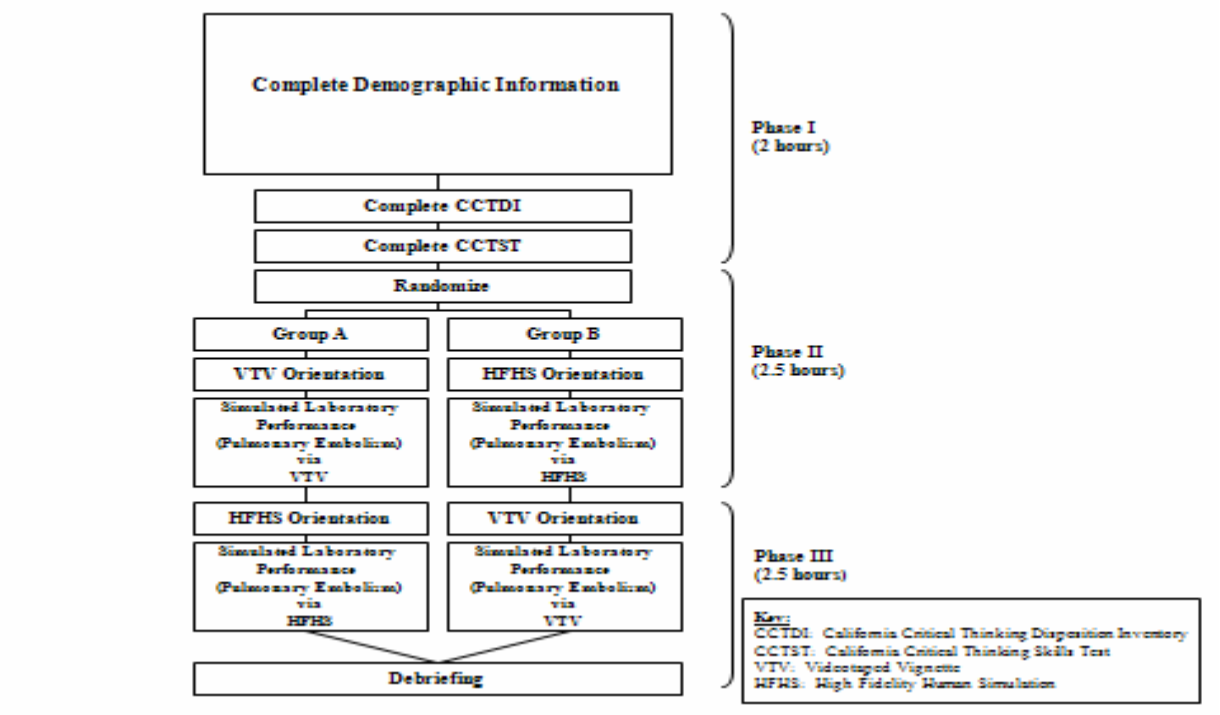

Figure 2 Study Design

4.2 SETTING

The study was conducted at the Winter Institute for Simulation Education and Research (WISER), a 12,000 square foot, multi-disciplinary simulation center on the University of Pittsburgh campus jointly owned by the University and University of Pittsburgh Medical Center (UPMC). The mission of the center is to improve patient safety and increase the effectiveness of health care education for all care providers through education, research, advanced instructional

technology and the development and assessment of innovative simulation programs. WISER has been performing health care simulation since 1994, helping health care professionals gain new skills in a variety of simulated settings. Participants have included undergraduate nursing, pharmacy, and medical students, residents, fellows, practicing physicians, nurses, respiratory therapists, and paramedics. All phases of the study were conducted within this setting. The facility houses 16 mannequin-based adult simulators, two pediatric simulators, one birthing simulator, 60 wireless classroom laptops, 13 state-of-the-art simulation theaters that can realistically portray operating rooms, intensive care units, patient rooms, emergency and trauma rooms, ambulance or helicopter training areas, and outdoor disaster sites. During actual simulation sessions, data collected was stored in a central Standard Query Language server database (SQL) using a unique subject identifier. Each participant was assigned a unique, non-sequential randomized identification stored in the SQL server database. This identification remained with the participants through all phases of the study. Students participating in the HFHS scenario were placed in a room separate from those taking part in the VTV assessment. The HFHS room had video equipment permanently located within the room to record the experience. During the HFHS scenario, the participant was alone in the simulation room to provide care during the pre-planned scenario. Simulation experts were outside the room at the bank of computers used to facilitate the scenario. Following the simulation, the students re-located to another classroom within the WISER center. Both the VTV and HFHS classrooms had trained investigative team members present to ensure that participants did not discuss the content or their performance in either the VTV or HFHS scenario.

4.3 SAMPLE

A convenience sample of 48 registered nursing students within their last term of academic preparation from an accredited nursing school in the greater Pittsburgh area completed the study. There were 74 diploma students approached and eligible for participation, of which 26 enrolled, fifty-eight associate students, of whom 12 participated and 57 baccalaureate students of whom 10 participated. All 48 students committing to the study were retained. Due to unequal distribution of diploma prepared nurses, a random sample of 14 diploma students was selected for analysis.

Diploma prepared nurses attend a 76-week program. College level pre-requisites to admission include completion of courses in anatomy and physiology, psychology, nutrition, microbiology, English composition, human growth and development, and sociology. The first level of the nursing program consists of three sequential basic nursing courses. The second-level courses involve more complex and interrelated nursing and/or health problems, which affect individuals of all ages. It concludes with a course on nursing issues and management. Clinical experience takes place in both the acute care and community environment. The school is accredited by the National League for Nursing Accrediting Commission (NLNAC) and approved by the Pennsylvania State Board of Nurse Examiners.

Students prepared at the associate level attend a program that can be completed in two years. The program is approved by the Pennsylvania State Board of Nurse Examiners and accredited by the National League for Nursing (NLN). Students enrolled in the associate degree program complete college-level courses in anatomy and physiology, psychology, mathematics, English compositions, human growth and development, health promotion, and health care delivery. They also have clinical experience in both the acute care and community setting.

Students in the baccalaureate program attend a traditional four-year program, with the first two years consisting of a strong science foundation in addition to courses needed to fulfill the baccalaureate requirements and the remaining years a combination of clinical and elective courses. Courses taken include chemistry, anatomy and physiology, English composition, psychology, sociology, microbiology, pharmacology, pathophysiology, nutrition, nursing research, nursing informatics, ethics, acute/chronic health problems, and advanced management of the adult with acute/complex health problems. Clinical experiences are provided in schools, clinics, senior citizens' centers, long-term and acute care facilities. The program is approved by the Pennsylvania State Board of Nurse Examiners and is accredited by the Commission on Collegiate Nursing Education (CCNE).

4.3.1 Inclusion/Exclusion Criteria

Inclusion criteria required that subjects: a) were >18 years of age or older and able to read and speak English; b) have not obtained a license to practice as a Registered Nurse and were within their last term of academic preparation at an accredited nursing school; and c) had administrative support from their academic institution. Exclusion criteria included: a) preparation as an emergency medical technician, paramedic, or licensed practical nurse; b) prior exposure to a pulmonary embolism simulated scenario as reported by the participating nursing school; and c) enrolled in a 2nd degree accelerated program or Registered Nurse options program, e.g., RN-BSN or LPN-RN. The racial, gender and ethnic characteristics of the participants reflected the demographics of nursing students located in Pittsburgh and the surrounding areas. No exclusion criterion was based on race or gender.

4.3.2 Sample Size Justification

No prior studies were identified that compared simulation-based performance scores for VTV and HFHS, or explored possible predictors of simulation-based performance. Therefore, the study was exploratory by design. The sample size was not determined to test hypotheses (and not based on power analysis) but rather calculated on the basis of 1) recruitment feasibility within the time constraints of graduation from the three programs and 2) the need to estimate effect size concerning the direction and magnitude of relationships among study variables to guide future work. To achieve our specific aims, 48 participants were recruited of which 36 were included in the analysis. Each cohort contained a similar number of participants; diploma (n=14); associate (n=12); and baccalaureate (n=10). Most prior studies using HFHS included fewer than 50 participants or groups of fewer than 10 subjects (Chau et al., 2001; Chopra et al., 1994; Gaba, Fish, & Howard, 1994; Howard, 2007; Owen & Plummer, 2002; Schumacher, 2004; Schwid et al., 2002); however, these small-sample studies still detected significant results (Gaba & DeAnda, 1989; Nyssen, Larbuisson, Janssens, Pendeville, & Mayne, 2002). The proposed sample size was judged to be feasible to manage within the manpower needs necessary to accomplish the "hands-on" component of the study when utilizing HFHS with available resources.

The first aim focused on comparing simulation- based performance scores for VTV and HFHS (Refer to Section 1.1.1). These variables were dichotomous in nature (met expectations and did not meet expectations). Therefore, the Fleiss crossover binary response chi-square (Fleiss, 1986) statistical method was used to compare VTV and HFHS performance scores as well as account for the order of assessment administration. A sample size of 36 achieved 80% power to detect a moderate effect size (W) of 0.4669 using a 1 degree of freedom Chi-Square

Test with a significance level (alpha) of 0.0500. There have been no reported studies identified exploring the relationship between scores on the CCTDI, CCTST, VTV, and HFHS. Additionally, no studies have been published identifying predictors of simulation-based performance. Therefore, a power analysis was not possible. It is the intent to use the results in planning a larger future study.

4.3.3 Recruitment

Approval to conduct the study was obtained from the University of Pittsburgh's Institutional Review Board. Three accredited nursing programs with differing preparation levels were approached and agreed to allow students to participate in the study. Student participation was voluntary and the time spent during research participation did not interfere with or account for the time required for program completion.

Students were approached during one of their senior level nursing classes by a faculty member who briefly described the study and requested their voluntary participation **(Appendix A)**. After interest was established, the study was described in more detail by the primary investigator (PI) who was present at the time of the announcement **(Appendix B)**. Volunteers were asked to fill out contact information and acknowledge the inclusion and exclusion criteria **(Appendix B)**. Those meeting eligibility criteria had to have full support of the school's administrative team to enroll. If the subject did not meet inclusion criteria, all the collected information during the screening process was destroyed. The name of the potential participant was not recorded and all personal information was shredded at the conclusion of the informational session. Subject confidentiality was assured through the use of assigned, unique, non-sequential randomized identifications numbers stored in the server database at WISER. This

identification remained with the subject throughout the study. This system allowed for complete de-identification of data.

4.4 DATA COLLECTION

4.4.1 Phase I

Based on the student's graduation date and coordination with the participating nursing school, a day for testing was assigned. Subjects were advised to report to WISER on the day designated for assessment. They were informed that the study protocol would be completed in one 8-hour day. A total of four dates were offered. The first group consisted of 7 baccalaureate students, Group 2 had 12 associate degree students, Group 3 consisted of 3 baccalaureate and 13 diploma students, and Group 4 was comprised of 13 diploma students. Participation in the study protocol did not interfere or take the place of clinical time needed for graduation. Participants were asked to sign the informed consent after discussion of the protocol and questions were answered by the PI. Each individual participant completed a demographic questionnaire **(Appendix C)** which included information on age, race, gender, academic preparation, participation in an internship/residency program, experience working in a hospital as a nurses aide, and number of courses completed where simulation was used as a teaching tool. This took approximately 5 minutes to complete. Each participant was then asked by the PI to complete two instruments, the *California Critical Thinking Disposition Inventory (CCTDI)* which is designed to assess internal motivation toward critical thinking, and the *California Critical Thinking Skills Test (CCTST)* which measures the ability of the subject to draw conclusions in the areas of analysis, inference,

evaluation, deductive reasoning, and inductive reasoning. Participants were given instructions for test administration and allotted 25 minutes to complete the assessment. The CCTDI and answer sheets were collected at the end of the testing period. After a 10 minute break, participants were given CCTST instructions for test administration and allotted 45 minutes for completion. The CCTST and answer sheets were collected at the end of the testing period. A one hour lunch was provided for the participants after Phase I was completed. Phase I took approximately 2 hours for all participants to be tested. The Primary Investigator and a consistent investigative team member were present during Phase I of all four sessions to ensure consistency of delivery and ensure that details of the protocol were not discussed.

4.4.2 Phase II

Participants were randomized into two groups using the identification numbers assigned through WISER. Participants with numbers ending in an even digit were assigned to Group A, and those with an odd number to Group B.

Group A received a group orientation by a trained member of the investigative team to VTV and instruction regarding how to complete the assessment. They were each given a reference sheet to keep with them during the examination period. It contained prompts and examples on how to structure their answers **(Appendix D)**. Prior to the testing VTV scenario, each participant first had the opportunity to take part in an example case scenario to familiarize themselves with VTV and the assessment tool. They viewed a VTV of an actor portraying a patient experiencing a blood transfusion reaction. He was a post-operative, receiving blood products and experiencing an elevated temperature, chills, and hives. Each participant was provided with the video script that included the narrative background information about the

patient, as well as any data that were displayed on the screen **(Appendix E)**. Participants were given 10 minutes to individually complete the VTV assessment tool **(Appendix F)**. After completion of the sample assessment, the investigative team member reviewed the model answers with the participants and answered any questions. These answers included; a) the ability of the participant to recognize the blood transfusion reaction, b) notify the physician of an elevated temperature, rash, chills, and the fact that the patient was receiving blood products; c) stop and check the blood and monitor vital signs; d) anticipate an order for intravenous solution, Benadryl and Tylenol; e) prioritize the patient as urgent; and f) describe their rationale for decisions. The participants were then administered the VTV testing scenario. This scenario depicted an actor portraying a post-operative patient experiencing shortness of breath, right-sided chest pain, elevated temperature, and altered blood gas values. They were also provided a video script that included the narrative background information about the patient, as well as any data that was displayed on the screen **(Appendix G)**. Each participant was given 10 minutes to complete the VTV assessment tool **(Appendix F)** in which they were expected to state in writing the patient problem, essential clinical data to report to the physician, independent nursing interventions and assessments they would initiate, anticipated medical orders, rationale behind their chosen interventions, and the urgency in which they would treat the patient. After completion of the assessment, all materials (reference sheet, video scripts, and assessment tools) were collected by the investigative team member. The team member remained in the room until Group A and B switched locations to ensure that the scenario was not discussed. VTV performance was assessed utilizing the VTV/HFHS Assessment Tool **(Appendix H)**. Model answers were determined based on a panel of experts with experience in nursing education, and VTV/HFHS design and assessment. The same trained investigative team member was present

during the VTV orientation and testing of all four sessions to ensure consistency of delivery and ensure that details of the protocol were not discussed.

Group B participated in a group orientation to HFHS and given instructions regarding HFHS performance by the PI. They were each given a reference sheet to keep with them during the assessment period. It contained prompts and examples on how to structure their verbal responses and actions during the simulation **(Appendix I)**. Prior to the testing HFHS scenario, the group viewed a videotape of a HFHS scenario depicting a post-operative patient receiving blood products who was experiencing an elevated temperature, chills, and hives. Actors in the video were experienced nurses who managed this patient according to the protocol provided by the investigative team. Management included; a) the ability of the participant to recognize the blood transfusion reaction, b) notify the physician of an elevated temperature, rash, chills, and the fact that the patient was receiving blood products; c) stop and check the blood and monitor vital signs; d) anticipate an order for intravenous solution, Benadryl and Tylenol; e) prioritize the patient as urgent; and f) describe their rationale for decisions. This served as a model case and helped to familiarize the participants with simulation expectations. The participants were provided with a script that included background information about the patient, as well as data that were displayed on the bedside monitor **(Appendix E).** The PI then reviewed the model answers and answered questions.

