2008

The effect of simulated clinical experience on knowledge, near transfer, and far transfer in nursing education

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THE EFFECT OF SIMULATED CLINICAL EXPERIENCE ON KNOWLEDGE, NEAR TRANSFER, AND FAR TRANSFER IN NURSING EDUCATION

A Dissertation Presented
to

The Faculty of the School of Education
Learning and Instruction Department

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

by
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San Francisco
May 2008

This dissertation, written under the direction of the candidate's dissertation committee and approved by the members of the committee, has been presented to and accepted by the Faculty of the School of Education in partial fulfillment of the requirements for the degree of Doctor of Education. The content and research methodologies presented in this work represent the work of the candidate alone.

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Acknowledgements

Furthering my education under the guidance of the faculty in the Learning and Instruction Department of the University of San Francisco's School of Education has been an honor and a privilege. Each faculty member willingly shared expertise, provided support and encouragement, and created a learning environment that was challenging and invigorating. I am thankful to have had this experience.

My doctoral journey started as a solitary endeavor; it quickly became one of camaraderie, teamwork, and friendship. It has been my pleasure working with an exceptional group of doctoral students who enriched my life in many ways.

I am especially grateful for the guidance and expertise of three faculty members who formed my dissertation committee. Dr. Robert Burns, my chair and advisor, helped me turn ideas into research and provided the encouragement and shrewd guidance that helped me to navigate what at times seemed an overwhelming task. Dr. Mathew Mitchell's keen observations and logical perspective sharpened my work, and Dr. Susan Prion provided unconditional support, clinical expertise, and superb mentorship. These words only start to acknowledge the gift these three people gave me in terms of their time, advice, intellect, friendship, and ever-present humor.

The support provided by Academic Administration and my Nursing Department colleagues at Pacific Union College made it possible for me to pursue this goal. Laerdal Medical provided the loan of a SimMan™ human patient simulator for use during this project, significantly easing some of the practical and technical challenges of this research. I hope that my contributions to the learning community will help repay the generosity of these institutions.

Throughout this journey, my constant source of strength has been my family: Steve Ruggenberg, Ken and Myrna Plumlee, and Ken Plumlee and Peter Weight. I am humbled by and thankful for their unwavering faith, encouragement, and love.

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CHAPTER ONE

Statement of the Problem

Competent nurses are able to consistently transfer knowledge into appropriate action. To do this, nurses must be able to obtain patient data, make accurate decisions based upon their interpretation of the data, and take appropriate action based upon the information and the situation (Joint Commission on Accreditation of Healthcare Organizations [JCAHO], 2005; Nurse Practice Act, 1985). Student nurses begin to develop the theoretical basis for competent practice during their educational programs. Over time, and with experience gained on the job, fledgling nurses transition from novice to competent nurses (Benner, 1984).

And yet these new nurses do not have the time needed to develop competence. In fact, within weeks of starting their first job, new nurses are expected to function as full members of the healthcare team, thinking critically, and demonstrating sound clinical judgment. Unfortunately, between 65 and 74% of new nurses do not demonstrate minimally expected levels of clinical judgment (del Bueno, 2005). The challenge for nursing education is how to better prepare student nurses for the reality of clinical practice.

In order to develop skills of critical thinking and clinical judgment, student nurses must learn complex content, integrate that information in a dynamic environment, and transfer their knowledge into practice (JCAHO, 2005; National League for Nursing Accrediting Commission [NLNAC], 2006). Traditional teaching methods such as lecture emphasize concrete, linear thinking and acquisition of knowledge, rather than application, analysis, and synthesis of knowledge (del Bueno, 2005; Rauen, 2001).

In the clinical setting, student nurses learn to apply theory to practice by caring for patients: performing skills, gathering and interpreting data, and communicating their findings (Massarweh, 1999). Providing student nurses with opportunities to practice making clinical decisions is believed to improve their clinical judgment (Benner, 1984; del Bueno, 2005). However, patient-care experiences are limited by the hospital unit to which student nurses are assigned and the diagnoses of the patients on the unit at that time. Moreover, when the patient-care situation becomes critical, student nurses are either relegated to the role of observer, or eliminated from involvement in the situation altogether. Thus, student nurses have limited exposure to actual patient care situations that require them to independently assess, communicate, and take action when the results of their actions are critically important.

Seeking to address these educational challenges, researchers have examined a number of methods to improve development of clinical judgment and transfer of knowledge, including case studies and problem-based learning (e.g., Dowd & Davidhizar, 1999; Bechtel, Davidhizar, & Bradshaw, 1999). More recently, simulated clinical experience has been suggested as a means of promoting transfer and application of knowledge through experiential, situated learning (Feingold, Calaluce, & Kallen, 2004; Gordon, Wilkerson, Shaffer, & Armstrong, 2001; Nehring, Ellis, & Lashley, 2001; Weller, 2004).

Simulated clinical experience involves immersion of the student in a representative patient-care scenario, created in a setting that mimics the actual environment with sufficient realism to allow the learner to suspend disbelief (Halamek et al., 2000). Simulated clinical experiences rely on either a trained person (standardized patient) or, more typically, a computerized manikin (human patient simulator) to serve as the simulated patient. Human patient simulators are full-body manikins that can exhibit a wide range of physiologic responses, allowing a student to assess, interpret, and initiate a course of action, based upon their findings (Seropian, Brown, Gavilanes, & Driggers, 2004). The human patient simulator in turn, can respond to the action, or lack thereof, providing a realistic patient-care experience for the student. In this study, the term *simulation* is used to refer to patient-care scenarios using either a standardized patient or a human patient simulator. The human patient simulator is referred to as simply a *simulator.*

The objective in using simulation is to improve the application and integration of knowledge, skills, and development of clinical judgment among student nurses. Research, however, is not clear on the efficacy of simulation in achieving this objective for several reasons. First, much of the simulation research has focused on affective aspects of simulation (Becker, Rose, Berg, Park, & Shatzer, 2006; Byrnes & West, 2000; Feingold et al., 2004; Jeffries, Woolf, & Linde, 2003; Weller, 2004). For example, in one study of students in a baccalaureate nursing program, researchers evaluated a simulation experience in terms of transfer, realism, and value. The students were divided in their perception as to the degree to which skills taught in simulation would transfer to clinical practice, but agreed that simulation offered a realistic clinical experience, and highly rated the value of the experience in promoting learning (Feingold et al., 2004). Student perceptions of increased self-confidence, clinical reasoning abilities, and self-efficacy all speak to the motivational aspects of learning through simulation, but they do not provide evidence regarding transfer of knowledge.

Second, a large body of simulation research has focused primarily on skill performance, as observed on a simulator or standardized patient (Alinier, Hunt, Gordon, & Harwood, 2006; Coleman et al., 2004; Heaven, Clegg, & Maguire, 2006; Morgan, Cleave-Hogg, DeSousa, & Lam-McCulloch, 2006; Radhakrishnan, Roche, & Cunningham, 2007; Rosenthal, Adachi, Ribaudo, Mueck, Schneider et al., 2006; Wayne et al., 2005). For example, Abrahamson, Denson, and Wolf (1969), in the study considered the beginning point for contemporary simulation research, compared the time needed to develop proficiency in performing endotracheal intubations between medical residents who received training on a simulator and those who received only the traditional training. Residents in the simulator group achieved proficiency in significantly less time and with fewer trials than did the control group. While this finding is consistent across a number of studies, these studies do not address transfer of knowledge or skill to novel situations.

Finally, of the simulation research addressing cognitive measures of learning, few studies were found that used a simulator as the intervention and provided results on a cognitive measure (e.g. Becker et al., 2006), and only one evaluated the impact of simulation on cognitive learning among prelicensure nursing students. Alinier et al. (2006) used a randomized, control group, pretest-posttest design to determine the effectiveness of a simulation intervention on nursing student skill performance and competence. The students were evaluated on a 15-station objective structured clinical examination that included 11 clinical skills, and 4 cognitive measures related to clinical skill performance. The difference between the mean overall scores on the posttest was statistically significant in favor of the experimental group. Unfortunately, only group differences in overall posttest scores were reported, leaving unanswered whether gains were found in the skills, cognitive measures, or both. Neither this, nor any of the other studies reviewed, specifically addressed transfer of learning.

Although the research to date suggests that simulation may help student nurses develop psychomotor skills, and feel confident and self-efficacious in their abilities, additional research is needed to determine the efficacy of simulation in enhancing the acquisition and transfer of knowledge and development of clinical judgment. This study addressed the need for research on the effectiveness of simulation methods of learning in promoting cognitive outcomes.

Purpose of the Study

Simulation has been proposed as a method for addressing the limitations of learning through real-life clinical practice, and the need for learning strategies that effectively promote transfer of knowledge and development of clinical judgment. Despite the growing body of research on simulation, there is limited evidence as to the efficacy of simulation in helping student nurses apply knowledge and develop clinical judgment. Consequently, the purpose of this study was to investigate the effectiveness of a simulation intervention on the transfer of learning. Specifically the study sought to compare simulation with traditional methods of learning in promoting knowledge acquisition, transfer of learning, and development of clinical judgment among prelicensure nursing students. The study also investigated the role of simulation in facilitating active learning and the relationship between active learning and measures of knowledge.

Significance of the Study

This study is important for three reasons. First, it responds to an identified need for studies evaluating the effectiveness of simulation in promoting knowledge acquisition and transfer. The majority of the available research addresses the effectiveness of simulation in enhancing behavior and psychomotor skill performance (Issenberg, William, Emil, Lee, & Ross, 2005). This study is one of the few studies examining application of knowledge and skills, including transfer. Second, this study fills a need for research on the use of simulation in nursing education. Of the available research investigating the effect of simulation on cognition, only one quantitative study has been found that focuses on undergraduate nursing students as its population (Alinier et al., 2006). Research in other healthcare fields such as medicine can provide evidence in support of learning methods, but the results must necessarily be treated with caution as the differences in populations and educational programs may limit generalization from medicine to nursing. Third, this study sought to improve on methodological weaknesses found in much of the simulation research. The available research is weighted heavily towards descriptive and survey research, yielding little data regarding the efficacy of simulation in enhancing cognitive learning (Issenberg et al., 2005; Lammers, 2007). This study attempted to improve on methodological weaknesses in these studies by using a rigorous, experimental design.

Theoretical Rationale

This study is grounded in the literature on situated cognition. Students engaging in traditional classroom education learn concepts, knowledge, and skills in abstract forms. They are subsequently able to demonstrate their knowledge on a test, but often unable to apply the same knowledge in a real-life situation (del Bueno, 2001). A gap between declarative knowledge (knowing) and procedural knowledge (doing) exists (Brown, Collins, & Duguid, 1989). By contrast, situated cognition suggests that learning cannot be separated from context – that learning is a result of interactions between individuals and everyday situations (Brown et al., 1989; Greeno, Moore, & Smith, 1993).

Lave and Wenger (1991) present a classic distinction between classroom learning and learning that occurs in context, with ordinary people applying reasoning, negotiating meaning, and solving problems in everyday situations. Lave and Wenger describe the apprenticeship process of learning amongst Yucatec midwives and Vai and Gola tailors as they advance from novice learners to expert practitioners through immersion and participation in the culture of their profession and the social community in which they practice. In this apprenticeship model of learning, knowing and doing are inextricably linked.

Because knowing and doing are viewed as integral to the relationship between the individual and the situation, a learner's ability to transfer knowledge from one situation to another is influenced by the nature of the situation, and the interactions that are common to the two situations (Greeno et al., 1993). Nursing students learn to provide care in a social context, through individual interactions in clinical situations. Their ability to transfer knowledge from one situation to another relies on their ability to see the similarities or patterns between the situations (Renkl, Mandl, & Gruber, 1996).

It should be noted that situated cognition is a still-evolving theory with varying interpretations regarding the transfer of knowledge, the role of social versus individual learning, with discussion even extending to the definition of a situation (Anderson, Reder, & Simon, 1996; Greeno, 1997; Kirshner & Whitson, 1998). Anderson, Reder, and Simon (1997) note two fundamental commonalities between situated cognition and established cognitive perspectives: first, the situation of learning is important, but learning may occur outside of the real world, and second, knowledge can transfer between different tasks. The perspective taken in this study is consistent with Anderson, Greeno, Reder, and Simon's (2000) acknowledgement that both situated cognition and cognitive perspectives contribute to an understanding of the mechanisms of human learning. As such, this study studied the knowledge acquisition in an authentic learning situation (simulation), in order to explore (in part) whether simulation promotes transfer of knowledge to novel situations. Principles of learning that reflect this perspective are outlined below.

Situated learning models based on theories of situated cognition share several key principles aimed at helping students to learn to see patterns in context (Brown et al., 1989; Choi & Hannafin, 1995; Renkl et al., 1996; Stein, 1998). First, interesting authentic problems help generate student interest and motivate learning. These authentic problems are typically complex and ill-defined as they are in everyday situations. Second, students seek a solution to the problem in context, as part of a social process. Third, students must draw upon content knowledge and develop the ability to recognize similarities among different contexts. Fourth, higher-order thinking skills are emphasized over memorization of facts.

Over time, as knowledge grows, most students acquire the ability to distinguish between minor differences in situations, and apply knowledge and skills from one situation to another. In nursing, the ability to recognize increasingly discrete similarities and differences between clinical situations characterizes the progression from novice to expert practitioner (Benner, 1984). By the time a person has developed expertise in his craft, he is able to marshal vast quantities of detailed, domain-specific knowledge in solving situation-specific problems (Choi & Hannafin, 1995; Ericsson, 2004).

Studies of expert performance have pointed to the need for sustained practice in resolving authentic problems as essential to the development of expertise in medicine (Ericsson, 2004). Ericsson described a study of the relationship between experience and instruction in improving the performance of medical students and physicians in diagnosing heart sounds. Two trends were found. The first trend reflected an increase in performance with instruction and experience, with specialists (certified cardiologists) attaining the highest level of performance over time. The second trend reflected a peak at residency and then a decline over 10 years for general practitioners, with their level of performance at 10 to 20 years of practice falling below that of their performance as medical students, and continuing to decline. Similarly, the more a physician encounters a particular diagnosis or performs a procedure, the better his continued performance in related situations (Ericsson, 2004).

The learning of physicians and nurses is of greatest concern during initial development of knowledge and continued development of skills and knowledge in situations that are infrequently encountered. The challenge for nursing educators is to optimize the exposures students have to clinical situations and expand the ability to provide authentic situations for student learning (Taylor & Care, 1999). Simulation offers a unique method of supporting student learning by providing controlled, deliberate practice, in an authentic context, in keeping with the principles of situated learning models. This study investigated the effectiveness of a simulation intervention on the acquisition and transfer of knowledge, and on development of clinical judgment.

Background and Need

The public expects to receive safe care at the hands of nurses and other members of the healthcare team. Yet a pivotal report published by the Institute of Medicine (IOM, 2000) estimated that as many as 44,000 to 98,000 people die in hospitals each year as a result of medical errors. The reasons for this unacceptable loss of human life are many, but among the more common causes are lapses in communication, orientation and education, and patient assessment (JCAHO, 2005). Lapses that lead to compromised patient safety occur across the spectrum of healthcare providers and settings, but in ten years of research on nursing competence, del Bueno (1994; 2001; 2005) found that nearly three-quarters (65 to 74%) of inexperienced nurses failed to meet even minimum expectations for entry-level clinical judgment. In the face of such overwhelming need to improve competence, nursing educators must seek better methods of helping nursing students develop skills of clinical judgment.