Participants were then escorted individually into a HFHS room set up to orient them to the simulation environment and equipment. They were shown and able to introduce themselves to SimMan, experience measuring vital signs, attach a pulse oximeter and oxygen, assess lung and heart sounds, locate the "crash-cart", bedside monitor, telephone, video-recording equipment, and call the physician with a status report of the patient. This orientation process was

facilitated by a consistent and trained member of the investigative team **(Appendix J).** Each participant was asked to fill out an orientation checklist as they accomplished each item **(Appendix K)**. These checklists were then collected and put into their research file. After orientation was completed, each participant was then escorted into the HFHS testing room.

Each participant entered the testing simulation room individually and handed a script that included the narrative background information about the patient, as well as any data that was displayed on the cardiac monitor **(Appendix L)**. They also were handed the HFHS reference sheet that was discussed during orientation **(Appendix I)**. The HFHS case scenario recreated the same testing case presented in VTV. The patient was a young man who was status-post a splenectomy. He was experiencing shortness of breath, right-sided chest pain, an elevated temperature, and altered blood gas values. The participant was expected to verbalize the patient problem, determine the urgency of the situation, report essential clinical data via telephone to the physician, initiate independent nursing interventions and assessments, anticipate and prepare for any relevant medical orders and verbalize the rationale behind their chosen interventions. They were given 10 minutes to manage the patient scenario and complete the assessment. After completion of the assessment, all materials (reference sheet, scripts, and assessment tools) were collected by the principal investigator. A member of the investigative team then escorted the participant to an alternative classroom within WISER. An additional staff member remained in this room to ensure that the scenario was not discussed as more participants completed the simulation assessment and entered the room. Those team members administering both the HFHS orientation protocol and testing scenarios were present during all four sessions to ensure consistency of delivery and make certain that details of the protocol were not discussed. Additionally, the same two mannequins were utilized throughout the study; one for orientation

and the other for testing. They were prepared consistently by the same facilitator. HFHS performance was assessed utilizing the VTV/HFHS Assessment Tool **(Appendix H)**. A 15 minute break was given to the participants between Phase II and III of the session. Phase II took 2.5 hours for all participants to be tested.

4.4.3 Phase III

Based on the within-subject, cross-over design, Phase III involved the alternate test mechanism, e.g., Group A participants performed HFHS and Group B VTV. The same procedures, facilitators, and assessment tools were utilized. After completion of Phase III, Group A was brought back to the original classroom with Group B. A limited group debriefing exercise occurred regarding the participants perception of the 8 hour protocol including their likes and dislikes of both VTV and HFHS **(Appendix M)**. Participants were thanked for their time, and given their parking reimbursement of $15 and gift card of $10. Phase III took 2.5 hours for all participants to complete.

4.4.4 Retention Procedure

Participants were provided lunch on the day of testing, $15 for parking fees, and a $10 gift certificate to a major grocery store/gas station in the area. The email address and telephone number of the investigator was provided to participants so that they may freely seek clarification or share concerns about the study. One-hundred percent of those committing to the study were retained and completed the protocol

4.5 INSTRUMENTATION

4.5.1 Baseline Demographics

Based on the review of critical thinking literature, characteristics including, age, race, gender, academic preparation, participation in an internship/residency program, experience as an acute care nurses aide, and number of courses using high fidelity human simulation were collected for use as potential predictors of simulation-based performance. **(Appendix C)**.

4.5.2 The California Critical Thinking Disposition Inventory (CCTDI)

4.5.2.1 Purpose

The CCTDI was developed for use by educators and researchers to assess the critical thinking dispositions of working professionals, high school and college level students. The test is especially designed to apply to those who aspire to be health science professionals. The instrument is a 75 item Likert style attitudinal survey designed to assess internal motivation toward critical thinking, e.g., the disposition to use or not to use one's reasoning and reflective judgment when solving problems and making decisions. The instrument includes 7 subscales, each designed to measure a critical thinking habit of mind (Facione & Facione, 2001). The 7 subscales include; *Truth-seeking* which targets the disposition of being eager to seek the truth, courageous about asking questions, and honest and objective about pursuing inquiry even if the findings do not support one's interests or one's preconceived opinions; *Open-mindedness* which targets the disposition of being open-minded and tolerant of divergent views with sensitivity to the possibility of one's own bias; *Analyticity* which targets the disposition of being alert to

potentially problematic situations, anticipating possible results or consequences, and prizing the application of reason and the use of evidence even if the problem at hand turns out to be challenging or difficult; *Systematicity* which targets the disposition toward organized, orderly, focused, and diligent inquiry; *Critical Thinking Self-Confidence* which refers to the level of trust one places in one's own reasoning processes; *Inquisitiveness* which measures one's intellectual curiosity; and *Maturity* which targets how disposed a person is to make reflective judgments (Facione & Facione, 2001).

4.5.2.2 Reliability

Reliability has been established with an overall median alpha coefficient of 0.90 and subscale coefficients ranging from 0.71 to 0.80 (Facione & Facione, 2001)**.**

4.5.2.3 Validity

The relationship between the CCTDI and measures of academic achievement has been demonstrated among college students. A meta-study of baccalaureate nursing programs using the CCTDI indicated that the CCTDI sub-scales and overall scale scores correlate significantly with the ACT and SAT-Verbal scores (Facione, N., 1997).

4.5.2.4 Scoring

Total CCTDI scores range from 70 to 420. Each subscale score ranges from 10 to 60. Total scores were categorized into weak (1), average (2), and strong (3) critical thinking disposition. Those participants scoring below the 25^{th} percentile (< 300) were considered weak in disposition, those between the 25^{th} and 74^{th} percentile (between 301 and 341) average, and those scoring above the 74^{th} percentile (≥ 342) were considered having across the board strength in disposition

toward critical thinking (Facione & Facione, 2001). Subscale scores were also categorized in the same manner based on the possible points allotted. The CCTDI CapScore™ answer sheets were returned to Insight Assessment (Millbrae, CA) who scanned and scored the answer sheets. Scores were returned in a digital file reporting total and subscale scores by ID number and descriptive statistics for all participants. Testing time allotted for the CCTDI was 25 minutes.

4.5.3 The California Critical Thinking Skills Test (CCTST)

4.5.3.1 Purpose

The CCTST is based on the APA Delphi consensus conceptualization of critical thinking (Facione, P., 1990a). It is an expression of the expert consensus articulated without the constraints of accreditation or legislation, based on the input of 46 leading theorists, teachers, and critical thinking assessment specialists from several disciplines. The CCTST is designed to measure the skills dimensions of critical thinking. Critical thinking is viewed as a skill and a habit of mind; one must be disposed to think critically as well as have the skills to do so. The CCTST targets the core critical thinking skills of analysis, interpretation, inference, evaluation, and explanation. The CCTST is designed for use in post-secondary level assessment but has successfully been used with 10th through 12th grade high school students and with graduate and professional students (Facione, Facione, Blohm, & Giancarlo, 2002a). Form 2000 (used in this study) introduces critical thinking questions that require one to apply reasoning skills to contexts more appropriate to expectations of the new century and provides item context that more broadly represent the reasoning required to be a skillful critical thinker.

The CCTST is a 34-item multiple choice examination that provides an overall score and 5 subscores. Each item is assigned to one of three subscales; analysis, inference, or evaluation.

Thirty of the 34 CCTST items are classified as either inductive or deductive reasoning. The 5 subscales which include: *Analysis* - subskills of categorization, decoding significance, clarify meaning, examining ideas, detecting arguments, and analyzing arguments into their component elements; *Evaluation* - subskills of assessing claims, assessing arguments, stating results, justifying procedures, and presenting arguments; *Inference* - subskills of querying evidence, conjecturing alternatives, and drawing conclusions; *Deductive Reasoning* - assumed truth of the premises purportedly necessitating the truth of conclusion; *Inductive Reasoning* - that an argument's conclusion is purportedly warranted, but not necessitated, by the assumed truth of its premise (Facione, Facione, Blohm, & Giancarlo, 2002a). One correct answer was assigned to each item.

4.5.3.2 Reliability

The reliability of the 2000 version of the CCTST has been determined to be 0.78 to 0.80 using the Kuder-Richardson-20 internal reliability coefficient (Facione, Facione, Blohm, & Giancarlo, 2002b).

4.5.3.3 Validity

The instrument has been shown to correlate positively to college level grade point average, Scholastic Aptitude math and verbal scores, and Nelson-Denny reading scores (Adams, Whitlow, Stover, & Johnson, 1996; Facione, Facione, Blohm, & Giancarlo, 2002b).

4.5.3.4 Scoring

Each item is assigned to one of three subscales (analysis, evaluation, and inference). Together, these form a full representation of the core critical thinking skills. The remaining two subscores

(inductive and deductive reasoning) take 30 of the 34 items and reclassify them as either inductive or deductive. The CCTST offers six scores; the five subscale scores and the overall CCTST score. The Analysis subscore ranges from 0 to 7; Inference from 0 to 16; Evaluation from 0 to 11, Inductive reasoning from 0 to 17; and deductive reasoning from 0 to 17. Total score ranges from 0 to 34. The authors of the CCTST recommend that local norms be established based on the resulting scores of the participants tested (Facione, Facione, Blohm, & Giancarlo, 2002a). For the purpose of this study, percentiles were established for the total CCTST score based on the results and categorized as strong (3), average (2), and weak (1) critical thinking skills. Those participants scoring above the 74th percentile (≥ 22) were considered as having strong critical thinking skills, those scoring between the 25th and 74th percentile were regarded as having average critical thinking skills (between 16 and 21), and those scoring < the 25th percentile (< 16) were regarded as having weak critical thinking skills. Subscale scores were also categorized in the same manner based on the points allotted. The CCTST CapScore™ answer sheets were returned to Insight Assessment (Millbrae, CA) for scoring. They scanned and scored the answer sheets and returned the scores in a digital file reporting total and subscale scores by ID number and descriptive statistics for all participants. Testing time allotted for the CCTST was 45 minutes.

4.5.4 VTV/HFHS Assessment Tool

4.5.4.1 Purpose

The VTV/HFHS Assessment Tool was used in the evaluation of the participant's ability to recognize a clinical problem, report essential clinical data, initiate independent nursing interventions and assessments, anticipate relevant medical orders, understand decision rationale,

and prioritize care. For the purpose of this study, the clinical problem being assessed was a pulmonary embolism. Based on a formal survey of nurse educators, administrators, clinicians, and simulation experts (n=17), it was recommended that the design and use of a pulmonary embolism VTV/HFHS scenario would provide the greatest opportunity to capture the most information. The VTV/HFHS Assessment Tool was designed by the principal investigator to be used in the student and new graduate nursing population. The expectation in all six subsections of the tool reflects a novice level of knowledge in the management of a potentially critical patient situation. Prior to study commencement, a pilot study was conducted with 5 student nurse volunteers to provide experience with the measurement tool and study protocol.

4.5.4.2 Reliability

Inter-rater reliability was established as two experienced VTV raters, blinded to group, scored participant performance in the VTV simulation and two alternative experienced HFHS raters, blinded to group, scored participant performance in the HFHS simulation.

4.5.4.3 Validity

A correlation coefficient comparing CCTST, CCTDI, VTV, and HFHS results was computed to determine predictive validity. Additionally, the tool was reviewed by nurse educators with expertise in the use and assessment of both VTV and HFHS simulation.

4.5.4.4 Scoring

The VTV/HFHS Assessment tool scoring matrix is dichotomous in nature. The overall assessment and each category were rated as “met” or “did not meet expectations”. In order to meet expectations in each of the categories, all components under that category must be

completed (Table 3). In addition, the overall assessment was rated as "met" or "did not meet expectations" based on meeting expectations in a majority of subcategories (any 4 of the 6). Participants are given 10 minutes to complete both the VTV and HFHS performance assessment.

Table 3 Rating Matrix for Model VTV and HFHS Assessment

Category	**Subcategory Components Expected Answer (met expectations)**
1 Recognizes Clinical Problem	-Recognizes that the patient is having a pulmonary embolism or pneumothorax.
2 Reports Essential Clinical Data	-Reports that the patient is complaining of chest pain, shortness of breath, and/or compromised respiratory status -Reports all vital signs -Reports previously obtained arterial blood gas values
3 Initiates Nursing Interventions	-Reassures the patient -Completes a lung sound assessment -Places a pulse oximeter and oxygen on the patient
4 Anticipates Medical orders	-Anticipates an order for a Chest X-Ray or CT Scan -Anticipates an order for an additional arterial blood gas -Anticipates an order to draw a PT/PTT
5 Provides Rationale to Support Decisions	-Appropriate rationale stated for each subcomponent
6 Prioritizes	-Notifies the physician immediately of the clinical situation
Scoring used to determine if subject met expectations **Overall =** Carried out all subcomponent subcategory actions listed in a majority of categories (any 4 of the 6). **Category** = Carried out all subcategory actions listed in the category	

4.6 STUDY LIMITATIONS

The study is subject to several limitations. The performance assessments are based on simulated vignettes. It is possible that actual clinical performance may differ from both the stated and observed actions in a simulated environment. How the participants perform in an artificial setting may not be related to their performance in an actual clinical setting. There may be characteristics of participants that confer preference for assessment techniques that are not assessed on entry into the study. Different student experiences during their educational tenure and subsequent clinical exposure may aid or detract from their performance and may influence the study findings. The study was conducted with a small, convenience sample which limits the generalizability of results. Due to the nature of quasi-experimental designs, true causality cannot be inferred.

Instrumentation is also viewed as a limitation. Performance assessment utilizing VTV and HFHS may produce feelings of fear or anxiety in the participants and lead to results that may not represent how the participant would perform in an actual clinical setting. The VTV/HFHS Assessment Tool is a researcher developed tool with unknown psychometrics, although it was reviewed by experts in both VTV and HFHS development and assessment.

4.7 STATISTICAL ANALYSIS

All demographic data and test scores were categorized into nominal and ordinal variables. Descriptive statistics (frequencies, percentages, mode, and range) were used to analyze all collected data. Underlying assumptions were that the data were randomly sampled; there was a

sufficient sample size, adequate cell size, and independent observations. Data transformation was not necessary with categorical variables.

Statistical analysis was performed using the SPSS/PC+ software version 16.0 (SPSS Inc., Chicago, USA). A p-value of <0.05 was considered significant. Outliers were assessed for each variable utilizing histograms and scatterplots. All variables tested were categorical and cell counts were assessed for sparseness (<10% in each category). Analysis of the missing data was conducted on each variable.

4.7.1 Specific Aim 1

Compare simulation-based performance scores for videotaped vignettes (VTV) and high-fidelity human simulation (HFHS) of student nurses enrolled in their last term of academic preparation.

The overall score and all six category scores (problem recognition, reporting clinical data, independent nursing interventions and assessments, anticipates relevant medical orders, rationales, and prioritization) were categorical, nominal variables. They were categorized into "met" or "did not meet expectations" (1, 2) based on the rating matrix (Table 3). Frequency distributions of these variables were examined.

The Fleiss cross-over binary response chi-square (Fleiss, 1986) method was used to compare VTV and HFHS simulation performance. This method takes into account the cross-over design of the study and tests for order effect.

4.7.2 Specific Aim 2

Determine the relationship between critical thinking skills scores (California Critical Thinking Skills Test [CCTST], California Critical Thinking Disposition Index [CCTDI]) and simulation-based performance scores (VTV and HFHS) of student nurses enrolled in their last term of academic preparation.

The variables (CCTDI and CCTST scores) are ordinal variables categorized into strong, average, and weak critical thinking disposition and skills (3, 2, 1). Frequency distributions of these variables were examined.

Simulation-based performance scores (VTV and HFHS) are nominal variables categorized into "met" or "did not meet expectations" (1, 2). Frequencies and percentages were calculated for these variables.