Helping student nurses gain the theoretical knowledge necessary to understanding clinical concepts instills the foundation necessary for competence. But in addition to possessing sufficient knowledge, skill, and judgment, students must demonstrate the ability to apply concepts – acquiring information, analyzing and interpreting data, and acting on findings (Miller, 1990). Translating knowledge into action requires deliberate practice in solving problems and feedback on the solutions obtained (Ericsson, 2004; Norman & Schmidt, 1992; Young, 1993). Ensuring that the problems students are solving are complex and authentic enhances their ability to translate theoretical knowledge into practice (Corlett, Palfreyman, Staines, & Marr, 2003).

Providing nursing students with opportunities to practice making clinical decisions in real health-care settings helps to improve their clinical judgment. By caring for patients, student nurses gain the experience of performing skills, gathering and interpreting data, and communicating their findings in an authentic, complex environment. However, when patient-care situations become critical, student nurses are excluded from participation. Additionally, because of the diversity of clinical placements, student experiences vary widely, resulting in unequal opportunities for learning (Landers, 2000).

Among the instructional strategies that have been suggested to supplement learning that occurs in real-life settings are case studies (e.g., Dowd & Davidhizar, 1999), problem-based learning (e.g., Bechtel, Davidhizar, & Bradshaw, 1999), and simulation (e.g., Nehring et al., 2001). Each of these strategies encourages development of skills necessary to clinical judgment. These skills include the ability to (a) identify essential clinical data that indicates an acute change in a patient's health status, (b) initiate independent and interdependent actions that will rectify or reduce the risk to the patient's health, (c) understand why each action is relevant to the situation, and (d) distinguish between problems that need urgent attention from those that are less urgent (del Bueno, 1994).

Case studies offer rich detail and encourage students to exercise skills in identification and discrimination in data. A qualitative analysis of the experience of senior nursing students in using case studies (DeMarco, Hayward, & Lynch, 2002) illustrates the value inherent in this method of learning. Among the positive themes that emerged from the study were motivation (the cases were stimulating), real world (cases immersed students in authentic problems, depicted in context, solved with colleagues), and several themes related to active learning (learning, knowledge development, emerging from within, and group dynamics). Case studies appear to be particularly helpful in encouraging reflection and self-evaluation in students; they do not, however, allow students to experience the verbal and visual contextual cues found in an interactive clinical setting.

Problem-based learning has a rich history in medical education and shows promising results, but suffers from the same lack of contextual cues present in the case study approach. Additionally, problem-based learning requires significant domain-specific knowledge (Kirschner, Sweller, & Clark, 2006) that may not be present in the prelicensure nursing student population. In a comparison of case- and problem-based learning in two medical education programs, 89% of students and 84% of faculty overwhelmingly preferred case study methods to problem-based methods of learning (Srinivasan, Wilkes, Stevenson, Nguyen, & Slavin, 2007). Case study methods were preferred because of the increased guidance and increased ability to apply clinical knowledge. Research on problem-based learning continues, moving to focus on how problem-based learning helps students to learn rather than whether or not students learn from problem-based approaches (Svinicki, 2007). From a situated cognition perspective, problem-based learning does not offer sufficient opportunity for scaffolding and support for novice nursing students (Benner, 2004; Young, 1993).

Simulation shows promise as a strategy that combines the positive elements found in case-based and problem-based learning, and offers some ability to provide the rich contextual cues found in real-life clinical settings. In a comparison between problem-based learning and simulation for teaching acute-care management skills to fourth-year medical students, students in the simulation group performed significantly better than students in the problem-based learning group on the final assessment (Steadman et al., 2006).

Simulation has a rich history in health-care education, with contemporary computer-controlled patient-simulators descending from “Sim One” – used to teach medical residents endotracheal airway skills in the 1960s (Denson & Abrahamson, 1969), and “Harvey” – used to teach medical students cardiovascular assessment skills in the late 1970s (Gordon et al., 1980). Medical education and anesthesia programs increased their use of simulation over the next decade and by the mid 1990s nursing education started to incorporate simulation into the curriculum (Nehring & Lashley, 2004). Prior to 2002, however, the research on simulation was limited. A review of the literature at that time (Ravert, 2002) found only 23 research articles on simulation in healthcare, and of those, only nine reported quantitative data. Of the nine studies, eight reported results supporting the effectiveness of simulation on promoting skill, knowledge acquisition, or both. Only four of the studies were conducted by nurses with nurses as subjects – all four studies were related to cardiac assessment with three of the four focusing on skills performance, specifically, heart sound differentiation, and the fourth focusing on knowledge of cardiovascular arrest situations.

In 2004, as nursing education increasingly embraced simulation, Nehring and Lashley conducted a survey of early adopters of simulation technology. Simulation was most commonly used to teach assessment (91%) and provide critical event training (86%). A few years later, a comprehensive review of the medical literature on high-fidelity simulations from 1969 to 2003, revealed 109 studies that met empirical, quantitative, educational assessment criteria (Issenberg et al., 2005). Two primary findings emerged: first, that in general, the quality of the published studies was weak, and second, that the evidence suggested simulations were effective in facilitating learning under certain conditions. Of these, incorporation of feedback (47%) and repetitive practice (39%) were the two features most commonly reported as important in simulation-based learning. Both feedback and repetitive practice in an authentic environment are features associated with effective learning from a situated cognition perspective. The need for quality studies demonstrating the effectiveness of simulation remains. Further, as many believe that simulation is best for teaching higher-order skills of application and synthesis (e.g., Binstadt, 2007; Lammers, 2007), a crucial need exists for studies investigating the role of simulation in promoting integration of concepts and improving clinical judgment among nursing students.

Students both enjoy and believe their learning is enhanced through simulation. Nursing students state that simulation provides risk-free, yet realistic, hands-on learning (Bremner, Aduddell, Bennett, & VanGeest, 2006), and is a valuable means of learning relevant clinical concepts (Feingold et al., 2004). In one study, 68% of student respondents felt that simulation provided enough added value that it should be a mandatory part of the nursing curriculum (Bremner et al., 2006). Research in medical education provides similar findings. Following a simulation experience to teach resuscitation skills to fourth-year medical students, 94% of the students identified the experience as a very valuable learning tool and 90% indicated that their mastery of the content had increased following the simulation (Weller, 2004). Medical students studying cardiovascular physiology reported improved confidence in their knowledge regarding concepts taught in a simulation session (Euliano, 2001). Although each of these studies involved small, intact groups, and descriptive, self-report data, collectively, they provide insight into student perceptions regarding the efficacy of simulation.

A more rigorous body of research attempts to assess the efficacy of simulation in teaching various skills. Multiple researchers have used simulation to teach skills related to critical incident management (DeVita, Schaefer, Lutz, Wang, & Dongilli, 2005; Morgan, Cleave-Hogg, McIlroy, & Devitt, 2002; Morgan et al., 2006; Rosenthal et al., 2006; Shapiro et al., 2004; and Wayne et al., 2005). Of these, three utilized randomized, control group designs. Morgan et al. (2002) compared simulation and video-assisted learning of critical incident management during an anesthesia rotation during medical school. Both groups demonstrated gains in knowledge and skills, but there were no significant differences between the groups. Shapiro et al. compared the performance of two multidisciplinary teams during a shift in the emergency department after one team had received simulation training on crisis response. The group trained with simulation showed gains in performance following the intervention, where the control group did not, but the gains were not significant, nor were significant differences found between the groups.

Wayne et al. (2005) evaluated two groups of second-year Internal Medicine residents on their management of ACLS scenarios after one group had received simulation training and the other had not (using a wait-list, cross-over design). The experimental group performed significantly better than the control group. Three months later, the groups were switched and the group receiving simulation training again performed significantly better than the control group, but the practical difference was minimal. Similar to other affective research, residents in this group endorsed the method of learning through simulation as a valuable educational experience, and felt that simulation should be a required part of residency education.

Little research addresses the efficacy of simulation in teaching skills in nursing. Two exceptions are studies by Alinier et al. (2006) and Radhakrishnan et al. (2007). Alinier et al. compared the performance of two groups of randomly assigned prelicensure nursing students on a practical exam. The experimental group received simulation training that addressed situation awareness, teamwork, communication, decision-making, and clinical skills. The sessions were not designed to prepare students for the practical exam, but rather to provide them with additional clinical experience in a simulated environment. The practical exam included 15 stations focused primarily on performance of clinical skills, with 4 stations addressing theoretical aspects of various clinical skills. Students in the experimental group performed significantly better on the practical exam than students in the control group.

Radhakrishnan et al. (2007) also investigated the efficacy of simulation in helping senior nursing students develop competence in performing clinical skills. Skills related to safety, basic assessment, prioritization, problem-focused assessment and ensuing interventions, and delegation and communication were evaluated following a simulation intervention for the experimental group. The experimental group performed significantly better than the control group for aspects related to safety (patient identification) and basic assessment (assessment of vital signs), but not for aspects related to prioritization of care, problem-focused assessment and initiation of interventions, or delegation and communication.

Each of these studies adds evidence to the question of whether simulation is an effective learning method, but methodological problems and the focus on affective and behavioral variables leaves unanswered the question of transfer of knowledge and development of clinical judgment. With the exception of the few cognitive items measured by Alinier et al. (2006), no experimental studies were found that measured cognitive gains following a simulation intervention using a simulator. If, in fact, simulation is best at teaching to the higher levels of performance (Lammers, 2007), then research must be aimed at measuring its effectiveness in helping learners to apply knowledge in a clinical context and engage in effective problem-solving processes (Bradley, 2006; Weller, 2004). This study measured knowledge acquisition and transfer of knowledge to both similar and novel situations.

The development of clinical judgment requires transfer of knowledge to novel situations. In addition to knowing what response is called for in a given situation, the student nurse must develop knowledge of why each action is required and then take appropriate action (del Bueno, 1994; Benner, 2004). The student must also recognize when seemingly similar situations call for different actions. Simulations work best when learners are encouraged to reflect on the reasons behind their actions and engage in self-evaluation (Lammers, 2007). Simulations also provide opportunity for nursing students to observe and discuss the clinical decision-making process of an expert nurse. As both the expert and the student "think out loud" during a simulation session, the student learns about the connections the expert nurse is making and the expert is better able to evaluate and guide the student's decision-making process (Monti, Wren, Haas, & Lupien, 1998). This study asked students to demonstrate clinical judgment in response to a variety of clinical data as a measure of transfer of knowledge to novel situations.

Simulation is thought to be effective because it engages learners, encourages active learning, allows for varied learning styles, promotes reflection, facilitates collaborative learning, and allows for expert support and guidance (Issenberg et al., 2005; Jeffries, 2005; Lammers, 2007). It allows for presentation of specific patient-care problems in a controlled, risk-free environment, and provides opportunity for sustained, deliberate practice (Kneebone, 2005). This study considered the role of learning practices, including active learning, collaboration, and engagement, in promoting knowledge acquisition and transfer of learning.

The potential value of using simulation in nursing education seems significant. Ongoing research efforts continue to add to the growing body of knowledge regarding the effectiveness of simulation. Still, questions remain. This study attempted to address some of the unanswered questions by considering the effects of simulation on knowledge acquisition and transfer of learning, including clinical judgment.

Research Questions

This study addressed the following questions:

1. What is the effect of simulation on knowledge acquisition among prelicensure nursing students?
2. To what extent does simulation promote near transfer among prelicensure nursing students?
3. To what extent does simulation promote far transfer among prelicensure nursing students?
4. To what extent are the learning practices active learning, collaboration, and engagement promoted by simulation?

Definition of Terms

Knowledge acquisition: In this study, *knowledge acquisition* refers to learning that leads to later performance in a context more or less the same as the original learning context (Salomon & Perkins, 1989). Knowledge acquisition is measured by scores on test items reflecting content knowledge, and by measuring the change in subject knowledge from pretest to posttest.

Near transfer: In this study, the term *near transfer* is used to refer to the application of prior experience and knowledge in a situation that is new, but similar to that of the original learning context (Simons, 1999). Near transfer is measured by scores on test items reflecting application of content knowledge to new, but similar situations.

Far transfer: In this study, the term *far transfer* is used to refer to the application of prior experience and knowledge in a new and novel situation, unrelated to that of the original learning context (Simons, 1999). Far transfer is measured by scores on test items that require clinical judgment in applying content knowledge to new and novel situations.

Clinical judgment: In this study, *clinical judgment* is defined as the "exercise of reasoning under uncertainty when caring for patients" (Redelmeier, Ferris, Tu, Hux, & Schull, 2001, p. 358). When caring for patients, nurses must reason across time about changes in a patient's condition, seeking relevant information and selecting the best course of action based on the underlying structure of the problem and relevant prior knowledge. Clinical judgment is operationally defined in this study as far transfer and is measured by scores on test items that require clinical judgment in applying subject knowledge to new and novel situations.

Effective learning practices: Collectively, active learning, collaboration, and engagement, are referred to in this study as *effective learning practices*. Each of these practices is believed to contribute to effective learning and is a feature associated with simulation as a method of learning (Issenberg et al., 2005; Jeffries, 2007). The term *active learning* is used to refer to practices that allow students to participate in some activity that pushes the student to think about and discuss the information presented (Chickering & Gamson, 1987). The term *collaboration* is used to refer to practices that allow students to share ideas and respond to others in a cooperative manner (Chickering & Gamson, 1987). The term *engagement* is used to refer to practices that encourage student interaction with the learning material and that serve to motivate student learning (Pintrich, 2004). The presence and importance of these three learning practices is measured by student ratings on a strength-of-agreement scale.

Simulation: "Simulation is the artificial representation of a situation, environment, or event that provides an experience for the purposes of learning, evaluation, or research" (Lammers, 2007, p. 505). In this study, the term *simulation* is used to refer to patient-care scenarios using either a standardized patient or a human patient simulator. The human patient simulator is referred to as simply a *simulator.*

CHAPTER TWO

Review of the Literature

This section presents the literature reviewed for the present study. The review is organized in three parts. The first section provides an overview of learning theories relevant to an understanding of how learners apply knowledge gained in academic settings to real-world problems. Theories of transfer are discussed in relation to principles of situated cognition. The second section addresses the role of education in the development of clinical judgment, and reviews a recent study from the nursing literature that investigated the role of simulation in enhancing clinical judgment. The third section reviews relevant simulation research, and is further subdivided to address acquisition and application of knowledge, and students' perceptions of the overall value of simulation as a learning experience. Attention will focus on the extent to which these studies provide evidence of transfer. The first subsection of simulation research, acquisition and application of knowledge*,* reviews two studies from nursing and five studies from the medical literature. The second subsection, students' perceptions of the value of simulation, reviews five studies from nursing and one study from the medical literature. The review of the literature concludes with a summary.

Transfer of Learning

The idea that knowledge learned in an academic setting should and must be transferred to the real world seems so obvious as to not require further discussion. Yet much has been discussed about how, and even if, knowledge transfers from one situation to another. Barnett and Ceci (2002) note that within the scholarly community there is little agreement about the existence, nature, and mechanisms of transfer. Some take the position that transfer is rare and difficult to obtain (e.g., Detterman, 1993). Others (e.g., Bransford & Schwartz, 1999; De Corte, 1999) assert that transfer does occur, and that the difficulty in recognizing transfer lies in the perspective from which we view it.

The difficulty in demonstrating transfer is not from a lack of research effort. Considered a fundamental outcome of education (Alexander & Murphy, 1999), transfer is one of the most reviewed constructs in educational psychology, and the various perspectives have been debated since at least the start of the 20th century. In order to provide background on transfer for the reader, this brief overview will define various types of transfer, propose a view of transfer as used for this study, and identify factors that support optimal transfer. For in-depth reviews of transfer and transfer research, see (for example) Alexander and Murphy (1999), Cormier and Hagman (1987), Detterman and Sternberg (1993), Hattie, Biggs, and Purdie (1996), and Simons (1999).

Cormier and Hagman (1987) define transfer as learning that "occurs whenever prior-learned knowledges and skills affect the way in which new knowledges and skills are learned and performed" (p. 1). Mayer and Wittrock (2006) define transfer as simply "the ability to use what was learned in new situations" (p. 289). Therein lies the crux of much of the discussion about transfer: to what extent are the situations similar, and how does a learner recognize the applicability of knowledge learned in one situation to the new situation? Further defining the various types of transfer will help to illuminate what is meant by situation similarity, how knowledge is transferred, and what kind of knowledge is transferred.

Types of transfer are often identified according to the degree to which transfer situations are similar. *Near transfer* refers to those circumstances in which knowledge gained in one situation is applied in a closely connected new situation and *far transfer* implies a greater conceptual distance between the original and new situations (Simons, 1999). A helpful distinction is to think of transfer as a continuum of learning, ranging from the familiar to the unfamiliar (Gick & Holyoak, 1987). For example, learning requires a simple demonstration of knowledge acquisition (e.g., learning and demonstrating the ability to memorize a list of anatomical terms). Students are taught something, and then they demonstrate their knowledge of that thing.

By contrast, transfer occurs when students demonstrate a side effect of their learning by using that knowledge in solving a different problem (Salomon & Perkins, 1989). Here, the question is primarily one of how similar are the two problems or situations. For example, near transfer requires the demonstration of knowledge in a new, but similar situation (e.g., learning a list of anatomical terms and demonstrating the ability to understand new anatomical terms that contain some of the same prefixes and suffixes), and far transfer requires the demonstration of knowledge in a new and novel situation (e.g., using prior knowledge of anatomical terms to identify what type of physiologic problem a patient has according to their medical or surgical diagnosis).

In addition to differentiating transfer by the degree of situation, transfer can be differentiated according to what is transferred: *specific responses* versus *general principles* (Mayer & Wittrock, 1996), or *surface structure* versus *deep structure* (Detterman, 1993). Surface similarities and specific responses are commonly shared elements reflected in the similar situations found in near transfer. Far transfer is more likely to occur when the learner actively searches for deep structural similarities in order to activate general principles or other appropriate prior knowledge, resulting in a satisfactory solution (Barnett & Ceci, 2002).

Situations that share surface similarities with problems solved in the past, or those that invoke automatic responses can result in transfer that is either *positive* or *negative*. In positive transfer, prior learning is helpful to the application of existing knowledge to a new situation. In negative transfer, activation of prior knowledge can inhibit performance in the new situation. For example, situations with a high degree of surface similarity may cause a learner to automatically apply a previously learned solution without noting the structural differences in the two situations (Barnett & Ceci, 2002; Gick & Holyoak, 1987).

A final distinction in characterizing transfer relates to how knowledge is transferred. Salomon and Perkins (1989) note the role of conscious effort in facilitating transfer by differentiating between *low-road* and *high-road* transfer. Low-road transfer is enhanced when a learner learns and practices a skill frequently enough and with sufficient variation that the knowledge becomes deeply encoded. When the learner encounters a new situation with similar surface features, the knowledge transfers. By extension, the greater the surface similarity in the two situations, the more likely transfer will occur. High-road transfer is enhanced by mindful abstraction and by conscious effort (Mayer & Wittrock, 1996). In high-road transfer, the learner extracts principles and strategies, searching for the underlying structure of a problem, and then encoding the structure as an abstraction (Salomon & Perkins, 1989).

When encountering a new situation, the learner searches prior knowledge for a solution that will help solve the current situation. By virtue of its reliance on surface similarity and automatic response, low-road transfer is more commonly associated with near transfer. Far transfer is better facilitated by high-road transfer, in which the learner actively seeks a solution by looking for structural similarities present in the new situation and abstract solutions stored in prior knowledge.

In seeking to develop clinical judgment among nursing student, it is clear that high-road, far transfer is needed. Nurses must be able to see the underlying structure of a patient's presenting problem in order to respond appropriately. Some nursing tasks may be performed automatically, however, developing habits of simply relying on surface similarities could result in a nurse missing an important underlying cue, leading to a wrong decision. Nursing education must focus on teaching in a manner that helps students learn to think in an effortful and conscious manner, seeking to identify the general principles and underlying structural aspects of any given problem. This study views high-road, far transfer as the goal and gold standard of nursing education. The discussion of transfer turns next to factors that assist students in learning for optimal high-road transfer.

An optimal environment for promoting transfer must consider elements of the context, the content, and the learner (Alexander & Murphy, 1999). Context is vital to a situated cognition view of learning. Lave (1988) argues that knowledge and skills are context-bound, calling into question the very possibility of transfer. Other situated cognitivists (Greeno et al., 1993; Hatano & Greeno, 1999) believe that transfer is possible, however the likelihood of transfer depends to a large extent on the learner recognizing the invariant nature (or structural similarity) between the initial learning situation and the new context. Factors that help learners to recognize salient features from one situation to another are discussed subsequently.

Elements related to content include a requirement that learners have sufficient domain knowledge for the task (Alexander & Murphy, 1999; Bransford & Schwartz, 1999). Without prior knowledge, a learner has no basis for reasoning. In addition, effortful learning, particularly the use of metacognitive strategies such as comprehension monitoring, is necessary for high-road transfer. Use of metacognitive strategies requires high domain knowledge (Bransford & Schwartz, 1999). During simulation, a facilitator prompts students to reflect on what they know and don't know, allowing students to identify what additional information they need in order to take action.

Elements related to the learner include their degree of expertise, and situational and individual interest in the situation. In this aspect, the degree of learner expertise influences motivation to learn. Novices are characterized by limited declarative (knowing), procedural (doing), and conditional (when and where) knowledge (Alexander & Murphy, 1999; Benner, 1984). Although novice nursing students may know what to do in a given situation (insert a catheter for urinary retention), and are able to do the task (the steps of catheter insertion), they may have limited understanding of the range of conditions (the context) under which this knowledge should be applied. As a result, their motivation to learn relies more on situational interest or engaged participation than on deep personal interest (Alexander & Murphy, 1999; Greeno, Collins, & Resnick, 1996). Simulation may increase student interest and engagement by providing a realistic, problem-solving environment. Combining elements of the context, content, and learner contributes to creating an environment conducive to learning for transfer.

Several instructional features may create an environment that nurtures transfer. First, the knowledge to be gained and transferred must be rooted in relevance (Alexander & Murphy, 1999). Authentic, contextual, meaningful experiences help learners to see connections between the concepts and knowledge they are seeking to learn and the problems they will face in the real world (Brown et al., 1989). Second, the knowledge to be gained and transferred must be learned deeply. Learners must be provided with varied opportunities to revisit important concepts from diverse perspectives and differing contexts (Alexander & Murphy, 1999; Salomon & Perkins, 1989). Bransford and Schwartz (1999) note the utility of contrasting cases in helping learners to recognize the relevant similarities between situations, an important aspect of teaching for transfer (Simons, 1999). Third, specific strategies for retrieving relevant domain knowledge must be taught and modeled (Alexander & Murphy, 1999). Strategies include making the relationships between concepts explicit, demonstrating relevance of knowledge and skills, situating learning in authentic experience, encouraging and modeling the use of metacognitive skills, and giving opportunities for reflection and varied practice (Simons, 1999).

An analysis of the effects of learning skills interventions on student learning (Hattie et al., 1996) suggests that the best results come when metacognitive strategies are used in the context of teaching course content. Alexander and Murphy (1999) recommend teaching learners to recognize the conditions under which a strategy works; explicit identification of similarities and differences between cases offers one means to assist learners in developing conditional knowledge. These recommendations are compatible with the thrust of situated cognition in that strategies are rooted in context, involve tasks relevant to the problem situation, and immerse the learner in active learning that will promote the development of higher-order thinking skills.

Simulation offers a method of learning that when done well facilitates high-road transfer of learning. Simulation offers students an opportunity to learn deeply, through reflection and varied practice, in an authentic, relevant setting. Cueing students to search for relevant prior knowledge during the course of a simulation and during debriefing after simulation can assist the student in developing patterns supportive of transfer (Salomon & Perkins, 1989). Similarly, the emphasis during simulation on having students solve clinical problems, serves both to motivate and engage the students, and to promote active learning. The review of literature turns next to the development of clinical judgment.

Clinical Judgment

Clinical judgment has been described as the most important dimension of a nurse's work (del Bueno, 1994). Clinical judgment is required in situations where a nurse must integrate information from a rapidly changing environment, use knowledge effectively, and think quickly and critically (JCAHO, 2005; NLNAC, 2006). It follows that if clinical judgment requires the ability to think critically, then critical thinking is a necessary component of clinical judgment. The two concepts are inextricably linked, as exemplified in the following definitions. Ennis (1989) defines critical thinking as "reasonable reflective thinking focused on deciding what to believe or do" (p. 4). An expanded description of critical thinking suggests that it involves "seeing both sides of an issue, being open to new evidence that disconfirms your ideas, reasoning dispassionately, demanding that claims be backed by evidence, deducing and inferring conclusions from available facts, solving problems, and so forth" (Willingham, 2007, p. 8). Each of these characterizations is in accordance with the expert consensus statement on critical thinking (Facione, 1990) that included this description of critical thinking and the ideal critical thinker:

> We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference … The ideal critical thinker is habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit (p. 3).

Within nursing, critical thinking has been defined as a process that is "reflective and reasonable thinking about nursing problems without a single solution and is focused on deciding what to believe and do" (Kataoka-Yahiro & Saylor, 1994, p. 352). In Kataoka-Yahiro and Saylor's perspective, clinical judgment is the outcome of critical thinking. More recently, an attempt to define critical thinking in nursing (Scheffer & Rubenfeld, 2000) resulted in the following consensus statement:

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

Each of these definitions of critical thinking demonstrates qualities that are also evident in clinical judgment. Facione's 1990 consensus statement definition of critical thinking as "purposive, self-regulatory judgment" (p. 3) demonstrates the considerable overlap between the two concepts. The phrase "thinking like a nurse" has been used to describe the thinking that goes into making nursing clinical judgments (Etheridge, 2007; Tanner, 2006). Tanner defines clinical judgment as an "interpretation or conclusion about a patient's needs, concerns, or health problems, and/or the decision to take action (or not), use or modify standard approaches, or improvise new ones as deemed appropriate by the patient's response" (p. 204). In exercising clinical judgment, the nurse uses capabilities of reasoning, including critical thinking, in order to arrive at an overall evaluation (Dowding & Thompson, 2003; Tanner, 2006). The need to reason when making clinical judgments is similarly noted in the definition of clinical judgment adopted for this study: "the exercise of reasoning under uncertainty when caring for patients" (Redelmeier et al., 2001, p. 358).

The literature on clinical judgment in nursing reflects the overlap of the concepts of critical thinking and clinical judgment, and research varies widely in conceptualization and measurement of clinical judgment. Following a review of the nursing literature, Tanner (2006) drew five general conclusions regarding clinical judgment. First, the knowledge and perspective a nurse brings to any given situation influences clinical judgment about the situation more than the objective data at hand. Personal experience, habits of thinking, philosophical and moral interpretations, and patient perspectives all contribute to clinical judgment (Redelmeier et al., 2001; Tanner, 2006). Second, clinical judgment is influenced by the nurses' knowledge of their patients, a concept referred to as "knowing the patient" (Radwin, 1996; Tanner, 2006). Knowing the patient embodies the ability of a nurse to recognize a patient's distinct patterns of responses, and responding to the patient's needs through individualized care. This concept has also been linked with expert and intuitive practice (Tanner, Benner, Chesla, & Gordon, 1993). Third, the context in which the situation occurs greatly influences nursing clinical judgment. Research on patient safety demonstrates the role of the workplace in influencing nursing judgment, particularly among novice nurses (Ebright, Urden, Patterson, & Chalko, 2004). Nurses may be more influenced by the need to fit into the unit norms for workflow patterns and behaviors, and concerns about co-worker opinions, than by textbook knowledge or patient-specific cues, to the detriment of clinical judgment.

The fourth conclusion regarding clinical judgment (Tanner, 2006) relates to the patterns of reasoning that a nurse uses in forming a judgment. These patterns include a combination of analytic processes, intuition, and narrative thinking. Which pattern or combination of patterns is used depends on the nurse's initial assessment of the situation, the specifics of the situation, and the outcome goals for the situation.

Analytic processes are typically invoked when a nurse lacks essential knowledge, there is a mismatch between reality and expectation, or a situation presents with multiple options. In each of these instances, specific rational processes help the nurse come to a clinical judgment. Intuitive processes typically rely on pattern recognition, whereby a nurse recognizes structural similarities from past knowledge or experience (Benner, 2004). Narrative thinking, defined as "thinking through telling and interpreting stories" (Tanner, 2006, p. 207), involves trying to make sense of an experience by understanding the patient as a person, and through this understanding, becoming better attuned to the patient's needs (Radwin, 1996). Regardless of clinical experience, the pattern of reasoning used will rely on the nurse's assessment of the situation, influenced by what the nurse brings to the situation, how well the nurse knows the patient, and the context of the situation.

The fifth conclusion drawn from the review of the literature on clinical judgment (Tanner, 2006) is that reflection on practice is often triggered by a real or perceived breakdown in clinical judgment. Similar to the mismatch between expectation and reality that triggers an analytic process, a breakdown in clinical judgment presents an opportunity for reflection and evaluation that can lead to enhanced learning. On the basis of these five general conclusions, Tanner proposed a model of clinical judgment that includes four primary aspects: noticing, interpreting, responding, and reflecting. The first three conclusions make up the aspect of *noticing*, in which the nurse forms an initial grasp of the situation, influenced by what the nurse brings to the situation, how well the nurse knows the patient, and the context of the situation. The aspect of *interpreting*, reflects the fourth conclusion drawn from the literature, that the nurse uses analytic, intuitive, and narrative patterns of reasoning in order to develop a sufficient understanding of the situation. The aspect of *responding*, reflects the course of action taken (or not) based on the nurse's understanding of the situation. The final aspect of *reflecting*, drawn from the fifth conclusion, includes both reflecting-in-action (Schon, 1983), as the situation is unfolding, and reflecting-on-action, after the immediacy of the situation, in order to improve clinical understanding.