Cramer's V was used to test the relationship between critical thinking disposition and skills (CCTDI and CCTST scores) and simulated-based performance scores (VTV and HFHS). The Phi coefficient of correlation was employed to measure the association between simulation-based performance scores on the VTV and HFHS assessment.

Demographic variables (age, race, gender, educational preparation, internship/residency participation, nursing aide experience, and number of classes utilizing HFHS) were categorized into either nominal or ordinal variables. Cramer's V was used to test the relationship between these variables and CCTDI and CCTST scores. Additionally, Cramer's V was also used to test the relationship between scores on the VTV and HFHS assessment and age, educational preparation, and number of classes utilizing HFHS. The Phi coefficient of correlation was used to measure the association between simulation-based performance scores on the VTV and HFHS

assessment and gender, internship/residency participation, and nursing aide experience. Race was eliminated as a variable in the analysis based on sparseness of cell size.

4.7.3 Specific Aim 3

Identify predictors of simulation-based performance (VTV and HFHS) of student nurses enrolled in their last term of academic preparation.

Simulation-based performance scores (VTV and HFHS) are nominal variables categorized into "met" or "did not meet expectations" (1, 2). Frequency distributions of these variables were examined.

Binary logistic regression was utilized to determine predictors of simulation-based performance (VTV) as the outcome measure is binary (met or did not meet expectations). Given the sample size of 36, three predictors were chosen to be included in the analysis (academic preparation, overall CCTDI scores, and overall CCTST scores). Each of these variables was categorical. Academic preparation, CCTDI, and CCTST scores were entered into each block of the model. Model summary statistics included Log Likelihood, Cox & Snell R Square, and Nagelkerke R Square. Logistic regression modeling was not possible to utilize for HFHS due to a lack in cell size. Based on the distribution of performance scores on this assessment, only 4 out of the 36 subjects met expectations. Therefore, model testing was not conducted.

4.8 HUMAN SUBJECTS RESEARCH

The study used data coded with unique subject identification numbers so that no linkage could be made to the individual enrolled in the study. All data was stored in a locked filing cabinet, and all records connecting names to numbers were stored in a separate locked filing cabinet. All study data were managed in a secure password-protected database. Video was taken in the simulation session for evaluation and scoring after the participant signed an informed consent assuring privacy and confidentiality. Research records will be maintained for a minimum of 7 years or as long (indefinite) as required to complete the research study. Participants were not identified by name in any publication of research results. Every possible effort was made to constantly maintain the anonymity of each participant.

4.8.1 Protection of Human Subjects

The study was approved by the Institutional Review Board of the University of Pittsburgh and informed consent was obtained for all participants. Characteristics of the sample population: number of participants was 48; 18 years of age or older; able to read and speak English; agreeable to randomization to one of two evaluation options; full-time student nurses in their last term of academic preparation in an accredited nursing school; will not have obtained licensure to practice as an RN; no prior experience as a licensed practical nurse, paramedic, or emergency medical technician; and no prior exposure to a pulmonary embolism simulated scenario as reported by the faculty. Second degree accelerated or RN option nursing students were not included. The minority distribution of the sample reflected the demographics of those currently practicing as registered nurses at the University of Pittsburgh Medical Centers which is 5%

African American, 87% White not of Hispanic Origin, 8% other. The gender and minority distribution of the sample reflected these demographics.

4.8.2 Sources of Material

The study utilized demographic data including age, race, gender, academic preparation, participation in an internship/residency program, experience as an acute care nurses aide and number of courses where simulation was used as a teaching tool. Additionally, three paper and pencil tools (CCTDI, CCTST, and the VTV assessment) were administered and a HFHS measurement assessment was completed.

4.8.3 Potential Risks

There were minimal risks involved in participation in the study. Participants may have felt embarrassed if they performed poorly during the VTV or HFHS scenario, but this risk was minimized as much as possible by emphasizing the need for exploration into the mechanisms of critical thinking and simulation performance in the nursing student and new graduate and potential benefits of utilizing VTV and/or HFHS in educational and orientation curriculum. At no point were results of participants shared with academic faculty or employers unless presented in aggregate. Privacy and confidentiality was assured.

4.8.4 Recruitment and Informed Consent

Recruitment was conducted through information sessions offered in each of the three chosen nursing schools. The information session stressed the importance of investigating the impact of VTV and HFHS assessment on critical thinking and simulation performance in the student and new graduate nurse. Prior to beginning the investigation, written informed consent was obtained per IRB protocol

4.8.5 Protection Against Risks

All simulation observations were done in a private room at the WISER Center to maintain confidentiality. If the participant developed serious anxiety during the simulated experience, the plan was to stop the simulation and the participant given the choice to engage in the simulation again or be excluded from the study. No participants experienced this outcome. All data was complaint with the guidelines of the Complete Health Insurance Portability and Accountability Act (HIPPA) of 1996, and no data were linked to the individual participant with the exception of the videotaped simulation which was used for evaluation and scoring. These videos were destroyed following the evaluation process. Privacy and confidentiality were assured.

4.8.6 Potential Benefits of the Proposed Research

While no direct benefit may result from participation in the study, there is a hope that participants benefitted from the information acquired, which will assist in the generation and

implementation of interventions to improve critical thinking and simulated clinical performance in the student and new graduate nurse.

4.8.7 Importance of Knowledge Gained from the Proposed Study

The knowledge gained through this investigation involving minimal risk to participants is of great importance in helping to understand critical thinking and simulated clinical performance. The nursing workforce will be dramatically changing over the next 20 years and more and more new graduates will come into professional practice. If the profession has no way of assuring bedside performance, patient safety will continue to be compromised and the potential risk to the healthcare infrastructure will continue to be at the forefront of discussion.

4.8.8 Inclusion of Women and Minorities

The nursing profession is currently dominated by women (approximately 95%). The enrollment was consistent with this statistic. To insure enrollment of male participants consistent with the percentage employed in Allegheny County, nursing faculty was asked to emphasize the importance of participation by both genders and the confidentiality of replies.

Approximately 13% of all nurses are minorities. 4.9% are African American, 3.7% are Asian or Pacific Islander; 2% are Hispanic; 0.5% are American Indian or Alaska Native; and 1.2% categorize themselves as "multiracial" (two or more races). Efforts were made to recruit minority subjects by contacting each of the participating schools of nursing and asking them to inform potential minority participants about the study. Recruitment efforts included publicizing information sessions with the nursing school faculty.

4.8.9 Inclusion of Children

Children were included in the study as one participant was under the age of 21 in their last term of academic preparation prior to completion of their nursing degree.

4.8.10 Data Safety Monitoring Plan

Data and safety monitoring was conducted during monthly meetings with the dissertation committee. During these meetings, recruitment accrual, confidentiality issues, and any adverse events were addressed. A summary of these reviews will be provided to the IRB at the time of the yearly renewal. Any adverse events will be immediately reported to the IRB.

5.0 RESULTS – MANUSCRIPTS

The results of this study are presented in the format of two manuscripts drafted for submission to the *Journal of Advanced Nursing* and *Simulation in Healthcare: Journal of the Society for Simulation in Healthcare*.

5.1 TITLE PAGE MANUSCRIPT 1

Comparison of Simulation-Based Performance with Metrics of Critical Thinking Skills in Nursing Students

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5.2 ABSTRACT MANUSCRIPT 1

Aim: To examine the relationship between metrics of critical thinking skills and performance in simulated clinical scenarios.

Background: Paper and pencil assessments are commonly used to assess critical thinking skills but may not reflect simulated or actual clinical performance.

Methods: In 2007, thirty-six student nurses participated in measurement of critical thinking skills and simulation-based performance using videotaped vignettes (VTV), high-fidelity human simulation (HFHS) and two standardized tests: the California Critical Thinking Disposition Inventory (CCTDI) and California Critical Thinking Skills Test (CCTST). Simulation-based performance was rated as "meeting" or "not meeting" overall expectations. Test scores were categorized as strong, average, or weak.

Results: Most (75.0%) students did not meet overall performance expectations using VTV or HFHS; most difficulty related to recognizing the problem and reporting findings to the physician. There was no difference between overall performance based on use of VTV or HFHS ($p=0.2771$). More students met expectations for the performance subcategory initiating nursing interventions ($p=0.0002$) using HFHS. The relationship between VTV performance and CCTDI or CCTST scores was not significant except for problem recognition and overall CCTST scores (Cramer's $V = 0.444$, $p = 0.029$). There was a statistically significant relationship between overall HFHS performance and overall CCTDI scores (Cramer's $V = .413$, $p = 0.047$).

Conclusion: Student nurses' performance reflected difficulty meeting expectations in simulated clinical scenarios. HFHS performance appeared to best approximate scores on standardized metrics of critical thinking. Further research is needed to determine if simulation-based performance correlates with critical thinking skills in the clinical setting.

Keywords nurses; critical thinking; simulation-based performance; videotaped vignettes; high fidelity human simulation; patient safety; nursing competency

5.3 SUMMARY STATEMENT

What is already known about this topic

- Nursing competency plays a vital role in promoting patient safety.
- Critical thinking is thought to be a key component of nursing practice.
- Deficiencies in critical thinking ability have been identified in new graduate nurses including the inability to successfully recognize and safely manage patients with commonly occurring problems or complications.
- No studies have explored the relationship between critical thinking scores on standardized tests and performance in simulated clinical scenarios including the use of videotaped vignettes and high-fidelity human simulation.

What this paper adds

- The majority of student nurses were unable to perform to the expected level with regard to synthesizing clinical information and reporting clinical findings in simulated clinical scenarios.
- There was no statistically significant difference in overall student performance based on the simulated method of assessing performance using videotaped vignettes or high-fidelity human simulation.
- There was no correlation between videotaped vignette performance and overall scores on standardized tests of critical thinking ability.

- Students with a strong critical thinking disposition scores were more likely to meet performance expectations when assessed using high-fidelity human simulation.

Implications for practice and/or policy

- Simulation-based performance using videotaped vignettes and high-fidelity human simulation can assist in identifying students' proficiency in problem recognition, reporting essential data, initiating appropriate nursing interventions, anticipating medical orders, providing rationale, and prioritizing.
- Innovative teaching and evaluation methods, including the use of simulation-based performance assessment, may support the development of critical thinking skills and thus improve performance outcomes.

Further study is needed to determine the role of simulation-based performance methods in assessing critical thinking and predicting clinical performance.

5.4 MANUSCRIPT 1 CONTENT

5.4.1 Introduction

Nurses must maintain a high level of vigilance and clinical judgment to detect early changes in patient status that signal the need for intervention (Buerhaus et al., 2005). This ability requires critical thinking, advanced problem solving and expert communication skills (NACNEP, 1996). Deficiencies in orientation, training, and competency assessment of healthcare providers have been identified as major factors contributing to patient safety errors over the past 10 years (1995 to 2005) (JCAHO, 2006).

Critical thinking is thought to be a key component of nursing practice, education and knowledge (Alfaro-LeFevre, 2004), yet it is ambiguously and inconsistently defined and applied within the profession (Duchscher, 2003). Furthermore, the relationship between critical thinking skill and simulated or actual clinical performance is unclear. Paper and pencil assessments of critical thinking pose significant challenges (Duchscher, 2003) as they represent an assessment of the nurses' proposed, rather than actual, clinical performance. Simulated methods, such as videotaped vignettes (VTV) and high-fidelity human simulation (HFHS), offer alternatives to paper and pencil examination. VTV is an assessment based on reflective, written responses elicited from watching a videotape of an actor portraying a patient in a potentially critical situation. The nurse observes the clinical scenario and provides a written description of proposed actions and rationale (Performance Management Service, Inc., 2007). HFHS is an experiential action assessment method using a lifelike computerized mannequin that can be programmed to respond to real-world inputs. Both methods can be used to identify specific deficiencies and provide remediation to ensure safe clinical practice.

To date, no studies have evaluated the relationship between scores on standardized critical thinking tests and nurses' clinical performance using simulation-based performance methods such as VTV and HFHS. Furthermore, there is limited literature about the areas of weakest clinical performance. Such information is needed to direct efforts to improve nursing education and practice.

5.4.2 Background

5.4.2.1 Critical Thinking

Numerous scholars have attempted to define and identify the essential attributes of critical thinking. The American Philosophical Association concluded that interpretation, analysis, evaluation, inference, explanation, and self-regulation were components of critical thinking (Facione, 1990a, 1990b). Watson and Glaser define critical thinking as, " the ability to recognize the existence of the problem, determine evidence in support of what is asserted, and apply attitudes and knowledge to logically determine a course of action" (Watson & Glaser, 1964; Watson & Glaser, 1980). Paul (1993) suggested that critical thinking is characterized by a process of analyzing, synthesizing, and evaluating information collected through observation, reflection, experience, or communication that may lead to a particular belief or action. Others define critical thinking as reasonable and reflective thinking focused on deciding what to believe and do, including the ability to compare and contrast numerous decision alternatives (Ennis & Millman, 1985; Landis & Michael, 1981). Based on these definitions, critical thinking appears to have several key elements including an individual's ability to seek and comprehend relevant information and an association with knowledge, reasoning, cognitive skills, problem identification, and exploration of alternative frames of reference.

Nursing competency plays a vital role in assuring patient safety (IOM, 2004). Sentinel events commonly occur in acute care settings where new graduate nurses traditionally begin their professional careers (JCAHO, 2006). The ability of new graduates to think critically, recognize clinical problems, set priorities and intervene effectively is essential to safely provide patient care (Redfern, 2002). VTV and HFHS are simulation-based methods that can potentially assist in the evaluation and application of critical thinking skills and clinical competence of nurses.

Given the known risks to patient safety, it is imperative that innovative teaching and evaluation methods be employed to support the development of critical thinking and improve performance outcomes.

5.4.2.2 Measurement of Critical Thinking in Nursing Students

The critical thinking skills of nursing students have been measured predominantly with commercially developed survey instruments (Rane-Szostak & Robertson, 1996). Two measures, the California Critical Thinking Disposition Inventory (CCTDI) and the California Critical Thinking Skills Test (CCTST) are principally cited in the literature.

The CCTDI assesses internal motivation toward critical thinking, e.g., the disposition to use or not to use one's reasoning and reflective judgment when solving problems and making decisions (Facione & Facione, 2001). The CCTDI has been used to examine critical thinking disposition of student nurses at the time of program entry, exit, and various other times during program completion (Colucciello, 1997; Thompson & Rebeschi, 1999) . It has also been used to examine the relationships between critical thinking and the National Council Licensure Examination© (NCLEX-RN) pass rates (Giddens & Gloeckner, 2005; Stewart & Dempsey, 2005), level of educational preparation (Shin et al., 2006), and alternative pedagogical strategies (Tiwari et al., 2006). Scores on the CCTDI have been reported to increase over the nursing student's academic tenure (Ip et al., 2000; McCarthy et al., 1999; Thompson & Rebeschi, 1999; Colucciello, 1997) and following curricular enhancements such as the use of problem based learning techniques and videotaped clinical vignettes (Tiwari et al, 2006; Yeh & Chen, 2005). However, findings of the relationship between CCTDI and NCLEX-RN scores have been equivocal. In one study (Giddens & Gloeckner, 2005) students who passed NCLEX-RN were

found to have statistically higher mean exit CCTDI scores, however, Stewart & Dempsey (2005) found no relationship with NCLEX-RN pass rates.