The potential for simulation to foster development of clinical judgment lies in its ability to stimulate patterns of thinking and reasoning that enhance clinical judgment. In a simulation, nursing students can assess the situation, the patient, and the context, develop an understanding of the situation, and take action (Rhodes & Curran, 2005). In simulation, because no harm can come to the simulator, the students' judgments and resulting actions can be allowed to progress to their natural conclusion, allowing opportunity for reflection both during and after simulation. Faculty may use elaborative questioning (Halpern, 1998) to help students notice structural aspects of a simulation situation, rather than focusing on surface features. Likewise, when faculty engage in questioning as a tool to aid reasoning, students may see the value of engaging in alternative thinking. Faculty may model the reasoning used in clinical judgment by talking through the process they follow in assessing aspects of the situation, the patient, and the context (Walsh & Seldomridge, 2006).

Simulation offers an additional opportunity for students to develop habits of mind associated with critical thinking, and therefore contribute to their ability to assess the situation, the patient, and the context. Habits of mind such as confidence, contextual perspective, creativity, flexibility, inquisitiveness, open-mindedness, and reflection (Scheffer & Rubenfeld, 2000) are particularly suited for reinforcement in simulation. The real world clinical setting reinforces students for getting along, accomplishing tasks quickly, and helping out. Although helpful for social integration, reinforcing students for these skills does not promote independent thinking, creativity, or questioning (Matsumura, Callister, Palmer, Cox, & Larsen, 2004; Walsh & Seldomridge, 2006). In the simulation setting, characteristics of independence, creativity, and insightful questioning can be encouraged and facilitated. Additionally, simulation provides opportunities for students to develop confidence by practicing clinical judgment skills repeatedly in a setting that allows for immediate discussion of the cues that were identified as well as those that were missed. As students are encouraged to exercise clinical judgment they become more confident in using the patterns of reasoning that lead to improved clinical judgment. In one student’s words, “Critical thinking and reasoning affects confidence, and confidence is important to critical thinking because it gives me faith that I can solve clinical problems" (Haffer & Raingruber, 1998).

A recent, qualitative study conducted by Lasater (2007) explored the experiences of nursing students participating in a simulation session as a part of their school's curriculum, and in particular, the effect of those experiences on the development of clinical judgment. Four dimensions of clinical judgment were identified as essential: students' confidence, aptitude, experience, and skill. A framework of experiential learning formed the basis for exploring the role of simulation in providing students with the type of experiences that assist in the development of clinical judgment.

Lasater (2007) proposed that simulation is well suited for providing experiential learning, in that it is one of few teaching strategies that allow nursing students to actively address the complexities of patient care in an environment that is controlled and safe. Noting the potential of simulation to provide active, experiential learning, Lasater compared the development of clinical judgment – ways in which nurses begin to understand problems, issues or concerns of patients, with characterizations of experiential learning – opportunities to see real consequences of one's actions, feeling both the thrill of success and the frustration of failure. Against this context, the author sought to investigate the role of simulation in helping students to develop clinical judgment. Research questions were not delineated, rather the expressed focus was simply to explore students' perceived confidence in their clinical judgment, students' aptitude for critical thinking (as an aspect of clinical judgment), and students' experience with simulation as a learning method.

A qualitative design allowed for open-ended exploration of students' lived experiences through focus group discussions. Participating students were recruited from a convenience sample of 48 junior-level nursing students attending a northwestern university. The university had recently starting using simulation for part of the students' clinical practicum in a course focusing on care of the acutely ill adult patient. Simulation sessions replaced clinical time for 2.5 hours, one morning a week, for students in this course. Sessions started with the facilitator teaching a topic related to the theory content for the week prior to starting the simulation scenarios. Small groups of three students each participated in one scenario each session, and observed three other student groups as they participated in one scenario each.

Students were observed during their simulation experience (as part of a larger study not reported in Lasater, 2007), and following the observations, the 39 students who had been observed received invitations to participate in a focus group. Of the 15 students who volunteered, eight were able to meet at a mutually agreeable time and thus formed the focus group. These eight students were characterized by the author as nontraditional: all were female, their ages ranged from 24 to 50, five of the eight had previous bachelor's degrees, and one identified with a racial or ethnic minority group.

Data were collected during an informal, participant-moderated discussion, guided by predetermined questions serving as prompts, with additional open-ended questions serving to clarify intent or meaning of various student comments. The 90-minute session was videotaped, allowing for accurate analysis of the comments in order to develop themes. Following the focus group session, major themes were identified and confirmed through review of the videotape. In all, 13 themes were identified; these were then further condensed into five major codes. The codes included (a) strengths and limitations of simulation, (b) the paradoxical nature of simulation, (c) students' desire for more direct performance feedback, (d) value of students' connection with others, and (e) general recommendations for facilitation and learning through simulation.

The main findings were that students felt simulation offered advantages to learning that were not afforded by either textbook or clinical practice. Simulation encouraged the students to become more actively involved, with a realistic and experiential approach not present in reading for learning. Additionally, the students were able to experience situations that they had not been exposed to in real-life clinical settings, and felt that simulation offered the opportunity to practice clinical judgment skills through anticipation and assessment of dynamic clinical events such as anaphylaxis. Although at times the learning experience caused students to "feel like an idiot" (Lasater, 2007, p. 273), they felt that the opportunity to reflect on their actions during debriefing resulted in their learning at a deeper, more visceral and emotional level.

Finally, students expressed an appreciation of learning as a shared experience; learning to assess team-members' strengths and weaknesses, hearing another student or teacher's perspective, and sharing stories related to the presented scenarios, all contributed to the students' learning. Students affirmed the value of recognizing the role that variations in the situation and environment play in altering the context and the trajectory of clinical judgment. Challenges associated with learning in groups included the inherent boredom of not always playing an active role, and point to the need to carefully design simulation to keep students as actively involved as possible – providing scaffolding to assist students in reflective observation and problem-solving could enhance the learning experience.

The author concluded that simulation offers students the opportunity to learn more deeply, by helping them to actively integrate knowledge learned in the classroom, in clinical experiences, and through reading. Working with complex, ill-defined patient care situations, required students to exercise their clinical judgment skills, and working with other nursing students and the instructor, exposed them to alternative approaches and perspectives.

Lasater (2007) presents a credible investigation into the role of simulation in promoting clinical judgment, from the students' perspective. Descriptions of the sampling, data collection, and data analysis procedures are sufficiently clear and detailed to provide a good understanding of the methods followed. The author reviewed the definition of clinical judgment with the students participating in the focus group at the beginning of the session, providing them with a common understanding of the construct of interest. Data were collected using a semi-structured approach, allowing a wide range of student ideas and comments to be expressed. The five codes presented in summary of the data appear to be a fair reflection of the larger number of themes identified in the initial analysis. A primary limitation of this study is the small sample. Only eight students volunteered to participate in the focus group, resulting in a self-selected sample of white, female, nursing students, over half of which held prior bachelor's degrees. The author notes that the sample was reflective of the university population, but the potential for sample characteristics to bias the data limits the generalizability of the results. Overall, this qualitative study provides insight into the simulation experiences of a small group of students, with specific attention paid to the development of clinical judgment.

Efficacy of Simulation

The literature reviewed for this study included a focus on research investigating the effects of scenario-based simulation on knowledge acquisition, transfer of knowledge, and development of clinical judgment among nursing students, and student perceptions of the value of simulation. Searches were performed in the two primary allied health databases, the National Library of Medicine database, PubMed, and the Cumulative Index to Nursing and Allied Health (CINAHL), using keyword combinations simulation or patient simulation, nursing or nursing education, and transfer. This search strategy yielded no scenario-based simulation research that included transfer as a research variable.

Another search, focusing broadly on simulation research in both the medical and nursing literature revealed a small number of studies that addressed the variables of interest for this study. The study addressing development of clinical judgment (Lasater, 2007) has been reviewed in the previous section. Research addressing the role of simulation in acquisition or application of knowledge, and students' perceptions of the value of simulation will be addressed in the next two subsections.

Acquisition and Application of Knowledge

This section reviews two studies from nursing (Alinier, Hunt, Gordon, & Harwood, 2006; Radhakrishnan, Roche, & Cunningham, 2007), and five studies from the medical literature (Morgan & Cleave-Hogg, 2002; Morgan, Cleave-Hogg, DeSousa, &

Lam-McCulloch, 2006; Shapiro et al., 2004; Steadman et al., 2006; Wayne et al., 2005). Each study will be presented, and then the studies will be collectively reviewed.

In the first of the two nursing studies, Alinier et al. (2006) investigated the effect of realistic scenario-based simulation on nursing student competence and confidence. Alinier et al. situated their study against a backdrop of wide spread adoption of simulation in healthcare education, adoption based on the belief and recommendation that simulation offers experiential learning in a safe environment. With the adoption of simulation comes the implication that the new methods of learning afford advantages over other methods of learning. Although some studies have evaluated the efficacy of simulation, fewer quantitative studies addressed student performance of clinical skills, communication skills, and confidence following simulation. And even fewer studies had addressed the use of simulation in nursing education. The authors sought to improve upon one or more methodological weaknesses in the previous research.

Reported weaknesses in previous studies included a tendency to evaluate student perceptions of experience rather than observation of performance; perceptions were characterized as useful, but subjective, and without providing empirical support for the transfer of knowledge and skill. Other studies focused on evaluating performance of psychomotor skills, but ignored the context or situation in which skills must be performed. Small sample sizes or failure to provide a comparison group also resulted in problems with design, generalizability of study results, or both.

Specifically, Alinier et al. proposed to investigate whether simulation offered learning value in nursing education, and if simulation would enhance confidence and competence. The researchers hypothesized that students exposed to a simulation experience would perform better on a simulated exam than a control group of students who had not received simulation training.

A pretest-posttest experimental design was employed to test the hypothesis. Participants were nursing students in their second year of a diploma program of nursing in the United Kingdom. Over three successive cohorts, 344 students were invited to participate in the research. Of these, 133 volunteered to participate, and 99 comprised the final sample by completing all phases of the project. Students in the sample were representative of the general student population; in the sample, the average age was 31.2 years, and students were predominantly female (83.8%). More students in the experimental group (40.8%) reported prior healthcare experience than those in the control group (32%).

After participating in an initial Objective Structured Clinical Exam (OSCE), the participants were randomly assigned to groups. Those in the experimental group were then further randomly divided into teams of four students each, and over the course of the next few months, each team participated in two simulation sessions. Six months after the initial OSCE, students from both the control and experimental groups completed a confidence questionnaire, and then participated in a second OSCE.

The OSCE is described as a competence evaluation consisting of 15 short exercises or stations, with 5 minutes allocated per station. In this study, the OSCE included 11 stations to assess clinical and psychomotor skills, and 4 stations to evaluate cognitive skills. Clinical and psychomotor skills focused on the ability to use and manage clinical equipment for assessment and medication administration, and on obtaining and interpreting various physiologic parameters (e.g., dysrhythmia recognition and blood pressure measurement). Cognitive skill stations addressed concepts related to outcomes of improper positioning of ECG electrodes, safety aspects of using a defibrillator, solving a problem related to the set-up of electrical equipment, and signs of cardiac arrest.

The first OSCE was summative, with no feedback provided to the students. This was the first experience of this kind for participating students, and they reported the experience as stressful, but useful and valuable to their overall learning. The second OSCE was both formative and summative, with students reporting less stress and greater appreciation of the experience because of the feedback received.

Following the first OSCE, students in the experimental group participated in two, 3-hour simulation sessions; two teams of 4 participants attended each session. All simulation sessions were completed a minimum of 5 weeks before the second OSCE. The simulation sessions were designed to provide each group with a session in which they were the active participants, and a session in which they were observers of the action. Simulations focused on patient care and clinical skills with four different scenarios provided to each team of students. Simulation sessions were presented in an informal manner to help students develop comfort and confidence in the new learning method. Each session included an introduction to concepts of teamwork and communication in a clinical environment, an introduction to the functioning of the simulator, and then sequential presentation of each scenario, with debriefing after each set of scenarios. Although at times the simulations required students to use equipment that was also used in the OSCE, students were not given specific education regarding the equipment as this was considered prior knowledge.

Demographic information and details concerning students' previous healthcare experience was collected on a researcher-developed questionnaire that included items about students' levels of confidence and stress when working in technological healthcare environments. OSCE performance data were collected during the second OSCE by the examiner completing a checklist for observed skills, and by the student completing an answer sheet for each of the cognitive skills. Experimental and control group responses to the questionnaire and performance results from the OSCE were evaluated to investigate differences between the groups.

The main finding of this study was that the average difference in performance between the first and second OSCE was greater for the experimental group (14.8% average gain) than for the control group (7.18% average gain). The difference between the means was statistically significant in the hypothesized direction ($p < .001$). There were no practical or statistically significant differences between the groups related to perceptions of confidence and stress (perception of confidence, $p = .819$; stress, $p = .562$). Item-level scores were not provided, nor were the results differentiated according to whether the items tested psychomotor or cognitive skills.

Alinier et al. (2006) concluded that the evidence supports simulation as a learning method in nursing education, provided that it is used appropriately and with attention to methodological details to improve the quality of teaching and learning. Appropriate methods include supporting realism by allowing students to make the decisions regarding their simulated patient without intervention on the part of the instructor. Allowing students to take action based on their own reasoning and judgment allows them to practice skills of clinical decision-making. The safety of the simulation environment also allows students to learn from their mistakes, and receive feedback about alternatives that might not have been considered, as well as an opportunity to review the experience by participating in another similar scenario.

The purpose of the second nursing study (Radhakrishnan et al., 2007) was to identify nursing clinical practices that are influenced by simulation practice and to measure improvement in clinical performance. The authors' review of the literature on simulation supported their premise that little nursing research exists to demonstrate the effectiveness of simulation in healthcare education. As pointed out by Alinier et al. (2006), much of the literature focused on descriptive analysis of students' perceptions of the value of simulation in preparing them to provide competent clinical care. Advantages of simulation in providing active, contextual learning were noted, as were barriers, including the time and cost of learning to use the technology. Additionally, some students reported that the skills and knowledge learned in simulation had little relevance to clinical practice.

Contrary to this view, Radhakrishnan et al. (2007) noted research from the medical community demonstrating that experience gained in a simulation does transfer to actual clinical performance. A review of the nursing literature found no studies that investigated the influence of systematic practice in a simulation situation on subsequent clinical performance. Therefore, Radhakrishnan et al. proposed to conduct research on the effectiveness of simulation as a method for promoting knowledge and skills, specifically, to identify clinical practice parameters that could be improved as a result of the influence of simulation. Research questions were not implicitly stated, however the authors expressed the intent to identify categories of clinical nursing performance most likely to be influenced by simulation. Categories of clinical performance included safety, basic assessment skills, prioritization, problem-focused assessment, ensuing interventions, delegation and communication.

The research was a pilot study employing a quasi-experimental design. A convenience sample was obtained by inviting 20 senior nursing students from a four-year nursing program to participate in the study. The first 13 students to volunteer were chosen for the sample. One student dropped out prior to data collection, leaving a sample of 12 students, each randomly assigned to either an experimental or control group. The experimental group participated in two, one-hour simulation sessions in which students were expected to care for two patients with complex diagnoses, in a dynamic situation. Variations in the scenarios were developed so that the second session was a variation of the first. Sessions were evenly spaced during the semester, and sessions were videotaped for future review. The control group received no intervention; both groups participated in the usual classroom and clinical learning methods for the course.

The dependent variable, clinical performance, was measured during an end-of-semester, clinical simulation experience that was a part of the normal coursework. During this simulation, the students were presented with a two-patient simulation, similar in complexity to the simulation used in the experimental condition in that the patients presented with competing priorities, but the patient diagnoses were different. Clinical performance was measured using the Clinical Simulation Evaluation Tool (CSET), a faculty-developed assessment tool. The tool measured key aspects of clinical performance by means of a checklist of expected behaviors in each of the five categories of clinical performance previously mentioned. A faculty member blind to the student condition, but with expertise in the content area, evaluated all participants.

A comparison of the differences between the experimental and control groups' mean total scores demonstrated one main finding. Mean scores for two of the six performance categories were significantly higher for the experimental group than for the control group: safety (p = .001) and basic assessment (p = .009). No significant differences were found between the groups for any of the other performance areas. The safety category included three aspects, hand hygiene, patient identification, and detecting medical error. Group mean scores were identical for performance of hand hygiene and detecting medical error; students in the experimental group scored significantly higher on performing patient identification procedures during the simulation posttest. In the category of basic assessment, students in the experimental scored significantly higher on monitoring and assessing vital signs during the simulation posttest. No differences were observed between the groups for initial assessment, the second skill assessed in the category of basic assessment. Radhakrishnan et al. (2007) reasoned that practicing patient identification procedures, and vital sign assessment and interpretation during simulation practice sessions, improves nursing students' clinical performance. Some might argue that any observed differences were a result of possible confounding of the experimental intervention with the outcome measurement. The authors refuted this argument by noting that there were no differences between the groups on the other four categories of clinical performance.

The conclusion drawn by Radhakrishnan et al. (2007) was that clinical simulations offer excellent opportunities for students to improve their habits of ensuring patient safety, in particular, of verifying patient identification. The link between the use of simulation and improvements in two key areas of clinical practice provides evidence to support the continued use of simulation as a risk-free methodology that reinforces the development of essential knowledge and skills among nursing students.

Several studies from the medical literature were also reviewed for their focus on enhancing the acquisition and performance of knowledge and skills. In two studies, Morgan and colleagues (Morgan & Cleave-Hogg, 2002; Morgan et al., 2006) considered the role of simulation in assisting medical students to improve their ability to manage clinical emergencies.

The purpose of the first study (Morgan & Cleave-Hogg, 2002) was to compare the outcomes on both performance-based assessments and written examination questions between students given simulation-based or videotape-based training. Because patient safety issues limit the ability of students to practice skills and exercise clinical judgment in real world environments, educators have turned to simulation as a mechanism for providing students with risk-free hands-on experiential learning that includes the opportunity for feedback and reflection. Against this context, Morgan and Cleave-Hogg pointed to the need for research aimed at exploring the usefulness of simulation as compared with other, less costly methods of learning. Video-assisted learning was identified as a commonly used, low-cost methodology that might be used to achieve the same learning outcomes as simulation-based learning, and the researchers designed a study to compare the effectiveness of the two methods of learning.

A randomized, pretest-posttest experimental design was selected. Participants were final-year medical students (*N* = 144) attending a Canadian university. Students were in a 6-week rotation that included three, 2-week blocks, including the 2-week anesthesia rotation. During the anesthesia rotation, students participated in educational sessions in small groups. For each educational session, 10 students were first oriented to the simulator and then they completed a performance-based simulation pretest involving concepts related to management of patients presenting with myocardial ischemia, anaphylaxis, or hypoxemia.

Upon completion of the pretest, students were randomly assigned to either a simulation or a videotape group. Each group participated in a 90-minute educational session expanding on the concepts covered in the pretest scenario. Students in the simulation group were facilitated in learning by working through a scenario related to the pretest concepts. Facilitators did not guide student management of the cases, nor did they demonstrate correct maneuvers; however, they provided feedback and ensured that misconceptions were addressed. Students in the videotape group observed a video of a faculty member appropriately managing a simulated scenario related to the pretest concepts. A facilitator was on hand to stop the videotape and initiate discussion and feedback similar to that occurring in the simulation session.

Following a lunch break, students again participated in a 90-minute educational session focusing on material unrelated to that presented in the pretest; however, this time students who had been in the morning simulation group participated in the videotape session and those in the morning videotape session participated in the simulation session. After this second educational session, all students completed a performance-based simulation posttest that was identical to the pretest. At the end of the 6-week rotation, all students completed a 10-item written examination based on the learning objectives outlined in the course curriculum, with one or two questions specifically related to general concepts from the topic of each groups' first educational session.

Data were collected during the pre- and posttest by means of a performance checklist including four items related to the critical event presented in each scenario: a statement of the problem, a differential diagnosis, a management plan, and a fourth item, either identification of the cause of the problem, or drug intervention. During the pre- and posttest, a faculty member trained in the research protocol assessed and recorded each student's performance on the checklist. Two, experienced faculty who had received training in the research protocol graded the written examinations. Data on student enjoyment and perceived value of both sessions were collected by means of a 5-point Likert-type scale.

The researchers compared the average group difference from pretest to posttest for each learning method (simulation and videotape) across all scenarios and within each scenario. The primary finding was a statistically significant improvement among all students from pretest to posttest, regardless of the scenario (F [1, 138] = 252.4, $p < .001$), demonstrating acquisition or retention of knowledge from pretest to posttest. No statistically significant differences in gain scores were found between the simulation and videotape groups, either when all scenarios were considered together (F [1, 142] = 1.09, $p = 0.29$), or when scenarios were considered individually. Students indicated that they enjoyed and valued learning through simulation more than through videotape-assisted learning ($p < .001$), although the mean values for both sessions were high.

The authors concluded that both methods of learning provided equivalent, valuable learning experiences. The gain in performance scores from pretest to posttest was an expected short-term educational outcome; Morgan and Cleave-Hogg (2002) suggested the need for future research to test long-term retention of knowledge learned in a simulation environment.

In a second study, Morgan and colleagues (Morgan et al., 2006) characterized the difficulty in applying knowledge as resulting from a gap between the high ground of academic scientific theory and the swamp ground of complex, real world problems. The purpose of their study was to evaluate the use of simulation as a means of helping students to bridge the gap by improving medical students' ability to apply theoretical knowledge in related practical situations.

The study was done because a needs assessment from previous years' medical students had indicated a lack of knowledge of the pharmacology of drugs used in the resuscitation and treatment of patients undergoing life-threatening cardiac arrhythmias, as well as an inability to practice skills related to these situations. Issues of case complexity, ethical considerations, and relative infrequency of critical event situations in the clinical environment all factored into the lack of opportunity for students to apply knowledge to practice. The authors wished to evaluate the use of simulation in enhancing acquisition of knowledge, and improving team performance in application of knowledge. Specifically, Morgan et al. (2006) sought to determine if simulation would improve medical student performance scores on simulation-based and written examinations.

The study was designed as a single-group, pretest-posttest design. Participants were drawn from all final year medical students ($N = 370$) attending a Canadian university over a 2-year period. The final sample consisted of 299 students, representing 80.81% of the original population. Simulation sessions were held every 2 weeks, with 10 students participating in each session. Each session began with students completing a brief demographic questionnaire and signing an agreement to keep the content and design of the simulation sessions and assessments confidential. Students next completed a 10-item pharmacology pretest, followed by the simulation session. During the session, students were assigned to teams of two to three members each, and over the course of four simulation scenarios, each team member was given the opportunity to assume various team roles. Student team performance was assessed via a performance checklist as a performance pretest, and each session was videotaped.

Following the initial four scenarios, students and faculty facilitators reviewed the students' performance using videotaped performance as a prompt for discussion. Students were then provided with American Heart Association (AHA) guidelines related to the scenarios that had been presented. After time allowed for review of the AHA guidelines and a lunch break, student teams again participated in the same four simulation scenarios, with their performance assessed according to the checklist as a posttest; team-leader roles were reassigned for the posttest scenarios. Following completion of the scenarios, students took a 10-item pharmacology posttest and completed an evaluation of the experience.

Three instruments were used. Data on knowledge of pharmacology were collected by means of a 10-item, multiple choice pharmacology test. Reports of the study do not indicate if there were any differences between the pretest and posttest. Data on team performance in the simulation scenarios were gathered by comparing faculty observations with performance criteria on a checklist. The checklist had been developed by the authors (Morgan, Cleave-Hogg, DeSousa, & Tarshis, 2004) for a prior simulation study and had previously been shown to have acceptable internal consistency with five scenarios (Cronbach's alpha ≥ 0.6 and ≤ 0.9). In addition, a global rating scale was used to denote team performance according to a 5-point scale ranging from 1 (*unacceptable*) to 5 (*superior*). Each point on the scale was accompanied by behavioral descriptors to enhance rater reliability. Finally, data were collected on students' evaluation of the simulation experience by means of a five-item strength-of-agreement scale.

The main findings were an increase in performance from pretest to posttest on all measures. Individual scores on the pharmacology test improved significantly from pretest to posttest ($t = -7.650$, $p < .0001$). No statistically significant differences were found between pharmacology scores from the two sessions of the academic year or between the two academic years. Team performance scores improved significantly, both when scenarios were considered collectively (F [1, 103] = 101.29, $p < .0001$), and when scenarios were considered individually (F [3, 103] = 15.63, $p < .0001$).

The authors concluded that simulation was effective in enhancing the acquisition and application of knowledge among medical students. Global performance ratings were believed to correlate with clinical judgment and thus represented behavior and skill that was more likely to transfer to real world practice. Suggestions for future research included the influence of simulation on long-term knowledge retention and performance of critical clinical skills such as clinical judgment, problem solving, and procedural skills.

The final three studies to be reviewed here, presented for their approach to evaluating the role of simulation in the acquisition of knowledge and skills, also come from the medical literature. Shapiro et al. (2004) situated their study in a real world, emergency department setting. Wayne et al. (2005) considered the use of simulation in strengthening medical students' cardiac support skills. Steadman et al. (2006) compared problem-based learning methods with simulation for teaching medical students about the management of patients experiencing respiratory difficulties (dyspnea). Each study employed a randomized, two-group, experimental or quasi-experimental design.

The purpose of Shapiro et al.'s (2004) study was to determine if simulation-based training could improve clinical team performance when added to an existing didactic teamwork curriculum. Responding to patient safety recommendations from the Institute of Medicine (2000), many healthcare institutions had initiated programs designed to improve team performance and thus improve patient safety. The authors sought to strengthen the didactic team training provided in their facility by incorporating elements of simulation. Rather than focusing on individual skill training, Shapiro et al. (2004) intended to focus on improving teamwork skills, arguing that improving teamwork offered opportunities to improve patient safety across a broader range of patient problems and healthcare delivery systems. Additionally, by evaluating team performance in a clinical situation, their study would provide evidence towards the transfer of learning from simulation to the real world.

Shapiro et al. (2004) identified their quasi-experimental study as having a single crossover, prospective, blinded, and controlled observational design. The facility, a level-one trauma center affiliated with an emergency medicine residency, already participated in a team-training project. For the study, four teams were randomly created from among the 32 residents and 120 nurses on staff. Each team consisted of 2 emergency department physicians (1 attending physician and 1 resident physician) and 3 nurses. The four teams were further randomized into two experimental and two control groups, and schedules were periodically manipulated in order to allow the teams to work together for observation purposes.

Physicians and nurses in this facility were accustomed to being observed in relation to the ongoing team-training project, and thus, Shapiro et al. (2004) were able to obtain baseline performance data through observation without team participants' knowledge of the purpose. Each team was observed twice during a regularly scheduled shift prior to the experimental intervention, and twice following the intervention.

The experimental intervention was a daylong simulation session at a nearby simulation center. The session focused on crew-resource management behaviors of cooperation, coordination, and sharing (see Oriol, 2006), followed by presentation of three patient care scenarios of increasing complexity. Debriefing focused on aspects of team performance rather than task work. During the time between the initial and final observations, the control groups worked together in their intact teams at least once. Within 2 weeks of the simulation session, the final team observations were completed.

Data were collected using the Team Dimensions Rating Form that consisted of five 7-point behaviorally anchored rating scales (BARS); median inter-rater reliability was .67 across the five scales. Participants in the experimental groups were asked to complete a seven-item survey related to features of the simulation experience, including realism and perceived value for the development of teamwork skills. The primary hypothesis, that an increase in BARS score would be observed in the experimental group but not in the control group, was tested by examining the differences in mean scores between the initial and final assessments for each group.

The main findings were that there were no statistically significant differences between the groups at the baseline assessment (Wilkes' lambda = 0.44, F [5, 10] = 2.56, p = .10), nor were there statistically significant differences from initial to final assessments, although the experimental group showed a trend toward improvement (Wilkes' lambda = 0.62, F [5, 20] = 2.43, p = .07). The control group showed no improvement (Wilkes' lambda = 0.83, F [5, 20] = 0.82, p = .55). Participants from the experimental group rated the overall simulation experience as *excellent* (n = 9) to *very good* (n = 1), and were equally divided as to whether the realism afforded in the simulation environment promoted or hindered transfer of learning to the clinical environment.

Despite the lack of statistical significance, Shapiro et al. (2004) concluded that training using simulation does have an impact on clinical performance. Teamwork practiced within the simulated environment could provide an additive benefit to that gained through didactic instruction by allowing healthcare providers to integrate task and teamwork skills in an environment that mimics the clinical setting.

Wayne et al. (2005) addressed the problem of skill retention following publication of studies demonstrating limited retention of life-saving resuscitation skills among physicians, nurses, and family members of cardiac patients (e.g., O'Steen, Kee, & Minick, 1996). The researchers sought to test simulation as an educational intervention that would result in better acquisition and retention of knowledge among physicians and nurses. They situated their study against an interpretation of the existing evidence that simulation provides controlled, deliberate practice with opportunity for feedback, promotes effective skill acquisition, and facilitates transfer of learning into the clinical setting.

The purpose of their study was threefold: first, to assess the baseline proficiency of second-year medical residents in managing simulated ACLS scenarios; second, to strengthen medical residents' skills through implementation of a simulation intervention; and third, to assess the feasibility of initiating a simulation-based educational program into the medical education curriculum.

The study design was described as a randomized, wait-list control design. Participants were drawn from the second year of an internal medicine residency program at a Northwestern university. Participating residents (N = 38) were randomly assigned to one of two groups: intervention or wait-list control. Following assignment, participants in each group underwent an initial baseline performance assessment. Next, the intervention group participated in four, 2-hour simulation sessions while the wait-list control group received no intervention. All participants underwent a second performance assessment 3 months later, after which the wait-list control group crossed over to become the intervention group, and the first intervention group crossed over to become the control group. After another 3 months, all participants completed a third performance assessment.