The CCTST measures the ability of the participant to draw conclusions in the areas of analysis, inference, evaluation, deductive reasoning, and inductive reasoning (Facione et al., 2002b). The CCTST has been used to examine the critical thinking ability of students enrolled in baccalaureate programs (Beckie et al., 2001; Thompson & Rebeschi, 1999), RN-BSN programs (White & Gomez, 2002), and compare performance on the NCLEX-RN (Giddens & Gloeckner, 2005). All but one of the these studies (Beckie et al., 2001) reported significant improvement in scores as students progressed to their final year (Spelic et al, 2001; Thompson & Rebeschi, 1999; McCarthy et al., 1999; Colucciello, 1997) and higher scores for students who passed the NCLEX-RN© (Giddens & Gloeckner, 2005). Curricular revisions and the addition of VTV as a teaching method did not improve CCTST scores (Beckie et al., 2001; Chau et al., 2001).

5.4.2.3 Simulation-Based Performance Assessment

Several methods are currently used to test application of critical thinking skills in a simulated setting. The most widely published performance assessment tool that uses VTV is the Performance Based Development System (PBDS) (Performance Management Service, 2007). Respondents are asked to view vignettes and describe in writing the actions they would take and their rationale. In 2001, del Bueno reported that 70% of 760 new nursing graduates completing the PBDS assessment did not consistently demonstrate the ability to recognize and safely manage acute care patients with commonly occurring problems or complications. A subsequent larger study reported that up to 76 percent of 10,988 inexperienced nurses (< 1 year experience) failed to meet expectations on the assessment (del Bueno, 2001). Fero et al., (in press), reported that 28.5% of 1211 new graduates and 21% of 933 experienced nurses did not meet expectations

on the PBDS assessment. Baccalaureate and associate prepared nurses were more likely to meet expectations as years of experience increased. A similar trend was not seen for diploma nurses (Fero et al, in press). These finding suggest that there are serious deficiencies in the critical thinking ability of new graduate and experienced nurses. Assessments such as the PBDS may facilitate identification of specific areas of deficiency and guide the development of targeted orientation and remediation.

Few studies have evaluated outcomes of using HFHS to educate nurses (Alinier et al., 2006) and only one study focused on new graduates. Trossman (2005) described the use of HFHS in the orientation of new graduates and concluded that HFHS was helpful in recreating low occurrence, high risk situations and overcoming new graduates' fears of being assertive (Trossman, 2005). Nearly half of the faculty and baccalaureate students reported that HFHS increased confidence, competency and perceived ability to practice in a real-world setting; the faculty felt that the skills gained through the HFHS experience would transfer to the clinical environment (Feingold et al., 2004). Nevertheless, results of three unpublished dissertations indicate no clear consensus (Howard, 2007; Schumacher, 2004; Wortock, 2002). Wortock (2002) found no statistically significant difference in critical thinking scores when teaching methods included traditional, HFHS, web-based delivery, or web-based and HFHS in combination. Schumacher (2004) exposed students to classroom instruction, HFHS, or a combination of both. Findings indicated a significant difference between critical thinking abilities ($p<.0.002$) and learning outcomes ($p<0.001$) favoring simulation or a combination of classroom and simulation (Schumacher, 2004). Howard (2007) compared HFHS to interactive case studies. A significant difference was found in knowledge gained and critical thinking ability, with the HFHS group scoring significantly ($p = 0.051$) better than the interactive case

study group (Howard, 2007). No studies were identified that explored the relationship between critical thinking scores using survey instruments and simulation-based performance.

5.4.2.4 Conceptual Framework

The theoretical framework guiding this study is an adaptation of Argyris' and Schon's theories of Action Espoused, what people say they will do, and Theory-in-Use, what people actually do (Argyris, C., 1980; Argyris, C. & Schon, D. , 1974).) In this study, three elements central to this theory were operationalized: 1) Governing values, values that people try to keep within acceptable limits, were operationalized as sound clinical performance and judgment (i.e. critical thinking); 2) Action strategies, plans or assessments used to keep governing values within acceptable limits, were operationalzed as applying critical thinking to accurately assess and plan care; and 3) Outcomes, the intended or unintended consequences of the action, were operationalzed as critical thinking scores and simulation-based performance.

5.4.3 The Study

5.4.3.1 Aim

The purpose of this study was to examine the relationship between metrics of critical thinking skills and performance in simulated clinical scenarios of nursing students in their last term of academic preparation. The aims were to; 1) compare simulation-based performance scores for VTV and HFHS; and 2) determine the relationship between critical thinking skills scores (CCTST, CCTDI) and simulation-based performance scores (VTV and HFHS).

5.4.3.2 Design

The study employed a quasi-experimental, cross-over design. A within-subject method provided greater study power and a reduction in error variance associated with individual differences (Hulley et al., 2001).

5.4.3.3 Participants

Thirty-six student nurses prepared at the diploma (n=14), associate (n=12), or baccalaureate level (n=10) and in their last term of academic preparation in the spring of 2007 were eligible for inclusion in the study. All were English speaking, and 18 years of age and older. Participants were excluded if they were enrolled in an RN completion or second degree program, prepared as an emergency medical technician, paramedic, or licensed practical nurse. Because the study was exploratory, sample size was not designed to test hypotheses. Sample size was calculated on the basis of 1) recruitment feasibility and 2) the need to estimate effect sizes concerning the magnitude of relationships among study variables.

5.4.3.4 Instruments

The CCTDI is a 75-item Likert style attitudinal survey (Facione & Facione, 2001). Total CCTDI scores range from 70 to 420. The instrument includes 7 subscales, each designed to measure a critical thinking habit of mind (Facione & Facione, 2001). Each subscale score ranges from 10 to 60. Reliability has been established with an overall median alpha coefficient of 0.90 and subscale coefficients ranging from 0.71 to 0.80 (Facione & Facione, 2001). A meta-study of baccalaureate nursing programs using the CCTDI indicated sub-scales and overall scale scores correlate significantly with the ACT and SAT-Verbal scores (Facione, N., 1997). For this study,

total and subscores were categorized into weak, average, or strong critical thinking disposition as follows: < 25th percentile (< 300) = weak; 25th through 74th percentile (301-341) = average; > 74th percentile (≥ 342) strong.

The CCTST consists of 34-items that measure an individual's ability to draw conclusions in the areas of analysis, inference, evaluation, deductive reasoning, and inductive reasoning (Facione et al., 2002b). Each item is assigned to one of three subscales; analysis, inference, or evaluation. Thirty of the 34 CCTST items are classified as either inductive or deductive reasoning. Reliability and validity of the CCTST has been reported previously (Shin et al., 2006; Stewart, S., & Dempsey, L., 2005; Beckie et al, 2001). For the purpose of this study, scores and subscores were categorized into strong, average, and weak critical thinking skills as follows:74th percentile (≥ 22) = strong skills; 25th through 74th percentile (16 - 21) = average, and < the 25th percentile (< 16) = weak.

The VTV/HFHS Assessment Tool was a researcher-developed tool (LF) designed to assess simulation-based performance. Content validity was established from a literature review and input from nurse educators, administrators, clinicians, and simulation experts (n=17). The tool provides an overall rating of knowledge and performance and six subcategory ratings, i.e., ability to recognize the clinical problem, report essential clinical data, initiate nursing interventions anticipate medical orders, provide rationale to support decisions, and prioritize care (Table 4). Performance was rated as "met" or "did not meet expectations" for the six subcategories and overall performance. To obtain a rating of "met expectations" for overall performance, students were required to meet expectations in any 4 of the 6 categories.

The testing scenario involved assessment and management of a patient with a pulmonary embolism. The scenario was written by a member of the research team (LF) and revised with

input from nursing educators and a statistician with expertise in use and assessment of VTV and HFHS. The scenario was pilot tested using 5 students (not included in the present study) to determine feasibility and clarity of instructions. No problems were identified.

5.4.3.5 Data Collection

The study protocol was completed in one 8-hour session (Figure 3). In *Phase I*, each student completed a demographic profile, CCTDI, and CCTST. In *Phase II*, students were randomized into two groups. Group A received orientation to VTV and instruction regarding how to complete the assessment. They were each given a reference sheet containing prompts and examples on how to structure their answers. Prior to the study scenario, Group A participants had the opportunity to participate in a practice VTV session. They viewed a VTV scenario of an actor portraying a patient experiencing a blood transfusion reaction and were given 10 minutes to individually complete the assessment and identify the patient problem, clinical data to report, nursing interventions they would initiate, anticipated medical orders, rationale for their chosen interventions, and the urgency in which they would treat the patient. Model answers were then shared with the participants. Next, they were administered the VTV testing scenario which depicted a post-operative patient experiencing shortness of breath, right-sided chest pain, elevated temperature, and altered blood gas values. Each participant was given 10 minutes to complete the assessment with the same expectations as previously.

Group B participants received an orientation to HFHS and instructions regarding HFHS laboratory performance. They were given a reference sheet similar to that used in the VTV assessment to keep with them throughout the simulation. For practice, the group viewed a videotape of a HFHS scenario depicting a post-operative patient receiving blood products who was experiencing a transfusion reaction. Expected performance was then reviewed. Next, they

were given an individual orientation to the HFHS equipment and environment. A Laerdal SimMan (Laerdal Corporation, Stevangen, Norway) was used for both the orientation and testing scenario. An operator provided the patient and physician voice. Relevant vital signs were displayed on the monitor. After orientation, each participant entered the testing simulation room alone and was given a script that included narrative background information about the patient, as well as any data that was displayed on the bedside monitor. The HFHS case scenario recreated the same testing case presented in VTV. Students were given 10 minutes to manage the scenario and complete the assessment. In *Phase III*, assignments were alternated. Group A participated in the same process to become familiar with HFHS and was tested using HFHS and Group B participated in the same process to become familiar with VTV and was tested using VTV.

Two experienced VTV raters, blinded to group assignment, scored participants' performance on the VTV simulation and two different HFHS raters, blinded to group assignment, scored HFHS performance. Responses were rated by comparing the participants' answers to the model answers. Raters determined whether the student met or did not meet expectations on the overall assessment and in each of the six subcategories.

5.4.3.6 Validity and Reliability

Reliability and validity of the CCTDI and CCTST have been previously reported (Shin et al., 2006; Stewart, S., & Dempsey, L., 2005; Beckie et al, 2001). Measures to insure reliability of VTV/HFHS ratings included use of expert raters blinded to group assignment and comparison to model answers

5.4.3.7 Ethical Considerations

Approval to conduct the study was obtained from a university institutional review board. Written informed consent was obtained from all participants.

5.4.3.8 Data Analysis

Statistics were calculated using SPSS/PC+ software version 16.0 (SPSS Inc., Chicago, USA). Descriptive data included age, race, gender, educational program, internship/residency participation, nursing aide experience, and number of classes within their curriculum using HFHS. The Fleiss crossover binary response chi-square (Fleiss, 1986) method was used to compare VTV and HFHS simulation performance scores. This method takes into account the cross-over design of the study and tests for order effect. Cramer's V was used to test the relationship between critical thinking disposition and skills (CCTDI and CCTST scores) and simulation-based performance scores (VTV and HFHS). The level of statistical significance was set *a priori* at 0.05.

5.4.4 Results

A total of 36 nursing students participated in the study. 38.9% were diploma graduates, 33.3% associate degree graduates, and 27.8% baccalaureate graduates (Table 5). The majority were between the ages of 20 and 30 (63.9%) and female (83.3%). Five students (13.9%) reported having participated in an internship/residency program, 14 (38.9%) had nursing aide experience, and 24 (67.0%) had simulation experience prior to participation in the study.

5.4.4.1 Comparison of Simulation-Based Performance

The majority of student nurses did not meet overall (4 of 6) expectations on the VTV (75.0%) or HFHS assessment (88.9%) (Table 6), and most were unable to identify essential clinical data to report to the physician in either VTV (69.4%) or HFHS (75.0%). The primary deficiencies related to inability to anticipate appropriate medical orders (95%) and provide rationale for their decisions (100%). Nevertheless, almost half correctly recognized the clinical problem in VTV (63.9%) and HFHS (41.7%) and approximately half initiated appropriate nursing interventions (VTV = 38.9% and HFHS = 72.2%). Students performed well when asked to prioritize the patient condition as urgent (VTV = 97.2% and HFHS = 91.7%). Although some students were unable to identify the actual clinical problem, they were able to identify it as serious and took immediate action by calling the physician.

There was no statistically significant difference between overall VTV and HSHS performance (p=0.2771). However, more students initiated nursing interventions in HFHS (p = 0.0002). No statistically significant order effect was found for performance overall or any of the subcategories based on assessment delivery (Table 6).

5.4.4.2 Relationship Between Critical Thinking Scores and Simulation-Based Performance

CCTDI scores ranged from 267 to 384 (Table 7). Of the 36 participants, 25.0% had a strong critical thinking disposition, 55.6% were average, and 19.4% were considered weak. The highest mean score (50.33) was achieved for the inquisitiveness subscale. The lowest mean subscale score (41.75) was achieved for truth-seeking.

CCTST scores ranged from 13 to 30. Of the 36 students, 30.6% had strong critical thinking skills, 41.7% were average, and 27.8% were considered weak. The highest mean

subscale score (10.83) was achieved for inductive reasoning. The lowest mean score (4.94) was achieved on the analysis subscale.

There was no significant relationship between overall VTV performance and CCTDI (Cramer's V = 0.145, p = 0.683) or CCTST (Cramer's V = 0.235, p = 0.372) scores. Analysis of VTV subcategories showed a relationship between problem recognition and overall CCTST scores (Cramer's V = 0.444, p = 0.029) indicating that students with strong critical thinking skills were more successful at synthesizing clinical data and accurately identifying the clinical problem. There was a statistically significant relationship (Cramer's V = 0.413, p = 0.047) between overall HFHS performance and CCTDI scores. Students with a strong critical thinking disposition met overall expectations on the HFHS assessment at a higher rate which included the ability to identify the clinical problem, report essential data to the physician, initiate nursing interventions, and prioritize the care. Conversely, there was a negligible relationship between overall HFHS performance and CCTST scores (Cramer's V 0.155, p=0.647).

5.4.5 Discussion

5.4.5.1 Study Limitations

The study had several limitations. The performance assessments were based on simulated vignettes; it is possible that actual clinical performance may differ from both stated and observed actions in a simulated environment. Different student experiences during their educational tenure and subsequent clinical exposure may have influenced their willingness to volunteer and aided or detracted from their performance. Those students who agreed to participate in the study may be different from those who did not (e.g., less confident or less prepared). Students were required to perform alone in the HFHS scenario; this may have heightened anxiety and

influenced performance. Although all types of RN students were represented, the sample was small and may limit generalizability.

5.4.5.2 Discussion of Results

Findings of this study contribute to our understanding of both critical thinking and the transition of certain metrics to simulation-based performance by illuminating areas of potential deficiencies in student nurses. The results suggest that student nurses had difficulty meeting overall performance expectations with VTV and HFHS. The percentage of students who did not meet expectations fell within or above the range of previously published results utilizing the PBDS assessment (del Bueno, 2005). From a sample size of 10,988 inexperienced nurses (<1 year of experience) between 65% and 76% did not meet expectations on the PBDS. A study completed by Fero et al. (2009) found that 28.5% of 1211 new graduates (< 1 year of experience) and 21.0% of 933 experienced nurses (≥ 1 year of experience) failed to perform to the expected level as measured by overall PBDS results. In the later study, approximately 57% of nurses not meeting expectations were deficient in problem recognition, 62% did not anticipate relevant medical orders, 65% did not report essential clinical data to the physician, 67% did not differentiate the urgency of the clinical situation, and 97% were not able to initiate independent nursing interventions (Fero et al., 2009).