The simulation intervention was designed to provide residents with deliberate practice in the more commonly encountered cardiac arrest situations (asystole, ventricular fibrillation, supraventricular tachycardia, ventricular tachycardia, symptomatic bradycardia, and pulseless electrical activity). Practice, feedback, and correction in a supportive environment were the hallmarks of the intervention. Throughout the simulation intervention sessions, residents were given the opportunity to both direct resuscitation efforts and perform cardiopulmonary resuscitation or other necessary tasks as a member of the resuscitation team.

Data were collected by measuring residents' performance on three (of six) randomly selected simulated scenarios according to an institutional checklist developed from ACLS treatment algorithms. The checklist items were listed in the order recommended by AHA guidelines, and scored in a dichotomous fashion (0 = *not done/done incorrectly*; 1 = *done correctly*). All items were weighted equally. Validity for the instrument was demonstrated by expert consensus. Demographic data were also collected by means of a course assessment survey administered at the end of the study period (there were no differences between the groups on any of the demographic items).

The main findings were a significant difference in mean performance scores (t [36] = -8.58, $p < .0001$) at the second performance assessment, with the initial intervention group achieving a mean score ($M = 265.6$, $SD = 9.5$) that was 38% higher than that of the wait-list control group ($M = 192.5$, $SD = 35.9$). Following crossover and the third performance assessment, the second intervention group achieved a mean score ($M = 268.98$, $SD = 12.63$) that was practically similar to the second control group ($M = 256.15$, $SD = 20.28$), but differed statistically (t [36] = 2.34, $p < .05$). Similar to the findings of previous research, course assessment survey results indicated that students believed practice in a simulation setting enhanced their clinical skills, provided a valuable learning experience, and helped them develop skills of clinical judgment necessary to leadership in ACLS situations. Wayne et al. (2005) concluded that using simulation for deliberate practice of ACLS skills yielded “large, consistent, and sustained improvement in residents’ skills” over time (p. 214).

The purpose of Steadman et al.’s (2006) study was to determine whether simulation-based learning was superior to problem-based learning in a medical education context. The authors cite the paucity of quantitative evidence supporting the effectiveness of full-scale patient simulation. Research reviewed as background for the study had either not compared simulation with another method of learning, or had not found evidence that simulation was more effective.

In medical education as in nursing education, the need to help students develop skills of clinical judgment fueled an increasing emphasis on interactive methods of teaching and learning. Among these methods were video-assisted learning, screen-based simulated case studies, problem-based learning, and simulation. The benefits simulation offered for students in terms of providing a learner-focused, non-threatening, safe educational environment, lead to rapid adoption in the medical community. Early research efforts cited by the authors substantiated these benefits, showing that participants became more confident while learning without a fear of harming their patients, and while developing an increased motivation and enthusiasm to learn in the realistic setting afforded by simulation.

Notwithstanding these benefits, the lack of clear evidence supporting the effectiveness of simulation as compared to other interactive methods of learning left a gap in the literature. In their study, Steadman et al. (2006) sought to determine if simulation offered advantages over another commonly-used interactive method of learning: problem-based learning. They chose problem-based learning not only due to the prevalence of its use within medical education, but also because it promotes interactive learning in a small group setting by presenting complex, patient-care problems within a clinical context. Thus, both problem-based learning and simulation afford opportunities for students to develop skills of clinical judgment and apply knowledge learned elsewhere to novel situations. Although research problems were not explicitly stated, the authors wanted to determine whether simulation was superior to problem-based learning for teaching acute care assessment and management skills to medical students.

The study used an experimental design including two treatment conditions, simulation and problem-based learning (PBL), with each student learning content by both methods. All fourth-year medical students ($N = 34$) enrolled in a one-week acute care course were eligible to participate; missing any portion of the course excluded students from the study. Students were informed that, although the content of the study was embedded in the course, performance assessments arising out of the study would not affect their standing in the course. Students were randomly assigned to one of the two treatment conditions, resulting in a final sample of 31 students (simulation, $n = 15$, 60% female; problem-based learning, $n = 16$, 69% female).

All of the students received an orientation to the simulator, and completed an initial simulation-based performance assessment. Subsequently, all students participated in two intervention sessions, one simulation session and one PBL session. The only difference in the sessions was the distribution of topics between the two learning methods. The simulation group received a simulation session on dyspnea and a PBL session on abdominal pain, whereas the PBL group received a simulation session on abdominal pain and a PBL session on dyspnea. Students completed simulation scenarios in pairs, and were allowed up to 15 minutes to proceed through the assessments and actions required in their assigned scenario. All students attended lectures on each topic, spent an equal amount of time on each topic, and were exposed to the same topic materials (objectives, case information, scenarios). The final simulation-based performance assessment presented the students with scenarios related to dyspnea.

The data collection tool was an institution-specific standardized checklist, consisting of a variety of performance parameters (assessment, diagnostic evaluation, and management items), scored in a yes or no fashion according to whether the behavior was observed. Scoring was weighted in that critical aspects of performance were assigned higher point values. Two raters, blinded to group assignment, completed the final performance assessments. Initial and final assessment scores were computed and the means, standard deviations, and differences compared between the groups.

The main findings of this study were that the simulation group performed significantly better than the PBL group on the final assessment ($p < .0001$). The mean change in scores also differed significantly for the groups between the initial and final assessment; the average improvement in the simulation group was 25%, and in the PBL group it was 8% ($p = .04$). There were no significant differences between the groups at the initial assessment ($p = .64$).

Steadman et al. (2006) concluded that simulation-based learning was superior to PBL learning for acquiring and applying clinical skills among fourth-year medical students. The primary difference was the realistic patient environment afforded through simulation. Learning within the context of a clinical environment, including aspects of the social situation present in a clinical setting, allowed the learners to immerse themselves in the problem and examine it from multiple perspectives. Although both simulation and PBL invoked active, cognitive learning strategies within the learners, simulation was able to elicit visual, auditory, and tactile cues resulting in a more engaged response from the learners.

Collectively, the presented research is credible and well executed. All but one (Morgan et al. 2006) of the studies employed random assignment in a two-group design to reduce selection bias and improve internal validity. In the case of Radhakrishnan et al. (2007), the small sample size (N = 12) and selection process limit the beneficial effects of randomization. Shapiro et al.'s (2004) study is also limited by a small sample size. Pretest-posttest designs were used in six of the seven studies (all but Radhakrishnan et al. 2007), potentially sensitizing participants to the posttest measure. In one of the six studies employing a pretest measure (Shapiro et al. 2004), the participants were accustomed to being observed as part of a separate, ongoing team training project, and so any effect of sensitization was likely negligible. Two of the studies (Morgan & Cleave-Hogg, 2002; Wayne et al., 2005) used crossover designs, potentially resulting in carryover effects to the dependent variable. In the case of Morgan and Cleave-Hogg, the crossover occurred on the same day as data collection, and each group was exposed to both methods of teaching (simulation and video). No significant differences were found between the groups. In Wayne et al., the crossover occurred in a three-month window between the second and third testing occasions. Significant differences were found between the groups at both the second and third testing, but very little practical difference was noted at the time of the third testing, potentially due to a carryover effect of the first intervention session.

Generalization of the results of these studies is limited to nursing and or medical students in settings similar to those described in each study. Shapiro et al. (2004) enhanced the external validity of their study by randomly selecting subjects from the real world setting, and observing for transfer of knowledge and skills from the simulation setting to the real world setting of the emergency department. In addition, two observers, who were blinded to the identity of the control and experimental teams, obtained the teamwork performance measures. Wayne et al. (2005) and Steadman et al. (2006) also used raters blinded to the participants' condition to complete the final performance assessments.

The length of the intervention varied widely among the studies. The least amount of time spent in active involvement in a simulation was 15 minutes. In Steadman et al.'s (2006) study, the educational session took place in one afternoon with each team allowed a maximum of 15 minutes to manage their allotted scenario. Three other studies provided only one intervention session. Morgan et al. (2002) provided a single 90-minute simulation session focused on one topic, Morgan et al. (2006) provided a morning session (length of time not specified) in which four scenarios were presented, and Shapiro et al. (2004) provided a day-long session, a portion (unspecified) of which was devoted to the presentation of three scenarios. The remaining three studies each provided two or more sessions. Radhakrishnan et al. (2007) provided two, one-hour sessions with students responding in groups to a different two-patient scenario at each session. Alinier et al. (2006) provided two, 3-hour sessions. Each session presented students with four scenarios. Student teams observed for one of the two sessions and actively participated during the other session. Wayne et al. (2005) provided the greatest amount of involvement with simulation. Over the course of the study, each participant attended four, 2-hour sessions as part of a group of 2 to 4 students.

With the exception of Shapiro et al. (2004), each of these studies measured the dependent variable in a situation identical or very similar to the learning situation. Thus, no inference can be made regarding transfer. Shapiro et al. attempted to measure the extent to which knowledge gained in simulation was applied to the real world environment of an emergency department. Despite the lack of a statistically significant result, the authors noted a trend for improvement in the simulation group as evidence that simulation impacts clinical performance, a situation that would fulfill criteria for far-transfer. The final section in this review of the literature addresses student perceptions of the value of simulation.

Students' Perceptions of the Value of Simulation

This section considers four studies from nursing (Bearnson & Wiker, 2005; Bremner, Aduddell, Bennett, & VanGeest, 2006; Jeffries & Rizzolo, 2007; Schoening, Sittner, & Todd, 2006), and one study from the medical literature (Euliano, 2001). As in the preceding subsection, the studies will be collectively reviewed after each is individually presented.

During the 2002 Olympics, clinical rotations were disrupted for nursing students in a private university in Salt Lake City. Seeking an alternative clinical experience, Bearnson and Wiker (2005) designed a simulation experience for the students. In exploring the literature regarding the use of simulation in nursing, the faculty researchers noted the benefits of simulation in providing a safe, risk-free environment for skills practice. They found only two studies describing the use of simulation with undergraduate nursing students, however, so they designed their study to investigate learning outcomes related to increasing students' knowledge, ability, and confidence in administering medications.

The study employed an exploratory, descriptive design, in which two groups of junior nursing students participated in a simulation experience at the end of a 6-week clinical rotation. For the simulation experience, each group of students participated in a single 2-hour session in which three patient scenarios were presented. Simulation scenarios portrayed increasingly complex postoperative patient situations; students were required to assess each patient, respond to ratings of pain, and assess the patient's response to any interventions that were initiated.

Survey data were collected on the dependent variables of knowledge, ability, and confidence. The survey asked students to indicate on a Likert-type scale (1 = *strongly disagree*, to 4 = *strongly agree*) their level of agreement with four positive statements about the simulation session. Three additional questions elicited student comments regarding what they had learned, what would improve the experience, and whether the students would recommend future simulation sessions.

The main findings were 100% agreement (agree or strongly agree) with each of the four scale items. Students agreed that the simulation experience had increased their knowledge of medication side effects ($M = 3.13$), their knowledge of differences in patients' responses ($M = 3.31$), their ability to safely administer medications ($M = 3.06$), and their confidence in their own medication administration skills ($M = 3.00$). Student comments reflected a perception of increased confidence in skills following the simulation activity, and additional positive comments included a general appreciation for the learning opportunities afforded through simulation. One student commented on the value of working as a member of a team, saying, “Many times as we collaborated with each other, we ended up coming to different conclusions about what we felt the diagnosis was, and several times we had different methods for solving the problems” (p. 424). In general, although students agreed the experience had been valuable, they indicated that simulation should be supplemental to, rather than in lieu of a clinical day.

The conclusion drawn was that the simulation experience had met the purpose of the study in that students’ knowledge, ability, and confidence had increased. As a result, continued use of simulation in the undergraduate nursing education setting was recommended.

Responding to calls for evidence-based practice, Bremner et al. (2006) proposed to evaluate novice nursing students’ responses to the use of simulation to begin developing a framework of best practices in using simulation in nursing education. Similar to other researchers, Bremner et al. noted the increasing adoption of simulation technology, and catalogued the array of uses for simulation in nursing education. After exploring the advantages and limitations of simulation as noted in the literature, the authors chose a descriptive approach to their study in order to gain insight from the student perspective into both the potential pitfalls and the best practices associated with simulation as a tool for learning.

Participants were drawn from a convenience sample of 56 novice nursing students in a baccalaureate program. As part of their course, students were provided with a simulation experience in which they were instructed to complete a head-to-toe assessment on a simulator. Following the initial assessment, physiologic parameters were adjusted on the simulator, and the students were instructed to re-assess the simulated patient. After the simulation experience, students were asked to complete a questionnaire designed to elicit their perspectives on the use of simulation in nursing education. Of the initial 56 students, 41 (73%) completed the questionnaire.

The questionnaire included two parts. The first part used a Likert-type rating scale to obtain student responses to five categories of questions related to the simulation experience: (a) overall perceptions of the experience, (b) opinions as to whether the experience should be a mandatory part of the curriculum, (c) if the experience increased their confidence in physical assessment skills, (d) if the experience had reduced the stress associated with their first in-hospital clinical day, and (e) if the experience had reduced their anxiety about starting hospital clinical rotations. The second part of the questionnaire asked students to reflect on the simulator experience after having completed the clinical rotation for their course.

The main findings were that students indicated that simulation added value to their learning experience. Most of the students (95%) rated the session as either good or excellent, and most indicated that simulation should be a mandatory part of the curriculum (68%). In addition, the majority of the students (61%) felt that they had gained confidence in their physical assessment skills as a result of the experience.

Of the qualitative responses, the primary themes were related to simulation's utility for teaching and learning, and its realism. Students indicated that simulation was helpful for learning to differentiate heart and lung sounds (29%), and served to motivate them to practice more (5%). One student stated, "this session made me realize how much more I needed to practice heart and lung sounds before clinical started" (Bremner et al.

2006, p. 172), and another stated that the experience “helped me feel a little more confident with my head-to-toe assessments” (p. 172). Students remarked on the advantages of learning in a risk-free environment in a setting that allowed them to obtain hands-on practice (20 to 22%). A number of students (24%) commented on the high realism afforded by simulation, although one student (2%) noted the lack of realism present in the simulation. A few limitations were mentioned, including concerns related to a lack of sufficient time to work with the simulator (15%), challenges inherent in group work (5%), and feelings of anxiety related to this first interaction with a simulator (2%).

The results demonstrated that students had identified the value inherent in learning through simulation, specifically noting advantages related to active learning and to development of confidence. Bremner et al. (2006) concluded that simulation provides opportunities for novice nursing students to increase their comfort and confidence in developing clinical skills.

Similar to other researchers, Schoening et al. (2006) situated their study against a context of limited availability of real world clinical sites, a perceived failure of nursing education to produce competent graduate nurses, and an increasing focus on patient safety issues. In light of these challenges, simulation offered one approach to encouraging active, mindful, context-rich learning among nursing students. Faced with limited clinical sites, and with an understanding of the theoretical advantages offered by simulation, a decision was made at the researchers’ university to replace 6 hours of clinical obstetrical experience with simulation. In an effort to better understand the role and value of simulation in student learning, Schoening et al. designed a study to examine students' perceptions of a preterm labor simulation as a method of instruction.

A non-experimental pilot evaluation study was designed to identify and refine learning objectives and activities for the simulation, and to explore student perceptions of the experience. The participants were a convenience sample of 60 junior-level baccalaureate students enrolled in a nursing course that included a 3-week clinical rotation in obstetrics. All of the students but one were female; their average age was 22.