Although a majority of the students in the present study had learning needs with regard to identifying the problem, reporting essential clinical data, and anticipating medical orders, they performed well in initiating nursing interventions and prioritizing the patient as urgent. Nursing educators are frequently challenged by the assignment of large clinical groups which provides limited time to focus on the use or application of knowledge and logical reasoning (del Bueno, 2005). It is apparent that students recognized that the situation in both VTV and HFHS was

pressing and needed to be reported immediately; however they struggled with what to report and the treatment to anticipate. Students had more difficulty functioning independently when asked to synthesize the data presented to them in the HFHS environment. This may reflect their unfamiliarity with acting alone, rather than with the support of their clinical instructor. A majority of nursing programs rely heavily on multiple-choice examination in the classroom and acute situations are often managed by staff nurses due to urgency. This limits opportunities to critique their practice and increase their independent decision making ability. Student nurses have limited opportunity to communicate one-on-one with the physician as this role tends to be assumed by nursing staff to facilitate verbal orders. Finally, these results may reflect a limitation in the tool used to assess both VTV and HFHS performance.

Although, no studies identified directly compared VTV and HFHS performance, several studies have investigated the relationship and effectiveness of alternative performance evaluation methods. The ability of VTV to enhance critical thinking ability, as measured by both the CCTST and the nursing knowledge test, was examined by Chau et al. (2001). Results indicated that CCTST scores increased slightly, however the difference was not significant. The mean score of the nursing knowledge test did increase ($p=0.01$) indicating that VTV increased knowledge regarding the management of clinical situations (Chau et al., 2001). Rogers et al., (2001) evaluated medical students learning using multiple-choice, structured clinical, and simulation examination. Finding supported simulation as the superior evaluation tool, because unlike written examinations, the simulator provides opportunity to evaluate both cognitive and psychomotor skills (Rogers et al., 2001). In a prospective, randomized trial Stedman et al. sought to determine whether full-scale HFHS was superior to problem-based learning in the training of fourth-year medical students in acute care assessment and management skills. The

simulation group performed significantly better ($p<.0001$) in the simulated assessment of dyspnea leading the authors to conclude that the use of HFHS in the training of medical students in critical assessment is superior to problem-based learning (Steadman et al., 2006). Other trials comparing HFHS to other innovative educational technologies have shown no difference between methods or that simulation was not as effective (Morgan et al., 2005; Nyssen et al., 2002). In the present study, overall performance in both VTV and HFHS environments was similar with the exception of a higher performance level in initiating independent nursing interventions via HFHS. Items in this subcategory are weighted heavily in psychomotor skill (lung sound assessment and placing a pulse oximeter and oxygen on the patient). These results may reflect the reality of the HFHS environment and the student's confidence in their skill set. However, when asked to combine cognitive and task-based skills, the students did not perform to the expected level. Although the students were able to recognize that the situation was urgent and needed to report it immediately, many struggled with reporting a complete and accurate set of data to the physician. These results emphasize the importance of investigating alternative methods of promoting communication skills within the context of an urgent situation. HFHS would offer this potential.

Results of scores on both the CCTDI and CCTST in the present study fell within or above scores previously published in the nursing literature (Giddens & Gloeckner, 2005; Beckie et al., 2001, Thompson & Rebeschi, 1999; McCarthy et al., 1999; Colucciello, 1997) suggesting that the participants in this study reflect nursing students' critical thinking disposition and skills. The present study found no relationship between overall VTV and CCTDI or CCTST scores. However, there was a relationship noted between HFHS performance and overall CCTDI scores. Participants performing well in HFHS tended to have higher CCTDI subcategory scores in

analyticity and systematicity. These results suggest these students were more alert to potential problems, able to anticipate consequences, accept challenging and difficult situations, and organize their approach to care (Facione et al., 2001). They appeared to perform better in situations that activate visual, auditory and tactile pathways and evoke a more engaged response. In contrast, those students performing well on the VTV assessment had greater strength in the truthseeking and inquisitiveness subcategories of the CCTDI which indicates a greater preference for intellectual curiosity, objectivity, and inquiry (Facione, 2001). VTV testing was carried out using a written assessment which may indicate that these students perform better when asked to cognitively reflect on the situation presented. Results suggest that students with a strong overall critical thinking disposition and a greater ability to systematically analyze a situation perform better when faced with a clinical scenario that more closely mimics reality such as those created in HFHS.

Despite favorable reviews of simulation-based methods of critical thinking assessment, quantitative evidence supporting their effectiveness is still lacking (Steadman et al., 2006). There remains a call to correlate simulation-based performance and actual clinical competency (Wong, 2004). Several randomized clinical trials demonstrate the effectiveness of simulation-based training in improving actual clinical performance on procedures, including laporascopic cholesystectomy (Cossman et al., 2007; Grantcharov et al., 2004; Seymour et al., 2002), colonoscopy (Ahlberg et al., 2005), and catheter-based endovascular procedures (Chaer et al., 2006). However, these procedural skills may differ from those involved in carrying out the nursing process.

As competency assessment methods evolve, nursing administrators' and educators need to prepare for the growing number of new graduate nurses as they must be able to deliver

effective and safe care as early as possible in their nursing careers (Nursing Executive Center, 2008). In a recent report published by the Nursing Executive Center (2008), the authors argued that a broad analysis of new graduate practice is not helpful. Instead, they suggested a detailed evaluation of specific shortfalls that, in turn, help to close the gap in knowledge between academic preparation and practice. Specifically, they identified critical thinking as one of the top priorities. Mutually agreed upon competencies include the ability to recognize changes in patient status, anticipate risk, interpret assessment data, facilitate decision making, and recognizing when to ask for assistance (Nursing Executive Center, 2008). Both VTV and HFHS appear to have potential utility in assessing achievement of this goal.

5.4.6 Conclusion

Student nurses' performance reflected difficulty meeting expectations when tested in simulated clinical scenarios. Overall performance in HFHS appeared to best approximate scores on the standardized measure of critical thinking disposition (CCTDI). Further research is needed to determine if simulation-based performance correlates with critical thinking skills in the clinical setting. This will allow both nursing educators and administrators to determine the best, most-cost effective method of evaluating and preparing new graduates for clinical practice.

5.4.7 Tables and Figures

Table 4 VTV/HFHS Assessment Tool

Category	Expected Subcategory Actions (met expectations)
1 Recognizes Clinical Problem	-Recognizes that the patient is experiencing a pulmonary embolism or pneumothorax.
2 Reports Essential Clinical Data	-Reports that the patient is complaining of chest pain, shortness of breath, and/or compromised respiratory status -Reports all vital signs -Reports previously obtained arterial blood gas values
3 Initiates Nursing Interventions	-Reassures the patient -Completes a lung sound assessment -Places a pulse oximeter and oxygen on the patient
4 Anticipates Medical orders	-Anticipates an order for a Chest X-Ray or Computerized Tomography Scan -Anticipates an order for an additional arterial blood gas -Anticipates an order to draw a PT/PTT
5 Provides Rationale to Support Decisions	-States appropriate rationale for each category
6 Prioritizes	-Notifies the physician immediately of the clinical situation
Subject met expectations if **Overall =** Carried out all actions listed in a majority of categories (any 4 of the 6) **Subcategory** = Carried out all actions in the subcategory	

Figure 3 Study Protocol

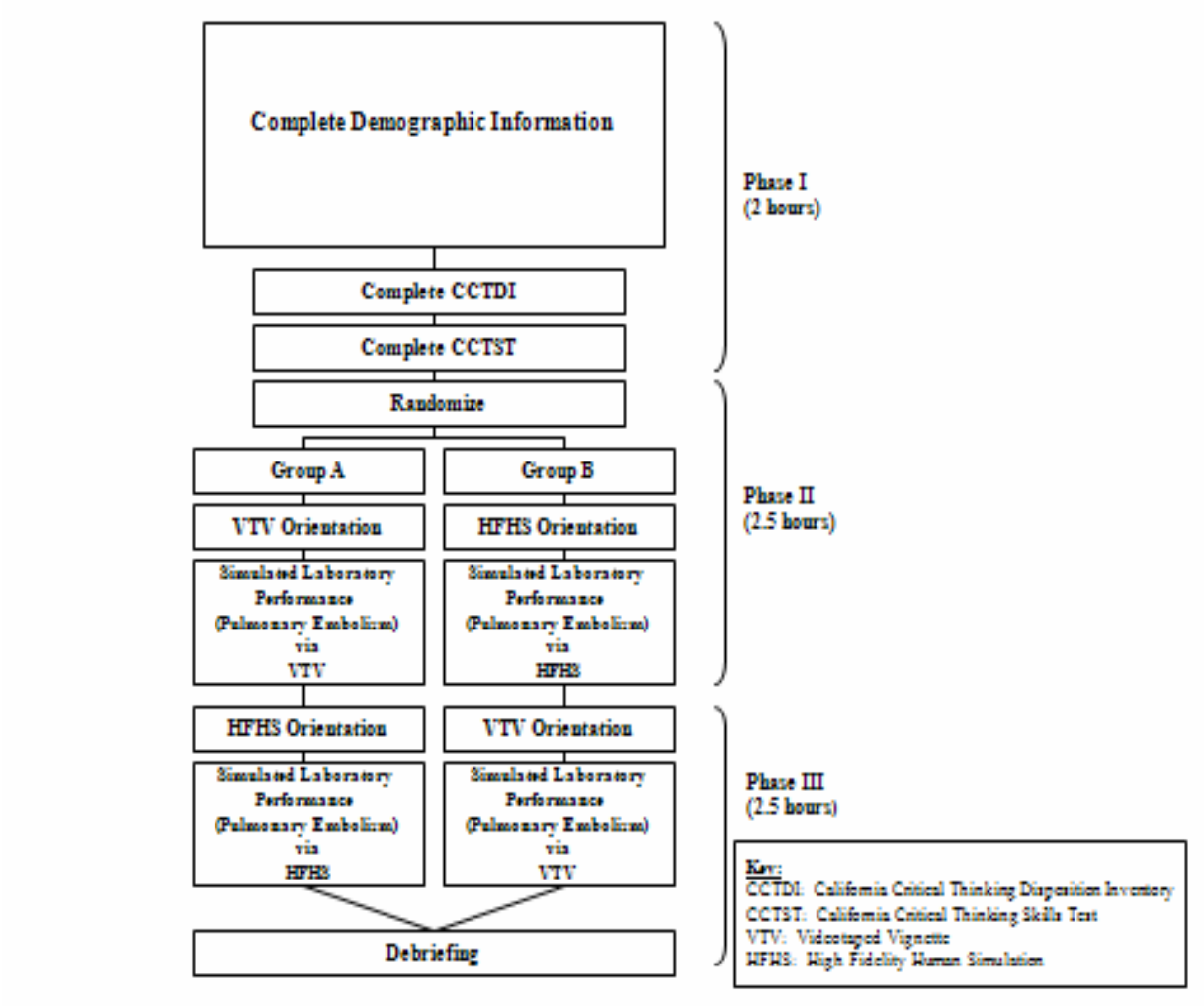

Table 5 Demographic Characteristics of Participants (N=36)

Variables	Number (% of Total)
Age (yr)	
20-23	13 (36.1%)
24-30	10 (27.8%)
31-54	13 (36.1%)
Race	
Caucasian	33 (91.7%)
African-American	2 (5.6%)
Asian	1 (2.8%)
Gender %, female	30 (83.3%)
Educational Program	
Diploma	14 (38.9%)
Associate	12 (33.3%)
Baccalaureate	10 (27.8%)
Internship/Residency Participation, n (% yes)	5 (13.9%)
Nursing Aide Experience, n (% yes)	14 (38.9%)
Number of Classes Using Simulation, n (% yes)	
0 Classes	12 (33.3%)
1-2 Classes	14 (38.9%)
3-5 Classes	10 (27.8%)

Table 6 Comparison of Simulation-Based Performance

VTV/HFHS Assessment Categories	% of Sample Not Meeting VTV Expectations	% of Sample Not Meeting HFHS Expectations	Results of Method Comparison	Assessment Delivery Order Effect
Overall Assessment Rating	75.0%	88.9%	p=0.2771	p=0.7314
Recognizes Clinical Problem	36.1%	58.3%	p=0.0833	p=0.0510
Reports Essential Clinical Data	69.4%	75.0%	p=1.000	p=0.3541
Initiates Nursing Interventions	61.1%	27.8%	**p=0.0002**	p=0.5453
Anticipates Medical Orders	100.0%	97.2%	*	*
Provides Decision Rationale	100.0%	100.0%	*	*
Prioritizes	2.8%	8.3%	*	*

**unable to calculate due to the lack of variability in the results*

Table 7 Critical Thinking Disposition and Skills Scores

Measure	Mean (SD)	Critical Thinking Disposition/Skills		
		Weak	Average	Strong
CCTDI				
-Truth Seeking	41.75 (5.89)	4 (11.1%)	15 (41.7%)	17 (47.2%)
-Open-Mindedness	45.81 (5.17)	5 (13.9%)	20 (55.6%)	11 (30.6%)
-Analyticity	46.08 (5.83)	7 (19.4%)	14 (38.9%)	15 (41.7%)
-Systematicity	44.86 (6.08)	9 (25.0%)	17 (47.2%)	10 (27.8%)
-Self Confidence	46.33 (7.29)	7 (19.4%)	18 (50.0%)	11 (30.6%)
-Inquisitiveness	50.33 (6.36)	9 (25.0%)	15 (41.7%)	12 (33.3%)
-Maturity	49.33 (4.53)	6 (16.7%)	18 (50.0%)	12 (33.3%)
Total CCTDI Score	**324.5 (28.3)**	**7 (19.4%)**	**20 (55.6%)**	**9 (25.0%)**
CCTST				
-Analysis	4.94 (1.41)	6 (16.7%)	14 (38.9%)	16 (44.4%)
-Inference	9.64 (2.56)	9 (25.0%)	14 (38.9%)	13 (36.1%)
-Evaluation	5.08 (2.01)	9 (25.0%)	15 (41.7%)	12 (33.3%)
-Induction	10.83 (2.48)	8 (22.2%)	12 (33.3%)	16 (44.4%)
-Deduction	8.83 (3.20)	10 (27.8%)	16 (44.4%)	10 (27.8%)
Total CCTST Score	**19.67 (4.65)**	**10 (27.8%)**	**15 (41.7%)**	**11 (30.6%)**

CCTDI minimum score achievable = 70, maximum score achievable = 420
CCTST minimum score achievable = 0, maximum score achievable = 34
$< 25^{th}$ percentile of scores = weak critical thinking disposition/skills
$\geq 25^{th}$ to 74^{th} percentile of scores = average critical thinking disposition/skills
$\geq 75^{th}$ percentile of scores = strong critical thinking disposition/skills

5.5 TITLE PAGE MANUSCRIPT 2

Comparison of Performance Assessment Using Videotaped Vignettes

and High-Fidelity Human Simulation in Nursing Students: A Pilot Study

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5.6 ABSTRACT MANUSCRIPT 2

Introduction: Videotaped vignettes (VTV) and high-fidelity human simulation (HFHS) move beyond conventional assessment to identify areas of deficiency in simulated environments. The aims of this study were to: 1) compare the utility of VTV and HFHS in evaluating students' simulation-based performance; 2) identify specific performance deficiencies; and 3) compare students' perceptions of their experience.

Methods: Participants were 20 nursing students rated using the VTV/HFHS Assessment Tool while performing a simulation-based assessment using VTV and HFHS. The tool rated overall performance and six subcategories. Participants also identified positive and negative perceptions regarding the experience during a debriefing session.

Results: Few participants met overall VTV (30.0%) or HFHS (10.0%) expectations. There was no statistically significant difference in participants' overall performance based on method of assessment. Regardless of assessment method, participants had difficulty with subcategory performance including recognizing the clinical problem, reporting clinical data, and anticipating orders. Participants initiated independent interventions ($p = 0.014$) and reported patient symptoms ($p = 0.002$) more often in HFHS and reported pertinent lab values more often ($p=.007$) in VTV. Feedback from the debriefing indicated that participants felt HFHS provided a better assessment of their individual weaknesses.

Conclusions: Both VTV and HFHS were useful in identifying those who had difficulty recognizing the clinical problem, reporting clinical data and anticipating orders. While participants scored higher in performing tasks associated with initiating independent nursing interventions and reporting patient symptoms in HFHS, further research is needed to determine which simulation-based testing method better reflects skills needed in clinical practice.

Keywords nurses; critical thinking; simulation-based performance assessment; videotaped vignettes; high fidelity human simulation; assessment methods; deficiencies

5.7 MANUSCRIPT 2 CONTENT

5.7.1 Introduction

Nursing graduates are expected to possess the critical thinking skills and clinical competence to provide safe and appropriate patient care. They are expected to recognize changes which signal instability, revise care, and inform the medical team if indicated (AACN, 1997). Nursing educators are challenged to identify teaching strategies that develop students' critical thinking skills and clinical competency.

Traditionally, nursing education takes place in the classroom, laboratory and clinical setting and relies heavily on written examination and direct observation of students. Although students are given opportunities to demonstrate their skills under supervision, there are limited opportunities to assess independent performance and critical thinking skills. The use of alternative performance-based approaches may be more effective in assessing students' abilities to demonstrate the knowledge and skills required to safely manage patient care. The most commonly used strategies are videotaped vignettes (VTV) and high-fidelity human simulation (HFHS).

5.7.2 Background

VTV and HFHS are alternative performance-based assessment methods that may provide more insight into students' actual performance. VTV is a narrative-based assessment; the nurse views a videotaped clinical scenario of an actor portraying a patient in crisis and describes, in writing, how he/she would act in the situation (Performance Management Service, Inc., 2007). HFHS is an experiential action assessment; the nurse is observed performing his/her assessment and carrying out actions. Both methods have the goal of identifying areas of deficiency to target remediation and promote patient safety. However there are notable differences. Assessment via VTV is based on reflective responses elicited from watching a videotape of a potentially critical patient scenario. There is no mannequin, medical equipment, or requirement to integrate both cognitive and psychomotor skills. In contrast, HFHS provides an interactive environment that requires students to demonstrate skills, synthesize, and apply knowledge in a simulated clinical environment (Steadman et al., 2006).

The use of VTV or HFHS to measure or enhance critical thinking skills and clinical performance has been evaluated in several studies. The most widely used performance assessment tool based on VTV is the Performance Based Development System (PBDS). With the PBDS, the nurse observes 10 videotaped vignettes and provides a written description of proposed actions and rationale (Performance Management Service, Inc., 2007). Studies using the PBDS indicate that serious deficiencies exist in new graduates' critical thinking skills, including the ability to recognize clinical problems, initiate interventions, and understand the rationale behind decisions (del Bueno, 2001; del Bueno, 2005). The use of HFHS has been shown to have a positive impact on physicians' ability to learn technical skills, perform tasks associated with patient care, improve crisis response, and facilitate medical emergency team

management (DeVita et al., 2005; Schwid et al., 2002; Gallagher & Cates, 2004a; Gallagher & Cates, 2004b; Seymour et al., 2002; Chopra et al., 1994). A limited literature has evaluated outcomes of HFHS training involving nurses. Findings suggest HFHS improves time-management and leadership skills (Marshall, et al., 2001); confidences in ability to face future hospital experiences and identify knowledge deficiencies (Bremner et al, 2006; Henneman & Cunningham, 2005).

The usefulness of VTV and HFHS to assess students' performance, identify deficiencies in specific performance subcategories, and influence student perceptions of their learning experience remains unclear. Furthermore, a systematic assessment and analysis of specific subcategories of performance competency and/or deficiencies of nursing students in their final term of academic preparation is lacking. Therefore, the specific aims of this study were to: 1) compare the utility of VTV and HFHS in evaluating students' simulation-based performance; 2) identify specific performance deficiencies; and 3) compare students' perceptions of their experience.

5.7.3 Methods

5.7.3.1 Design

The sample for this cross-sectional, descriptive pilot study was 20 of the 48 student nurses recruited from academic institutions in Southwestern Pennsylvania who participated in a parent study designed to examine the relationship between critical thinking skills and simulation-based performance (in review). Participants included students for whom complete data were available for VTV and HFHS assessments and debriefing sessions.

5.7.3.2 Study Setting and Participants

All participants were English speaking, at least18 years of age and in their last term of academic preparation at an accredited nursing school. Exclusion criteria included: preparation as an emergency medical technician, paramedic, or licensed practical nurse or enrollment in an RN to BSN or second-degree accelerated program. Given the pilot nature of the work, the sample size was not determined to test hypotheses but instead based on recruitment feasibility within the time constraints related to graduation dates. The study was conducted at the Peter M. Winter Institute for Simulation Education and Research (WISER), a multi-disciplinary simulation center on the University of Pittsburgh campus.

5.7.3.3 Measures

A baseline questionnaire was used to assess participants' demographic characteristics and educational experience.

The VTV/HFHS Assessment Tool was designed to rate participants' knowledge and performance at the novice level. The tool provided a rating for overall performance and six subcategories: ability to identify the clinical problem, report appropriate clinical data, initiate nursing interventions, anticipate orders, state rationale to support decisions, and prioritize care (Table 8). Performance was rated as "met" or "did not meet expectations". To attain an *overall rating* of "met expectations", participants were required to perform all listed actions in a majority of categories (any four of the six). To attain a *subcategory rating* of "met expectations", participants were required to perform all actions listed in that subcategory. The tool was developed by a member of the research team (LJF) based on a review of the literature and input from nurse educators, administrators, clinicians, and simulation experts (n=17). Content validity was established by seven nursing educators, a statistician, and 3 researchers with expertise in the

use of VTV and HFHS. The tool was pilot tested by five nursing students not included in the present study. No revisions were required.

The testing scenario required participants to assess and manage care of a patient with a sudden change in status consistent with a pulmonary embolism or pneumothorax. After completion of the assessment, a videotaped debriefing was conducted. Participants were asked to identify three positive and three negative perceptions regarding each simulation method and suggest curriculum modifications to address areas of performance deficiency.

5.7.3.4 Data Collection

After obtaining IRB approval and written informed consent, each participant completed the baseline questionnaire. Participants were recruited in two groups and underwent evaluation in separate sessions. Each group was divided into two subgroups (Group A, Group B) and the order for VTV and HFHS orientation and testing was randomized as shown in Figure 4.

Group A received a general orientation to VTV by a trained member of the investigative team and instruction regarding how to complete the written assessment. Participants 1) received a reference sheet to keep during the orientation which contained prompts and examples on how to structure their answers in writing, 2) viewed a VTV orientation video of an actor portraying a patient experiencing a blood transfusion reaction, and 3) received a video script that included the narrative background information about the patient, as well as any data that was displayed on the video screen. Participants were given 10 minutes to independently complete the VTV assessment. After completion of the practice session, an investigative team member reviewed the expected responses and participants were given the opportunity to ask questions.

Following the practice session, the VTV testing scenario was administered. This scenario depicted a post-operative patient who experienced acute onset of shortness of breath, right-sided

chest pain, and elevated temperature. Participants were given a video script that included narrative background information about the patient and could view data displayed on the video screen**.** Each participant was given 10 minutes to independently complete the VTV assessment in which they were asked to state, in writing, the clinical problem, appropriate clinical data to report to the physician, nursing interventions to initiate, anticipated orders, rationale to support their interventions, and the urgency in which they would treat the patient. After completion of the assessment, all materials were collected by an investigative team member. The team member remained in the room until Group A and B switched locations to ensure that the scenario was not discussed.

Group B participated in a group introduction to HFHS and was given general instructions regarding HFHS performance. Participants 1) received a reference sheet to keep with them during the assessment period which outlined prompts and examples on how to structure their verbal responses and perform actions during the simulation, 2) viewed an orientation videotape of a HFHS scenario depicting a post-operative patient receiving blood products who experienced an elevated temperature, chills, and hives, and 3) received a script that included background information about the patient and data displayed on the bedside monitor. The videotaped model performance was then reviewed and questions answered.

Each participant was also individually oriented to the HFHS environment and equipment by the same member of the investigative team who facilitated all orientation sessions. Each student completed an orientation checklist. During the orientation, each participant was shown and given the opportunity to interact with the Laerdal SimMan (Laerdal Corporation, Stevangen, Norway), practice measuring vital signs, attaching a pulse oximeter, administering oxygen, assessing lung and heart sounds, locating equipment (the "crash-cart", bedside monitor,

telephone, video-recording equipment), and calling the physician with a status report. After orientation was completed, each participant was escorted into the HFHS testing room. Participants were given a script that included narrative background information about the patient and data displayed on the bedside monitor. They also were given the HFHS reference sheet that was discussed during orientation. This case scenario recreated the same testing case presented in VTV. The participant was expected to verbalize the clinical problem, determine the urgency of the situation, report appropriate clinical data via telephone to the physician, initiate nursing interventions, anticipate and prepare for any relevant medical orders and verbalize the rationale behind their chosen interventions. They were given 10 minutes to manage the scenario and complete the assessment. Each participant's performance was videotaped for later review. A member of the investigative team collected all testing material and escorted each participant to an alternative classroom. A team member remained in this room to ensure that the scenario was not discussed until all participants completed the assessment.

Consistent with the within-subject, cross-over design, the same procedures, facilitators, and assessment tools were utilized to complete the alternate testing method, i.e., Group A participants performed HFHS and Group B VTV. After testing, participants were brought together for a joint-debriefing session to review expected performance using VTV and HFHS and discuss their experience with each assessment method. The total time required for testing and debriefing was approximately 5 hours.

5.7.3.5 Data Analysis

Two experienced VTV raters, blinded by group, scored participants' written VTV response and two alternative raters, blinded by group, scored their videotaped HFHS performance. The raters determined if the participant met or did not meet expectations on the overall assessment and in

each of the six subcategories by comparing participant answers to expected answers for each subcategory and each item contributing to each subcategory.

Descriptive statistics were calculated using SPSS, version 16.0. The Fleiss crossover binary response chi-square method was used to compare VTV and HFHS performance scores (Fleiss, 1986). This method takes into account the cross-over design of the study and tests for order effect of assessment mode. The level of statistical significance was set *a priori* at 0.05. Positive and negative perceptions expressed by participants during the structured debriefing were counted and classified into thematic groups by two independent investigators (LJF, JMO); discrepancies were resolved by consensus.

5.7.4 Results

Most participants were female (85%) and split between the ages of 20 to 23 (40.0%) and 31 to 54 (40.0%) (Table 9). Prior experience was variable; only 20% participated in an internship/residency program and nearly half were nursing aides. All participants had 1- 2 simulation classes prior to participation in the study.

5.7.4.1 Comparison of Assessment Method

There was no statistically significant difference in overall performance between VTV and HFHS (p=0.505) (Table 10). However, there were differences for subcategory performance. In HFHS, more participants met subcategory expectations for reporting the patient complaint of chest pain and shortness of breath to the physician (p = 0.002), initiating independent nursing interventions (p=0.014) which included reassuring the patient (p=0.002), completing a lung sound assessment (p=0.006), and placing the pulse oximeter on the patient (p=0.015). In VTV, more participants

met subcategory expectations for reporting previously obtained blood gas values to the physician in ($p = 0.007$). No statistically significant order effect was found based on the sequence of delivery.

5.7.4.2 Performance Deficiencies

Few student nurses met overall performance expectations (defined as carrying out all actions in a majority of categories (any 4 of the 6) using VTV (30.0%) or HFHS (10.0%) (Table 10). One-half of the participants did not recognize the clinical problem as a pulmonary embolism or pneumothorax using VTV and 30.0% did not using HFHS. Regardless of assessment method, participants had difficulty reporting all clinical data (VTV = 45.0%; HFHS = 35.0%), anticipating all orders (0.0%), and stating the rationale to support decisions (0.0%). Based on subcategory analyses, participants who did not recognize the pulmonary embolism or pneumothorax misidentified the clinical problem as a myocardial infarction. Although nearly 40.0% of the participants did not report all clinical data listed in the subcategory to the physician, the majority did report that the patient was having chest pain and shortness of breath (VTV = 85.0%; HFHS = 100.0%) and all necessary vital signs (VTV = 55.0%; HFHS = 75.0%). However, they reported blood gas values less frequently in HFHS (VTV = 95.0%; HFHS = 40.0%). Participants performed well on both assessments when asked to initiate nursing interventions (VTV = 55.0%; HFHS = 75.0%) which included the ability to reassure the patient (VTV = 85.0%; HFHS = 100.0%), assess lung sounds (VTV = 65.0%; HFHS = 90.0%), and place the pulse oximeter (VTV = 75.0%; HFHS = 90.0%) and provide supplemental oxygen (VTV = 95.0%; HFHS = 85.0%). Additionally, participants were able to prioritize the patient situation as urgent in both assessment methods (VTV and HFHS = 95.0%). Although not statistically significant, 65.0% of the participants were able to anticipate an order for a chest x-

ray or computer assisted tomography scan in VTV compared to only 35.0% in HFHS, and 40.0% were able to anticipate an order for an additional arterial blood gas in VTV compared to only 10.0% in HFHS.

5.7.4.3 Perceptions of Experience

Participants in both debriefing groups reported that VTV and HFHS were superior assessment methods compared to traditional case studies presented in a written format (Table 11). Benefits of VTV included the ability to view a patient (portrayed by an actor) experiencing a crisis. However, many participants reported that VTV did not provide the necessary environment to promote urgency of action. Participants overwhelmingly stated that HFHS provided a more realistic clinical environment that facilitated their ability to identify areas of clinical weakness. The majority acknowledged that it was more difficult to integrate the cognitive and psychomotor skills necessary to manage the HFHS scenario. Although most participants were very nervous and anxious about being alone in the HFHS portion of the assessment, many requested that their academic institutions integrate more individualized performance-based testing into the curriculum rather than a group-centric model which limits opportunities for students to be alone in a room with a patient needing immediate intervention. Several expressed that they felt unprepared to transition into clinical practice after graduation but viewed this experience as helping them to focus on needed remediation.

5.7.5 Discussion

Few participants met overall expectations, defined as meeting all expectations in four of the six categories. Regardless of assessment method, participants had difficulty with subcategory

performance including recognizing the clinical problem, reporting clinical data, and anticipating orders. Some actions, e.g., initiated independent interventions and reported patient symptoms, were performed more often using HFHS and others, e.g., reported pertinent lab values, using VTV. Feedback from the debriefing indicated that participants felt HFHS provided a better assessment of their individual weaknesses. These findings suggest that VTV and HFHS provide common, as well as unique, input regarding students' proficiency.

5.7.5.1 Comparison of Assessment Method

Although no prior studies were identified that directly compared performance using VTV and HFHS, several studies have examined the relationship between other types of assessment methods and HFHS performance. Little evidence exists to support a relationship between ratings of performance during HFHS and clinical evaluations or written examinations (Devitt et al, 1997; Morgan et al., 1997). Rogers et al. (2001) evaluated medical student learning using a multiple-choice written examination, objective structured clinical examination, and a patient simulator. Findings indicated that the simulator was a superior evaluation tool because, unlike written examinations, it provided the opportunity to evaluate the students cognitive and motor skills in real-time. The authors concluded that written examinations overestimate students' ability to reach educational objectives.