During weeks 2 and 3 of their obstetrical rotation, student groups spent half of each clinical day in simulation and the other half in a traditional clinical assignment. Simulations were facilitated by the students' usual clinical instructors, and followed a four-phase teaching model for simulation: orientation, participant training, simulation operations, and debriefing. During the orientation phase, students were given clinical learning objectives and resources to attain the necessary domain knowledge to accomplish the objectives. During the participant training, students were oriented to the simulator and to the simulation experience. Each student was given an opportunity to assume the role of either the primary nurse or an observer; expectations were that the students would participate in simulation to the same extent expected of them in the traditional clinical setting.

During the simulation operations phase, each group of 7 to 8 students was presented with a two-part scenario involving a patient presenting with preterm labor and subsequently destabilizing. Half of the group managed the initial patient presentation while the other half observed and developed a written plan of care. The following week, the groups switched roles to resume the continuing care of the patient. Each session lasted 1 to 2 hours, with students required to perform all of the necessary care for the patient, including admission and assessment, receipt and implementation of physician's orders, initiation of therapeutic interventions, and all necessary communication. Throughout the simulation, the clinical instructor remained available to ask questions, provide cues, and redirect students as necessary. Each session was followed by the debriefing phase. At this time each group reviewed their findings, discussed the case and the plan of care, and provided and received feedback about their successes and challenges. Debriefing lasted 30 to 60 minutes.

Data were collected by means of a researcher-developed, 10-item Likert-like evaluation tool administered at the end of the second simulation experience. The tool asked students to indicate their level of agreement (1 = *strongly disagree* to 4 = *strongly agree*) as to whether the simulation objectives had been met. Additional questions addressed perceptions of the experience by asking students to indicate if they agreed that simulation had increased their confidence in the clinical setting, helped them gain skills useful in the clinical setting, and increased their knowledge of preterm labor. One additional source of data was reflective journals maintained by several students. Student entries provided a qualitative, narrative record of some students' experiences that served to support the quantitative data collected by the researchers.

The main findings were total mean scores reflecting a high level of agreement on the items addressing attainment of objectives (grand $M = 3.64$, range 3.54 to 3.74), and those reflecting student perceptions of the experience ($M = 3.75$, range 3.71 to 3.80). Qualitative analysis of the journal entries using a line-by-line analysis to compare and cluster data yielded five themes: skills, hands-on learning, and practice; confidence, self-efficacy, and non-threatening environment; critical thinking, realism, knowledge, review, and decision making; value, transferability, and satisfaction; and teamwork, communication and preparedness.

The theme with the most comments was that of confidence, self-efficacy, and non-threatening environment. Students perceived that simulation helped them to “go into the client’s room being more confident,” “more comfortable with tasks,” and “more comfortable with knowing when to call the doctor and when to try other [nursing] interventions” (Schoening et al. 2006, p. 256). Other themes reinforced the usefulness of simulation in helping students try out the nursing role in a way they had not done so before. One comment related to developing an understanding of situations from the perspectives of the patient and other care providers. Another student recognized the importance of “performing good assessments and developing professional communication in order to collaborate with other disciplines” (p. 257). Each of the themes contained aspects related to the development of skills needed for clinical judgment.

The authors concluded that not only was simulation an effective vehicle for learning, but it also served to increase students’ confidence in their clinical skills and abilities. Increased confidence was attributed by student journal entries to practice in skills of patient care, teamwork, communication, and decision-making that had been fostered in the simulation experience. Overall, simulation offered a means of providing students with an opportunity to experience providing total care to patients in a safe environment, where students were free to learn from their mistakes and view patient care from multiple perspectives.

One other nursing study is of note. From 2003 to 2006, the National League for Nursing (NLN) and Laerdal Medical, a manufacturer of human patient simulators, sponsored a national, multi-site, multi-method project aimed at developing and testing models to assist nursing faculty in using simulation to advance student learning (Jeffries & Rizzolo, 2007). The goals of the research were to explore how to design and implement simulations, and evaluate the learning outcomes achieved through simulation. Over the course of the first year, a teaching-learning framework was designed to guide simulation design and implementation, instruments were developed in collaboration with content experts to measure the concepts in the framework, and simulation case studies were developed.

During the first half of the second year, 395 nursing students from five sites completed a pretest, viewed an instructional video, completed a parallel forms posttest, and then completed three scales. The first scale, designed to measure the students' perceptions of the presence and importance of educational practices, was the Educational Practices in Simulation Scale (EPSS), a 16-item, Likert-type scale (Cronbach's alpha for presence of specific practices = .86; and for importance of specific practices = .91). The second scale, the Student Satisfaction with Learning Scale, was a five-item instrument designed to measure student satisfaction with the instructional method (Cronbach's alpha = .94). The third scale, designed to measure students' perceived confidence in caring for a post-operative patient, was the Self-Confidence in Learning Using Simulations Scale (Cronbach's alpha = .87). Data revealed that learning had occurred in this traditional method of instruction, as indicated by a significant increase ($p < .0001$) from pretest to posttest on the knowledge measure. Students expressed satisfaction with the method of learning, and confidence in their ability to care for postoperative patients.

During the second half of the second year, 403 nursing students from six sites participated in the first experiment. Participating students were predominantly female (87%) and Caucasian (77%), with an average age of 29 years (other ethnic groups represented included African American, 8%, and Asian, 6%). The majority (62%) of students attended baccalaureate programs, the remaining students attended associate degree nursing programs. Following a videotaped presentation on the care of a post-operative patient, students were randomly assigned to work in one of three conditions: control, static manikin, or simulation. The control group worked to complete a written scenario; the static manikin group participated in a simulated patient care experience using a static manikin; the simulation group participated in a simulated patient care experience using a simulator. Each of the conditions involved care of a post-operative patient, and each condition required students to work in small groups of four persons each for 20 minutes, followed by a 20-minute group debriefing session. After each session, the students completed the same knowledge, educational practices, satisfaction, and confidence measures previously described. Additionally, the students completed a performance rating scale, the Self-Perceived Judgment Performance Scale, designed to measure self-perceptions of problem-solving skills during the intervention. This 20-item scale (Cronbach's alpha = .90) was adapted from items on Facione and Facione's (1998) Judgment Performance Scale.

The primary findings for this phase of the study included no significant differences between the groups on knowledge gains from pretest to posttest, or between the groups on the performance rating scale (Jeffries & Rizzolo, 2007). The simulation group had a significantly higher level of satisfaction with their instructional method than the other two groups, and the static manikin and simulation groups reported higher levels of self-confidence than the control group. Students involved in the simulation conditions were assigned to roles (nurse 1, nurse 2, significant other, observer), allowing the researchers to analyze data according to roles. No significant differences were observed between roles other than for the measure of judgment. On average, students in both the nurse 1 role, and the significant other role, rated themselves significantly higher on judgment when compared with students in the nurse 2 role. Students in the observer role rated themselves significantly lower on judgment when compared with students in the nurse 2 role. There were no other significant differences among the groups.

During the third year, a second experiment presented both a written scenario and a simulation scenario to each of two groups of students. Since the first experiment had presented only one learning experience to each student, the second experiment was designed to allow students to compare both types of learning experiences. A total of 110 students participated (86% female, 82% Caucasian, with a mean age of 26 years) from two study sites; one site offered a baccalaureate nursing degree, the other an associate degree in nursing. The two conditions differed only in which order the scenarios were presented. In one group, the written scenario was presented first, followed by a different, but parallel simulation scenario. In the other group, the simulation scenario preceded the written scenario. Minor procedural changes included elimination of the knowledge measures and changing the observer role to that of recorder. The remaining data collection instruments were the same as previously described.

On average, the simulation group reported significantly higher levels of satisfaction and self-confidence than the written scenario group. Judgments of problem-solving performance were significantly higher in the written scenario group. Overall, Jeffries and Rizzolo (2007) concluded that simulation offers advantages of active learning and immersion in a clinical care situation, allowing students to practice skills of observation, assessment, and problem-solving. The higher ratings for judgment in the written scenario group were attributed to students' greater degree of familiarity with written problem-solving problems than with the situated, in-action problem solving that occurs during simulation. The researchers further concluded that as a result of the deliberate, guided practice of skills afforded during simulation and with appropriate feedback and reflection on performance, students experience increased self-confidence, and are more likely to experience increased learning and transfer of knowledge to the real world environment.

A medical education program provided the setting for the final study reviewed relative to the role of simulation in promoting student learning. As a professor of physiology in a medical education program, Euliano (2001) was clearly aware of the potential advantages afforded by small-group instruction, and wished to explore the potential for using simulation to teach concepts in small, interactive settings. Medical education has used strategies such as problem-based learning with varying degrees of success, but with an overall trend toward a more active method of learning. Advantages attributed to small-group instruction include increased retention of knowledge, enhanced transfer of knowledge, and increased student interest. Small-group interaction would also allow for early identification and correction of misconceptions.

Because of increasing constraints on the use of animals for teaching physiologic concepts, Euliano (2001) sought another method of small-group teaching that would allow for interactive demonstration and student participation. Simulation appeared to be well suited for this instructional purpose, given its facility with small groups, its history of stimulating interest, and its ability to involve students in active learning. However, because the efficacy of simulation as a learning method had not been fully demonstrated, Euliano designed an exploratory study using a single-group, pretest-posttest design to investigate the utility of simulation in enhancing medical students' knowledge and their confidence regarding their knowledge.

The participants were first-year medical students (n = 87) enrolled in a 2-week physiology course at a Southeastern university. The course included two, one-hour workshops, one of which was the simulation workshop. Four topical areas were chosen for the simulation, each a topic that was historically difficult for students to understand. Two scenarios, one static and one dynamic, were created to demonstrate the four topics. The static scenario allowed students to explore concepts related to the physiology of the Valsalva maneuver. The dynamic scenario incorporated concepts related to venous return and cardiac output, baroreceptor function, and the normal Starling curve.

Students rotated through the workshop in groups of 10, and interacted with the simulator as the instructor guided them through actions and observations of the simulator's responses to their actions in order to explicate concepts. For example, by applying sustained bag and mask ventilatory pressure to the simulator, students elevated the simulator's airway and intrathoracic pressure, thus eliciting a Valsalva response. Students then observed the resulting increase in central venous pressure, subsequent decrease in arterial pressure, and increase in heart rate. The instructor prompted students to explain the physiologic sequence of events that lead to these observable changes. The dynamic scenario followed a similar pattern, with students responding to a simulated case requiring medical intervention; in this scenario, however, the simulator was programmed to respond differentially to the intervention, according to the initial physiologic state. The instructor again prompted students to analyze the physiologic process underlying the simulated patient's response.

Immediately before and after each workshop, the students completed an anonymous examination and survey. Assessing knowledge, seven questions required students to answer specific questions about concepts included in the workshop. Each question was accompanied by a request for the students to identify their level of confidence in their answer, using a Likert-type scale (1 = *not at all* to 5 = *very confident*). Seven more items assessed the students' confidence in their understanding of workshop concepts, using a similar scale, by asking, "How well do you feel you understand the following concepts?" (Euliano, 2001, p. 42). Students also completed a course evaluation form.

Posttest instruments were received from 75 of 87 participants, but because eight of the posttests were incomplete, the final sample size was 67. The primary findings were a statistically significant improvement in student scores from pretest to posttest for five of the seven knowledge items, and for all of the confidence items ($p < .0001$). Of note was the inclusion on the confidence survey of two control items addressing concepts unrelated to the simulation topics. Students' confidence on these two items also increased from pretest to posttest, but to a lesser degree than that of the other items (the author does not provide quantitative data, noting only that the test statistic, *W*, for the two control items improved at a level less than one-quarter that of the other items, but still at a statistically significant level). Euliano (2001) argues that although the increase of confidence on the control items might be interpreted as a failure of the instrument, it may be a reflection of an overall increase in interest and confidence developed through simulation.

The use of simulation was viewed as a useful method for reinforcing concepts learned in class. The active, hands-on approach allowed deeper learning through activation and elaboration of knowledge, and encoding specificity. Providing students with the ability to witness the clinical presentation of varying physiologic processes through simulation would likely result in improved retrieval and transfer of learning. Additionally, the small-group setting allowed students to learn in a collaborative setting, similar to the settings in which they would practice in their professional career.

Each of the studies reviewed provides evidence in support of the educational value of simulation. With the exception of one study (Jeffries & Rizzolo, 2007), single-group, descriptive designs were used to learn more about the advantages and limitations of using simulation as a method of learning. Methodologic weaknesses, such as no reported sample size (Bearnson & Wiker, 2005), lack of a comparison group, and the potential fallibility of self-perceptions require that the results should be considered with caution. Simply initiating a new method of learning could explain the increased confidence or satisfaction reported in these studies. And yet, individually each study provides evidence for the perceived benefits of learning through simulation at a particular institution and in a particular course. Collectively, the studies contribute to a growing understanding of the value offered by simulation as an effective teaching tool.

Jeffries and Rizzolo (2007) used a two-group, experimental, multi-site design with a large sample size to explore learning practices, develop a framework for teaching, and evaluate learning outcomes associated with simulation. Inclusion of both baccalaureate and associate degree nursing programs and a large representative sample adds to the external validity of the study. Careful attention to developing reliable, valid measures adds strength to the study. It is unclear how inevitable differences in implementation from one site to another affected the results.

A major limitation of Jeffries and Rizzolo's (2007) study is the lack of reported quantitative data. Findings are simply reported as either significantly different or not. At the time of this writing, the full report of this project is not yet available (M. A. Rizzolo, personal communication, April 13, 2007). Once the full report is published, reviewers will be able to make a better assessment of the factors affecting internal validity. This limitation notwithstanding, Jeffries and Rizzolo present a credible, thorough approach to considering the educational implications of using simulation in nursing education, adding foundational understanding to the research on simulation.

Summary

The review of the literature on transfer, clinical judgment, and simulation as it pertains to knowledge acquisition and application, and student perceptions of the value of simulation as a method of learning, demonstrates the challenge of understanding the processes by which individuals acquire knowledge and skills, and then use that knowledge to solve real world problems. Transfer has been historically difficult to demonstrate, yet must occur, otherwise how would individuals be able to solve problems or identify solutions in new situations? In order to get along in everyday life, individuals apply prior knowledge to new situations (Gick & Holyoak, 1987). Yet questions remain about the importance of situation similarity in facilitating transfer (Greeno et al., 1993; Hatano & Greeno, 1999).

Clinical judgment is likewise difficult to measure, as the contextual situations in which judgments are made are difficult to replicate and control. Although using actual patient outcomes might seem to offer evidence of good judgment, such approaches fail to consider the role of chance in determining patient outcome (Dowding & Thompson, 2003). One suggestion to improve the research on clinical judgment is to consider the process used rather than the outcome (Pauker & Pauker, 1999).

The research on simulation suggests that simulation may be an effective means of helping students to acquire knowledge. Even in studies where learning gains for students using simulation were no different from students using an alternative method of learning, students reported value in learning through simulation. In general, students reported that simulation was an enjoyable and satisfying way to learn clinical concepts and skills. The high realism, combined with the need to solve patient care problems during simulation served to motivate and engage them in learning. Students liked collaborating with peers and appreciated the opportunity to learn in a hands-on, realistic environment that was free from the risk inherent in real-life clinical practice. Students also expressed feeling increased confidence in their abilities as a result of learning through simulation.