Based on the results of the current study, overall performance in both VTV and HFHS was similar. Subcategory ratings favored HFHS for reporting the primary complaint of chest pain to the physician and initiating independent nursing interventions, i.e., reassurance, lung sound assessment, and placing a pulse oximeter and administering oxygen. This may have been prompted by verbal complaints of the "patient" regarding his distress and the immediate availability of equipment in the simulation room. Having equipment available could have

triggered recollection and action based on previous clinical experience. However, when participants were asked to identify the clinical problem, report relevant information, and anticipate orders, they struggled to do so in both the VTV and HFHS environment. During debriefing sessions, participants identified that both methods forced rapid decision-making. During HFHS testing, participants appeared highly emotional and had difficulty integrating both the cognitive and psychomotor skills necessary to manage the "patient". These observations suggest that HFHS may help educators move closer to creating actual clinical situations which encompass the urgency and emotional aspects of care and yield a more accurate assessment of higher-order critical thinking that combines affective cognitive and psychomotor components.

5.7.5.2 Performance Deficiencies

The percentage of participants not meeting expectations fell slightly above the range of published results utilizing the videotaped vignette-based PBDS assessment. In an analysis of PBDS results for a sample of 10,988 inexperienced nurses (<1 year of experience) between 1995 and 2004, del Bueno et al. (2005) found that between 65% and 76% of new nurses did not meet expectations on the assessment.

Because many participants had difficulty identifying the clinical problem, reporting all clinical data, and anticipating orders, we conducted further analysis of subcategory items. This analysis revealed that the majority were able to successfully complete some items. Nearly all reported the patient complaint of chest pain and shortness of breath to the physician and initiated interventions which included providing reassurance, completing a lung sound assessment, and supplying the patient with supplemental oxygen. Furthermore, 95% of the students recognized the clinical situation as urgent and requested immediate help. These results may indicate that the educational process currently being fostered is highly scaffolded, scripted, and focused on only

the initial tasks associated with managing critical patient situations. In contrast, areas of deficiency included their inability to synthesize the data presented into a clinical problem and subsequently anticipate what diagnostic testing might be needed to manage the situation in both the VTV and HFHS environment. These results may indicate difficulty in higher-order critical thinking which includes the ability to combine all the information presented. It has been reported that errors made by new graduates correlate with their inability to make clinical decisions based on patient assessment data and diagnostic tests (Smith & Crawford, 2003). Although not statistically significant, there was a trend toward participants having more difficulty meeting these expectations in HFHS. These differences may reflect the reality of the HFHS environment. HFHS forces action and integration of knowledge, whereas VTV is a more passive assessment. A review of literature supports the indispensable role of emotion in decision-making (Thagard & Barnes, 1996). Based on student feedback, HFHS evoked more anxiety because participants had to integrate cognitive and psychomotor skills in the management of the "patient". Additionally, students were alone during the assessment and had to rely on their own knowledge and skill. This may note difficulty in transitioning theoretical knowledge into practice (del Bueno, 2005). In response to their experience, many students suggested that participating in an individualized assessment may help them to better understand their own areas of weakness.

5.7.5.3 Perceptions of the Experience

Results of the current study indicate that nursing students had a strong preference for HFHS assessment. Although many felt it provoked anxiety and self-doubt, it mimicked a more realistic environment allowing them to better recognize their individual weaknesses. Previous studies support inclusion of HFHS in the nursing curriculum and note faculty and student satisfaction

with its use (Larew et al, 2006; Jeffries, 2005; Rauen, 2004; Beyea, 2004). Qualitative studies have suggested that simulation helps students to acquire skills, build confidence, and work through difficult clinical problems (O'Donnell et al., 2005). Some have reported perceived improvement in problem solving, decision-making, and critical thinking (Henrichs, et al., 2002). Overall, most find the use of HFHS to be beneficial in the nursing curriculum and emphasize the potential for skills acquired in a simulated environment to be transferred into clinical practice. Based on suggestions for nursing curriculum modifications, it was evident that participants in this study desired more one-on-one practice that required communicating with the physician and anticipating orders. Additionally they expressed a need to decrease group-centric instruction and integrate individualized performance-based assessment throughout the nursing curriculum.

5.7.6 Study Implications

In a recent report published by the Nursing Executive Center, the authors identified the need for a more detailed understanding of areas that need attention in the transition of new graduates into practice (Nursing Executive Center, 2008). Specifically, they acknowledged a gap between academia and organizational expectations. The use of alternative methods to evaluate critical thinking and clinical performance may assist in preparing graduates for this transition. The National Council of State Boards of Nursing has requested that additional research be conducted in the development of clinical competencies and has predicted the future of clinical education will include an increased use of assessment through simulation-based performance (National Council of State Boards of Nursing, 2005). Nursing educators must move beyond using simulation in the evaluation of technical skills and integrate these experiences in ways that require students to demonstrate assessment, technical, interpersonal, and critical thinking skills

(Gaba, 2004). The use of HFHS may provide the link between theory and practice and increase ability to synthesize knowledge and promote insight. When integrated into competency testing, simulation plays a fundamental role in acquiring the critical thinking skills to provide safe and competent care (Decker et al, 2008).

5.7.7 Limitations

Our study has several limitations. First, it was conducted with a small, convenience sample which limited generalizability and statistical analyses. Secondly, VTV and HFHS performance assessment was based on simulated vignettes. Actual clinical performance may differ from both the written and observed actions of the student nurse. The students had limited time to practice in both the VTV and HFHS environment. Therefore, students may have been both uncomfortable and unfamiliar with the assessment methods. Third, students' clinical experiences during their educational tenure may have influenced the results. Some may have experienced similar patient situations or have been exposed to more critically challenging environments. These limitations should be considered in future studies and the design should include a larger sample size and explore potential predictors of performance.

5.7.8 Conclusion

Both VTV and HFHS were able to identify students who had difficulty meeting overall and subcategory expectations. Participants scored higher in performing tasks associated with initiating nursing interventions and reporting clinical data in HFHS, however, they struggled with using this information to inform future treatment. These results may indicate difficulty in

transitioning theoretical knowledge into practice. In order to facilitate higher-order critical thinking, nursing educators may need to decrease group-centric instruction and integrate individualized performance-based assessment throughout the nursing curriculum. Further research is needed to understand which performance-based simulation assessment method encompasses critical thinking concepts and will facilitate the transition of new graduates into actual clinical practice.

5.7.9 Tables and Figures

Table 8 VTV/HFHS Assessment Tool

Category	Expected Subcategory Actions (met expectations)
1 Identifies the Clinical Problem	-Verbalizes or states in writing that the patient is experiencing a pulmonary embolism or pneumothorax.
2 Reports Appropriate Clinical Data	-Reports that the patient is complaining of chest pain, shortness of breath, and/or compromised respiratory status -Reports all vital signs (blood pressure, pulse, temperature, and respiratory rate) -Reports previously obtained arterial blood gas values
3 Initiates Nursing Interventions	-Reassures the patient -Completes a lung sound assessment -Places a pulse oximeter and oxygen on the patient
4 Anticipates Orders	-Anticipates an order for a Chest X-Ray or Computerized Tomography Scan -Anticipates an order for an additional arterial blood gas -Anticipates an order to draw a PT/PTT
5 States Rationale to Support Decisions	-States appropriate rationale for each category
6 Prioritizes the Clinical Situation	-Notifies the physician immediately of the clinical situation
Subject met expectations if: **Overall =** Carried out all actions listed in a majority of categories (any 4 of the 6) **Subcategory** = Carried out all actions in the subcategory	

Figure 4 Study Design

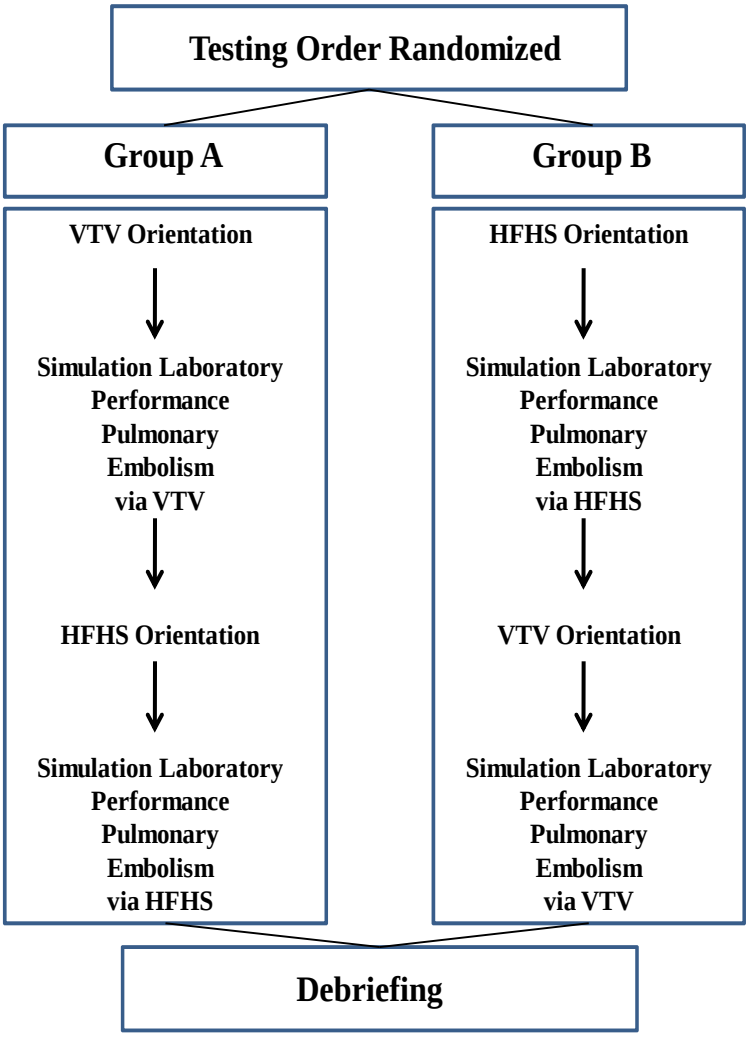

Table 9 Demographic Characteristics of the Participants (N=20)

Variables	Number (%of Total)
Age (yr) n (%)	
20-23	8 (40.0%)
24-30	4 (20.0%)
31-54	8 (40.0%)
Race n (%)	
Caucasian	19 (95.0%)
Asian	1 (5.0%)
Female gender n (%)	17 (85.0%)
Educational Program n (%)	
Diploma	13 (65.0%)
Baccalaureate	7 (35.0%)
Experience n (%)	
Internship/Residency Participation	4 (20.0%)
Nursing Aide Experience	9 (45.0%)
Classes Utilizing HFHS n (%)	
1-2 Classes	13 (65.0%)
3-5 Classes	7 (35.0%)

Table 10 Comparison of Simulation-Based Performance

VTV/HFHS Assessment Category/Subcategory	VTV % Meeting Expectations	HFHS % Meeting Expectations	p	Order Effect
Overall Assessment Rating	30.0%	10.0%	p=0.505	p=0.733
Identifies the Clinical Problem - Recognizes the pulmonary embolism or pneumothorax	50.0%	30.0%	p=0.317	p=0.188
Reports Clinical Data	45.0%	35.0%	p=1.000	p=0.139
- Reports chest pain/shortness ofbreath/compromised respiratory status	85.0%	100.0%	**p=0.002**	p=1.000
- Reports all vital signs	55.0%	75.0%	p=0.059	p=0.752
- Reports previously obtained blood gas values	95.0%	40.0%	**p=0.007**	p=0.418
Initiates Nursing Interventions	55.0%	75.0%	**p=0.014**	p=0.328
- Reassures the patient	85.0%	100.0%	**p=0.002**	p=1.000
- Completes a lung sound assessment	65.0%	90.0%	**p=0.006**	p=0.433
- Places pulse oximeter on the Patient	75.0%	90.0%	**p=0.015**	p=1.000
- Places oxygen on the patient	95.0%	85.0%	p=1.000	p=0.564
Anticipates Orders	0.0%	0.0%	*	*
- Anticipates order for a chest x-ray/CT Scan	65.0%	35.0%	p=0.103	p=0.788
- Anticipates order for an additional arterial blood gas	40.0%	10.0%	p=0.126	p=0.736
- Anticipates order to draw a PT/PTT	5.0%	0.0%	*	p=1.000
States Rationale to Support Decisions -Appropriate rationale stated for each subcategory	0.0%	0.0%	*	*
Prioritizes the Clinical Situation - Notifies the physician Immediately	95.0%	95.0%	*	*

**unable to calculate due to lack of variability in results*

Table 11 Perceptions of VTV/HFHS Experience & Suggestions for Improvement

Perception	Videotaped Vignette (VTV)	High-Fidelity Human Simulation (HFHS)
Positive	- Ability to see how a patient experiencing a pulmonary embolism/pneumothorax may present in a clinical setting - Forces rapid decision-making given the time allowed for the assessment (10 minutes) - Superior to discussing a case presented in a written format	- Mimics a more realistic clinical environment - Helpful in identifying individual weaknesses - Provided insight into how it feels to be alone in a crisis situation
Negative	- Did not provide interactive environment - Did not evoke urgency of the clinical situation - Did not clearly identify individual deficiencies	- Difficult to integrate both cognitive and psychomotor skills - Provoked anxiety - Experience made participants feel they were not ready for full-time practice
Investigator Observations	- Little emotional response after VTV assessment.	- Highly emotional response during and after the HFHS assessment
Suggestions for Curricular Improvement	- More one-on-one practice using HFHS - Integrate performance-based assessments into curriculum - Decrease time using group versus one-on-one instruction - Increased experience with physician communication - More activities that require one to anticipate orders necessary to manage the patient	

6.0 SUMMARY

The purpose of this study was to determine the relationship between critical thinking skills and simulation-based performance and to identify predictors of simulation-based performance of nursing students in their last term of academic preparation. The findings suggest that a substantial majority of student nurses had learning needs identified in both the VTV and HFHS assessment environment. Students were successful in prioritizing the clinical situation in both VTV and HFHS but had deficiencies with regard to their ability to synthesize clinical information into a recognizable problem and determine the plan of action to take.

Overall simulation performance in both VTV and HFHS environments was similar with the exception of initiating independent nursing interventions. The students appear much more successful in HFHS with regards to initiating the tasks required to manage the patient condition. There was not a relationship between overall VTV and CCTDI or CCTST scores. However, there was a relationship noted between HFHS performance and CCTDI scores. This may suggest that students with a greater disposition to critically think perform better when faced with the evaluation and management of a critical patient situation.

It is unclear in both VTV and HFHS if the rate of students not meeting expectations resulted from their lack of knowledge, anxiety, or unfamiliarity with the assessment methods. Student performed better when asked to initiate independent nursing interventions in HFHS. This could have resulted from previous clinical experience or the immediate tangibility of the

clinical equipment present in the HFHS room. Nevertheless, it emphasizes the importance of continued evaluation of alternative critical thinking evaluation methods that move closer to reflecting actual clinical practice with the end goal of improving critical thinking.

6.1 IMPLICATIONS FOR PRACTICE AND FUTURE RESEARCH

As competency assessment methods evolve, nursing administrators' and educators need to prepare for the growing number of new graduate nurses as they must be able to deliver effective and safe care as early as possible in their nursing careers (Nursing Executive Center, 2008). In a recent report published by the Nursing Executive Center (2008), the authors identified that a broad analysis of new graduate practice is not helpful. They suggest a much more detailed understanding of specific shortfalls that will in turn close the gap in knowledge between academic preparation and practice. Specifically, they identified critical thinking as one of the top priorities. Mutually agreed upon competencies include the ability to recognize the patient status, anticipate risk, interpret assessment data, facilitate decision making, and recognizing when to ask for assistance (Nursing Executive Center, 2008). In order to reach the goal of understanding areas of needed remediation, alternative methods of evaluation such as VTV and HFHS may be better options as they provide a more interactive, detailed oriented environment which offers debriefing to facilitate learning (Henrichs et al., 2002, Feingold et al., 2004, Bearnson & Wiker, 2005, O'Donnell et al., 2005, Trossman, 2005).

Student nurses' performance reflected difficulty meeting expectations when tested in a simulated setting. HFHS appeared to best approximate scores on a standardized measure of critical thinking disposition. Further research is needed to determine if simulation testing reflects

critical thinking skills in the clinical setting. This will allow both nursing educators and administrators to determine the best, most-cost effective method of evaluation to aid in the transition of new graduates into the workforce.

APPENDIX A

SCRIPT FOR FACULTY MEMBER INTRODUCING THE STUDY

Hello. I am pleased to introduce xxxxx, a Doctoral student at the University of Pittsburgh School of Nursing. She is here today to ask for your permission to participate in a research study entitled "*Evaluation of Critical Thinking Skills During Simulated Laboratory Performance Utilizing a Videotaped Vignette and High Fidelity Human Simulation*". The purpose of this study is to determine if students enrolled in different types of nursing programs differ in their critical thinking skills or performance scores when two methods of evaluation are used – videotaped vignettes and high fidelity human simulation. She is hoping to recruit at least 16 students from this program. Those of you who are 18 years of age or older, able to read and speak English, and enrolled in your last term of academic preparation might be eligible to participate. XXXX is here today to explain the study in more detail for those of you who may be interested in participating.

APPENDIX B

SCRIPT FOR RESEARCHER

Hello. My name is xxxxxxx. I am here today to ask for your permission to participate in a research study to determine if students enrolled in different types of nursing programs differ in their critical thinking skills or performance scores when two methods of evaluation are used – videotaped vignettes and high fidelity human simulation. I am recruiting nursing students from three nursing programs. In order to participate, you must be 18 years of age or older, able to read and speak English, and enrolled in your last term of academic preparation. If you have trained as an EMT, paramedic, or licensed practical nurse, or are enrolled in a 2nd degree or RN options program, you are not eligible.

If you elect to participate in this research study, I will ask you to complete a brief demographic questionnaire which will take approximately 5 minutes to complete, the California Critical Thinking Disposition Inventory which takes approximately 25 minutes to complete and the California Critical Thinking Skills Test which takes about 45 minutes to complete. You will then participate in a clinical scenario using a videotaped vignette and a second clinical scenario using high-fidelity human simulation. The study will take place at xxxxxxx.

I hope to recruit 48 nursing students (16 from each program) to participate in this study. There are few risks associated with this study. You may feel embarrassed if you perform poorly. We will not discuss your performance with others and your individual score will not be shared with school faculty or other participants. By taking the CCTDI, the CCTST and participating in both simulated scenarios, you may receive an educational benefit through the practice of taking these critical thinking examinations.

You do not have to participate. Your grade will not be affected if you choose not to participate. You may withdraw from the study at any time without incurring any penalty. All answers and data will be kept strictly confidential and kept in a locked file. You will be provided lunch the day of the study, be compensated for parking, and receive a $10 gift-certificate for participation. Does anyone have any questions?

If you choose to participate, please complete the second page of this form and return it to me now. I will collect these forms and use this information to notify you regarding the time and location of the testing. If you have any further questions, you can contact me, xxxxxx at xxxxxx or via email at xxxxxxx. Thank you for your time and consideration given to participating in this study.

I, _____, agree to

participate in the study *Evaluation of Critical Thinking Skills During*

Simulated Laboratory Performance Utilizing a Videotaped Vignette and

***High Fidelity Human Simulation.* I meet the eligibility and exclusion criteria listed below.**

I agree to be contacted at the following email address or telephone number regarding the

time and location of the testing:

Email_____

Contact phone number _____

Inclusion Criteria:

- Student nurse 18 years of age or older, able to read and speak English
- Student nurse who is not licensed to practice as an RN and enrolled in the last term of academic preparation at an accredited nursing school

Exclusion Criteria:

- Preparation as an emergency medical technician, paramedic, or licensed practical nurse
- Enrollment in a 2nd degree accelerated or RN options program

APPENDIX C

DEMOGRAPHIC SHEET

ID Number_____

What is your current age? _____

What is your race? Caucasian African-American Hispanic Asian Other

What is your gender? Male Female

What program are you enrolled in? Diploma Associate Baccalaureate

Did you participate in an Internship/Residency Program? Yes No

Have you worked in a hospital as a Nurses Aide? Yes No

How many courses have you taken in which Simulation was used as a teaching tool?

APPENDIX D

VTV REFERENCE SHEET

Make sure your answers are specific... **ID Number _____**	**Simulated Laboratory Performance - VTV Reference Sheet**
Problem Recognition: Synthesize the information you have been given and tell us what you think is going on.	Please synthesize the clinical data that you see into **ONE** problem label. A medical diagnosis is most acceptable, but if you choose to write a nursing diagnosis, please keep in mind that it must be **VERY SPECIFIC**. Do not simply list all the signs/symptoms.
Problem Management-Report essential clinical data: What will you report? To whom? Should this be reported "stat"?	**Be specific**… To whom will you report? "Report assessment changes, lab values, or clinical data" is not enough… What will you report? Is reporting this data urgent? **Example:** Notify MD "stat" of blood pressure, intake and output, pain, shortness of breath, potassium level, glucose level…..
Problem Management- Initiates independent nursing interventions and assessments: What would you do to manage this problem? What would you anticipate will be done? What would you assess? What information do you need? What interventions can you implement on your own? Does anything need to be done "stat"?	What will you assess or continue to monitor? **Be specific.** If you will assess vital signs, please list the specific vital signs that you will assess. Do any of these interventions need to be done urgently? **Example:** Assess lung sounds, neurological status, pedal edema, blood sugar values….. What will you do for the patient as nursing interventions? Patient teaching? Safety measures? Comfort measures? **Be specific.**
Problem Management-Anticipate relevant medical orders: What orders would you anticipate will be started for this patient? What orders would you recommend based on your assessment? Is there anything you would hold, stop, or discontinue? Are any of these orders "stat"?	What orders will you anticipate – medical and nursing? Continued lab work or diagnostic work-up are not sufficiently specific. Is there anything that you would hold or stop? Are any of these orders or interventions urgent? **Example:** Anticipation of a diuretic, antibiotic, or hemoglobin and hematocrit are more specific.

Rationale: Correlate your interventions with the rationale. Why are you doing this intervention for this patient?	**Please list rationale for each intervention above.**

APPENDIX E

VTV SAMPLE SCENARIO

Narrative Description

XXXXX is a 22-year-old carpenter who fell from a roof this morning. He sustained a fractured pelvis and ruptured spleen. He underwent an emergency splenectomy and returned from the recovery room one hour ago.

Clinical Data

Temperature 102.9 (39.4)

APPENDIX F

VTV ASSESSMENT TOOL

Make sure your answers are specific... **ID Number _____**	**Simulated Laboratory Performance - VTV Assessment Tool**
Problem Recognition: Synthesize the information you have been given and tell us what you think is going on.	
Problem Management-Report essential clinical data: What will you report? To whom? Should this be reported "stat"?	
Problem Management-Initiates independent nursing interventions and assessments: What would you do to manage this problem? What would you anticipate will be done? What would you assess? What information do you need? What interventions can you implement on your own? Does anything need to be done "stat"	
Problem Management-Anticipate relevant medical orders: What orders would you anticipate will be started for this patient? What orders would you recommend based on your assessment? Is there anything you would hold, stop, or discontinue? Are any of these orders "stat"?	
Rationale: Correlate your interventions with the rationale.	

Why are you doing this intervention for this patient?	

APPENDIX G

VTV TESTING SCENARIO

Narrative Description

While building a tree house for his children, xxxxxxx fell, striking a bicycle prior to hitting the ground. He sustained a ruptured spleen and multiple contusions. Since his splenectomy yesterday, he has been stable.

Clinical Data

8am

Temperature	99.4
Blood Pressure	118/74
Pulse	82
Respirations	18

Interim Blood Gas Report 8:30am

Reference		Room Air
pH	7.35 – 7.45	7.51
$PaCO_2$	35 – 45 mm Hg	28
PaO_2	80 – 100 mm Hg	70

APPENDIX H

VTV/HFHS ASSESSMENT TOOL – PULMONARY EMBOLISM

ID Number_____

VTV/HFHS Assessment Tool – Pulmonary Embolism

Problem Recognition	**Met Expectations**	**Did Not Meet Expectations**
Pulmonary Embolism (blood clot to the lungs) **or** Pneumothorax (punctured or collapsed lung)	☐	☐
Overall Subsection Rating (Must meet expectation)	☐	☐

Problem Management: Reports Essential Clinical Data		
Reports chest pain or discomfort **or** Reports shortness of breath **or** Compromised respiratory status	☐	☐
Reports all vital signs (temp, pulse, respirations, BP)	☐	☐
Reports previously obtained blood gas values (pH, $PaCO_2$, and PaO_2)	☐	☐
Overall Subsection Rating (Must meet all 4 expectations)	☐	☐

Problem Management: Initiates Independent Nursing Interventions and Assessments

Provides verbal reassurance to patient
Completes lung sound assessment
Places pulse oximeter on patient
Administers oxygen therapy

Overall Subsection Rating
(Must meet all 4 expectations)

Problem Management: Anticipates Relevant Medical Orders

Anticipates order for CXR or CT Scan
Anticipates order for additional blood gas
(pH, $PaCO_2$, and PaO_2)

Anticipates order for PT/PTT
Overall Subsection Rating
(Must meet all 3 expectations)

Rationales:

Calling MD Stat
Reporting chest pain or discomfort
or
Reporting shortness of breath
or
Reporting compromised respiratory status
Reporting all vital signs
(temp, pulse, respirations, BP)

Reporting previously obtained
blood gas values (pH, $PaCO_2$, and PaO_2)

Providing verbal reassurance to patient
Completing lung sound assessment
Placing pulse oximeter on patient
Administering oxygen therapy
Anticipating order for CXR or CT Scan
Anticipating order for additional blood gas
(pH, $PaCO_2$, and PaO_2)

Anticipating order for PT/PTT
Overall Subsection Rating
(Must meet all 11 expectations)

Prioritization:

Calls MD (stat)	☐	☐
Overall Subsection Rating (Must meet expectation)	☐	☐

Overall Assessment Rating: Participant must meet expectations in any four of the six subsections (problem recognition, problem management-reports essential clinical data, problem management-initiates independent nursing interventions and assessments, problem management-anticipates relevant medical orders, rationale, and prioritization**).**

Met Expectations	**Did Not Meet Expectations**
☐	☐

APPENDIX I

HFHS REFERENCE SHEET

Make sure your answers are specific... **ID Number _____**	**Simulated Laboratory Performance - HFHS Reference Sheet**
<u>Problem Recognition:</u> Synthesize the information you have been given and tell us what you think is going on.	Please synthesize the clinical data that you see into **ONE** problem label. A medical diagnosis is most acceptable, but if you choose to verbalize a nursing diagnosis, please keep in mind that it must be **VERY SPECIFIC**. Do not simply list all the signs/symptoms.
<u>Problem Management-Report essential clinical data:</u> What will you report? To whom? Should this be reported "stat"?	**Be specific**… To whom will you report? "Dr. Smith, I am reporting assessment changes, lab values, or clinical data" is not enough… What will you report? Is reporting this data urgent? **Example:** "Dr. Smith, Mr. Jones is experiencing changes in blood pressure, intake and output, pain, shortness of breath, potassium level, glucose level….."I am reporting this stat"
<u>Problem Management- Initiates independent nursing interventions and assessments:</u> What would you do to manage this problem? What would you anticipate will be done? What would you assess? What information do you need? What interventions can you implement on your own? Does anything need to be done "stat"?	What will you assess or continue to monitor? **Be specific.** If you will assess vital signs, please verbalize the specific vital signs that you will assess and perform that assessment. Do any of these interventions need to be done urgently? **Example:** Assess lung sounds **(auscultate with the stethoscope provided)**, neurological status **(perform a neurological exam)**, pedal edema **(assess the edema)**, blood sugar values **(review the blood sugar values)**….. What will you do for the patient as nursing interventions? Patient teaching? Safety measures? Comfort measures? **Be specific.**
<u>Problem Management-Anticipate relevant medical orders:</u> What orders would you anticipate will be started for this patient? What orders would you recommend based on your assessment? Is there anything you would hold, stop, or discontinue?	What orders will you anticipate – medical and nursing? Continued lab work or diagnostic work-up are not sufficiently specific. Is there anything that you would hold or stop? Are any of these orders or interventions urgent? **Example:** Anticipation of a diuretic **(obtain the diuretic out of the crash cart)**, antibiotic **(obtain the antibiotic)**, or hemoglobin and hematocrit **(obtain the lab equipment)** are more specific.

Are any of these orders “stat”?	
Rationale: Correlate your interventions with the rationale. Why are you doing this intervention for this patient?	**Verbalize a rationale for each of the interventions performed.**

APPENDIX J

HFHS FACILITATOR ORIENTATION SCRIPT

Hello my name is…..

The purpose of this orientation is to familiarize you with SimMan. We have given you a checklist to complete as you move through the orientation. Let's take a look at the case scenario (show stem on the monitor and have them read).

First I would like for you to introduce yourself to SimMan (controller plays the part of SimMan, introducing himself as Mr. Smith – Point out the microphone in the room)

Let's take his blood pressure (point out the cuff and have them ask for a blood pressure)

Let's take his pulse (show where the pulses can be located on SimMan)

Locate the pulse oximeter and place it on SimMan

Locate the oxygen source in the room (have them place a nasal cannula on the patient)

Go ahead and listen to his lung sounds (guide them if needed)

Now, listen to his heart sounds (guide them if needed)

Identify the blood pressure, heart rate, temperature, respiratory rate, and pulse oximeter reading on the monitor (guide them if needed)

Locate the crash cart in the room. Identify where you can access medications, blood drawing equipment, and airway support equipment.

Now, I would like you to find the phone. Pick up the phone and call the physician with the current status of Mr. Smith.

Lastly, I would like to point out where the video recording equipment is located in the room.

Do you have any questions?

*** Collect the completed checklist from the participant for the research files**

APPENDIX K

HFHS ORIENTATION CHECKLIST

ID Number_____

- ☐ **Introduce Yourself to SimMan**
- ☐ **Take a Blood Pressure**
- ☐ **Take a Pulse**
- ☐ **Place Pulse Oximeter on the SimMan**
- ☐ **Identify Oxygen Source**
- ☐ **Assess Lung Sounds**
- ☐ **Assess Heart Sounds**
- ☐ **Identify Blood Pressure, Heart Rate, Temperature, Respiratory Rate, and Pulse Oximeter Reading on the Bedside Monitor**
- ☐ **Locate the "Crash Cart" in the Room**
- ☐ **Identify Contents of the Crash Cart (medications, blood drawing equipment, airway support)**
- ☐ **Locate the Phone in the Room**
- ☐ **Call the Physician with a Status Report of the Patient**
- ☐ **Identify Video Recording Equipment in the Room**

APPENDIX L

HFHS TESTING SCENARIO

Narrative Description

While building a tree house for his children, xxxxxxx fell, striking a bicycle prior to hitting the ground. He sustained a ruptured spleen and multiple contusions. Since his splenectomy yesterday, he has been stable. He is now breathing heavily and grabbing his chest.

Interim Blood Gas Report 8:30am

	Reference	**Room Air**
pH	7.35 – 7.45	7.51
$PaCO_2$	35 – 45 mm Hg	28
PaO_2	80 – 100 mm Hg	70

APPENDIX M

DEBRIEFING QUESTIONS

What did you think about your participation in this protocol?

Was it beneficial as you move forward to graduation?

Name three things you like about the videotaped vignette assessment?

Name three things you did not like about the videotaped vignette assessment?

Name three things you like about the high-fidelity human simulation assessment?

Name three things you did not like about the high-fidelity human simulation assessment?

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