Simulation offers a bridge between the theoretical, classroom environment and the real world setting. From a practical perspective, simulation makes sense. This study proposes to address a gap in the literature by investigating the effects of simulation on knowledge acquisition, near transfer and far transfer of learning, and the development of clinical judgment. The study will also explore features of simulation that contribute to effective learning, including active learning, collaboration, and engagement, and the relationship of these features to measures of knowledge.

CHAPTER THREE

Method

The purpose of this study was to compare simulation with traditional methods of learning in promoting acquisition and transfer of learning, and development of clinical judgment, among prelicensure nursing students. The study investigated the following research questions:

1. What is the effect of simulation on knowledge acquisition among prelicensure nursing students?
2. To what extent does simulation promote near transfer among prelicensure nursing students?
3. To what extent does simulation promote far transfer among prelicensure nursing students?
4. To what extent are the learning practices active learning, collaboration, and engagement promoted by simulation?

This section presents the study methodology, addressing research design, sample, protection of human subjects, instrumentation, treatment description, procedures, proposed data analysis, pilot test, and descriptive statistics.

Research Design

This study used a two-group, pretest-posttest experimental design to investigate the efficacy of simulation among prelicensure nursing students. The study included one independent variable, learning method (two levels, simulation and comparison), and six dependent variables, knowledge acquisition, near transfer, far transfer, active learning, collaboration, and engagement.

The dependent variables were operationally defined as follows. The three cognitive dependent variables were measured by student responses to measures of subject knowledge. *Knowledge acquisition* was measured by scores on test items reflecting subject knowledge and by noting the change in subject knowledge from pretest to posttest. *Near transfer* was measured by scores on test items reflecting application of subject knowledge to new, but similar subject matter. *Far transfer* was measured by scores on test items that require clinical judgment in applying subject knowledge to new and novel situations. The three affective dependent variables, *active learning*, *collaboration*, and *engagement*, were measured by student ratings on a strength-of-agreement scale.

The study included five control variables. *Age*, *prior simulation experience*, and *prior healthcare experience* were measured by participant responses to questions on the posttest. *Prior academic achievement* was measured by scores on a pretest and *prior academic ability* was measured by scores on the SAT. Data obtained on the control variables were used to demonstrate equivalency of groups, to remove variance from the dependent variable associated with prior ability and achievement in an analysis of covariance, and to explore the relationship of these characteristics on measures of knowledge acquisition, near transfer, and far transfer. Some prior investigations have found that age is related to expert thinking and clinical judgment (Martin, 2002; Ruth-Sahd & Hendy, 2005), while others have found no relationship (Bowles, 2000). Similar discrepancies have been found related to the influence of prior healthcare work experience (Martin, 2002; Ruth-Sahd & Hendy, 2005; Shamian, 1991).

Students were randomly assigned to the two treatment groups. During a one-week period, sessions were scheduled at eight times on three different days. Participating students were assigned to a session according to their treatment group assignment, and their availability. Students in the experimental group participated in a simulation session lasting one hour, and then completed the posttest instruments. Students in the comparison group participated in an alternative, traditional learning session, also lasting one hour, and then completed the posttest instruments. Simulation and comparison sessions provided content on the same topic.

One potentially confounding variable was identified and addressed. Because the study intervention was administered to several student groups over a period of one week, there was a risk that changes would occur in the intervention over time. This risk, referred to by Krathwohl (1998) as instrument decay, was reduced by standardizing presentations to participants in both intervention and comparison conditions. A scripted approach was followed as closely and consistently as possible to ensure that student participants in the simulation condition received an equal orientation, introduction, scenario, and approach to debriefing. Similarly, scripts ensured that participants in the comparison condition received an equal introduction and application of the comparison condition. The researcher observed for fidelity of treatment implementation (Cook & Campbell, 1979) during each session, noting adherence to the script. The simulation followed a computer-programmed scenario, further enhancing fidelity and reducing the effects of instrument decay.

Sample

A convenience sample was recruited from a cohort of 78 junior-level prelicensure nursing students at a medium-sized private university in the San Francisco Bay Area. Permission was requested and received to recruit potential participants during week 9 of the fall semester. During a regularly scheduled class period, the researcher explained the study and invited participation. Students agreeing to participate in the study completed a written, informed consent (see Appendix A). Signed consents were received from 64 students; 58 students participated in the study and completed posttest instruments.

The participants in the final sample could be characterized as 20 years old (83%) and female (88%), with limited exposure to prior simulation experience and prior healthcare work experience. The gender distribution of students mirrored that of the nursing student population at the university (Registration statistics, 2006). In 2004, 39% of US nursing graduates were under 25 years of age and the average age of a baccalaureate nursing graduate was 26.2 (Steiger, Bausch, Johnson, & Peterson, 2007). Students participating in this study were slightly younger (M = 20.21, range 19-23) than the average baccalaureate nursing student graduate, but representative of the population. Half of the students had no prior experience with simulation, 26% had one prior experience, and 21% had two prior experiences with simulation. Most of the students (69%) had no prior healthcare work experience, 23% had up to one year of prior work experience, and five students (8%) had between 2 and 4 years of work experience in a healthcare setting.

The study site was chosen because of the researcher's access to the study population. Junior-level nursing students were chosen because they should possess sufficient domain-specific knowledge to learn from ill-defined, complex learning situations. Novice nurses function from a rules-based, closely prescribed perspective that does not require prior experience (Benner, 2004); the transition from novice to advanced beginner is an important aspect of nursing school as a senior nursing student typically functions very close to the level of a newly graduated nurse. This study sought to explore simulation as a method of helping nursing students learn to apply knowledge and use clinical judgment in order to help them more successfully transition from novice, to advanced beginner, to competent nurse. Thus, nursing students beyond the first year were selected as participants.

Protection of Human Subjects

An application was submitted to the University of San Francisco Institutional Review Board for the Protection of Human Subjects (IRBPHS), and approval received. Participants were informed that their participation in this research is voluntary and their involvement in any aspect of this research would not affect their course grade or standing. Individual participant scores on the dependent, intervening, and control variable measures would remain confidential; all research data would be kept in a secure location away from the University.

There were no anticipated risks to students participating in this study. Participants had attended clinical experiences, during which time they cared for patients in a hospital setting; they had also participated in skills training using manikins similar to those used in simulation. Because of these experiences, it was anticipated that participants would be comfortable in the simulation environment. An orientation to the simulator's capabilities and to the resources available in the simulation setting was provided at the start of each simulation session, preparing participants to function effectively in the simulation environment. Because some participants may have been concerned that their performance would reflect on their course grade, participants were reminded that their individual responses and performance during the simulation session remained confidential and would not affect their course standing. Students participating in this study followed their normal course curriculum during the study period. It was originally intended that student participation in this study would have no influence on student course grades, but after the recruitment presentation, the course instructor offered students extra credit points for participating.

Instrumentation

There were six dependent variables and five control variables in this study. The dependent variables were knowledge acquisition, near transfer, far transfer, active learning, collaboration, and engagement. The control variables were age, prior simulation experience, prior healthcare work experience, prior academic achievement, and prior academic ability.

Knowledge acquisition, near transfer, and far transfer were measured by means of a pretest and a researcher-developed posttest (Appendix B). A test blueprint was created to guide development of items using a two-way grid with a knowledge dimension and a cognitive process dimension (Anderson & Krathwohl, 2001). The knowledge dimensions used included conceptual, procedural, and metacognitive knowledge; the cognitive process dimensions used included the categories apply, analyze, evaluate, and create. Higher-order cognitive processes are believed to contribute to far transfer and to the development of clinical judgment (Anderson & Krathwohl, 2001; Mayer & Wittrock, 1996; Salomon & Perkins, 1989). Test items were further differentiated as either measuring content knowledge (knowledge acquisition), measuring application of content knowledge to new, but similar subject matter (near transfer), or measuring clinical judgment in applying content knowledge to new and novel situations (far transfer).

Pretest

The pretest included six items from the students' Nursing Therapeutics II course exam. The exam was a criterion-referenced content knowledge test administered during week 5 of the semester, covering concepts of endocrine disorders, perioperative patient care, burn injury management, and pulmonary dysfunction and disease. Items related to the topic of the intervention, respiratory distress related to asthma, were identified and provided a pretest measure of subject knowledge. The possible range in pretest scores was 0 to 6.

Posttest

The posttest included 12 knowledge acquisition, 15 near transfer, and 30 far transfer items. Knowledge acquisition items were four-choice selected-response items measuring content knowledge. Near transfer items were case-based selected-response items with four to seven response options for each item. Far transfer items included five case-based selected-response items identical in format to the near transfer items and 25 script concordance items. The possible range in scores for knowledge acquisition was 0 to 12, for near transfer 0 to 15, and for far transfer 0 to 18; higher scores reflect greater content knowledge, more near transfer, and more far transfer.

Knowledge acquisition items included the six items from the pretest, plus six additional items assessing participant's ability to recognize, understand, and apply their knowledge about the assessment and management of patients in respiratory distress or presenting with clinical indications of asthma. Each item was worth one point and items were scored on the basis of one best response.

Near transfer items were designed to reflect participant's ability to recognize underlying structural similarities in patient presentations. Three cases each portrayed a patient presenting with hypoxia due to an obstruction that disrupted oxygen delivery to a tissue, similar to the underlying problem present in asthma. Each case included five items designed to assess participant's ability to apply knowledge gained through study of asthma to similar clinical presentations involving subjects the students have studied. Near transfer items offered four to seven response options; items were again scored on the basis of one best response.

Far transfer items were of two types. The first question type was a case presentation following the format of the near transfer items. In this case, a labor patient presents with clinical indications of fetal hypoxia. Again, the underlying problem is that of clinical disruption in delivery of oxygen. This case reflects far transfer because the students had not yet studied pregnancy-related conditions.

The second far transfer question type assessed clinical judgment using a script concordance test. Script concordance items are designed to evaluate whether participants are able to access and apply stores of prior knowledge to enable clinical judgments in authentic situations (Charlin, Roy, Brailovsky, Goulet, & van der Vleuten, 2000). The script refers to the sets of knowledge that are used to understand a given situation. Scripts may differ somewhat, given the experience and understanding of the individual clinician, but should be similar among clinicians for situations with similar structural features.

Thus, a script concordance item evaluates whether an individual is able to transfer knowledge in order to make clinical decisions.

Two script concordance items each present a short descriptor of a patient presentation. Following the descriptor, the item presents the students with a series of potential problems, provides some additional clinical information for each potential problem, and then asks the student to decide whether each problem is more or less likely given the additional clinical information (see Appendix B, items 33 and 34). For each potential problem, five choices are available to the student: -2 (*ruled out or almost ruled out*), -1 (*less probable*), 0 (*neither less nor more probable*), +1 (*more probable*), or +2 (*certain or almost certain*). Each script concordance item requires the student to make 12 to 13 independent judgments. Scoring for the script concordance items reflects the degree of agreement between the participant and a panel of experts.

In order to score the script concordance items, a panel of expert nurses independently answered each of the items, the answers were tallied, and scoring assigned according to the number of experts that answered each item the same way. Charlin et al. (2000) recommend that 5-10 experts participate in developing the scoring in order to provide sufficient variability in responses. In this study, nine experts participated, resulting in a possible score of zero to .99 for each judgment, depending on the proportion of experts selecting each possible response. For an item that all experts agreed the diagnosis was less probable, a participant who also recorded a "less probable" answer would receive a score of .99; all other answers received a score of zero. For an item that four experts agreed the diagnosis was less probable and five experts agreed the item was neither less nor more probable, a participant recording a response of "less probable" would receive a score of .44, while a participant recording a response of “neither less nor more probable” would receive a score of .55, the maximum available for that judgment item. Each complete script concordance item was worth 6.71 to 6.38 points, depending on the respondent’s agreement with the panel of experts. In order to compute reliability for the far transfer measure, a panel of expert nurses reviewed the expert responses for the script concordance items and by consensus determined the one best answer for each judgment (Charlin et al., 2000).

Learning Practices Scale

Active learning, collaboration, and engagement were measured by means of a researcher-developed learning practices scale (Appendix C). The learning practices scale included 24 items designed to assess participants’ perceptions of the relevance of active learning, collaboration, and engagement in promoting effective learning. There were four possible responses for each item: 1 (*strongly disagree*), 2 (*disagree*), 3 (*agree*), or 4 (*strongly agree*). The active learning and engagement subscales each included nine items, with a possible range in scores of 9 to 36 each. The collaboration subscale included six items, with a possible range in scores of 6 to 24. Higher scores reflect a perception that the learning was enhanced through active learning and collaboration, and that the learning activity was engaging. In developing the scale, care was taken to avoid lengthy items, items that convey more than one idea, and use of ambiguous pronouns (DeVellis, 2003).

Participants provided data regarding age, prior experience with simulation, and prior healthcare work experience by answering three demographic items included on the posttest (Appendix B). Age was recorded to the nearest full year as written by each participant. Prior experience with simulation was recorded as 0 (*none*), 1 (*one prior experience*), 2 (*two prior experiences*), 3 (*three prior experiences*), or 4 (*four prior experiences*). Prior healthcare work experience was recorded as 0 (*none*), 1 (*up to 1 year*), 2 (*more than 1 and up to 2 years*), 3 (*more than 2 and up to 3 years*), or 4 (*more than 3 years*).

Data regarding prior academic achievement and prior academic ability were obtained with the assistance of the School of Nursing. The Nursing Therapeutics II course instructor provided pretest item data. Participants' SAT scores were retrieved from university records. SAT scores are reported as scale scores, with individual subscales ranging from 200 to 800 with a mean of 500 (College Board, 2007). SAT verbal and math scores were recorded and a total score computed. Only the verbal and math scores were collected because many of the student participants took the SAT prior to 2006, the first year for which data is available on the SAT writing test (Kobrin & Melican, 2007).

Treatment Description

The independent variable, learning method, included an experimental condition (simulation) and a comparison condition. The experimental condition consisted of a one-hour simulation session involving introduction to the simulator, interaction with the simulator in a clinical scenario, and a debriefing session. Participating students were presented with a case of a patient presenting with acute respiratory distress, and asked to proceed in providing care as if they were caring for the patient in the actual health-care setting. The simulation scenario was an NLN-validated scenario published by Laerdal Medical (see Appendix D). Students had access to physician's orders, simulated medications and other therapeutic supplies, and a resource nurse. If students responded to the patient and appropriately implemented interventions, the patient responded by improving. Delays or inappropriate treatments resulted in the patient condition deteriorating. Following a prescribed period, the simulation ended, and the participants and facilitator discussed the case and care issues in a debriefing session using scripted questions to guide the discussion (Appendix E). The posttest and learning practices scale were administered during a 30-minute period following the simulation session.

The comparison condition consisted of a one-hour traditional learning assignment on the same topic as the experimental group. The participating students read a written overview of the etiology, diagnosis, and management of asthma, and watched a 15-minute video on asthma. Following the video, the students read a case study and article, and then worked together on answering a set of discussion questions. The questions reflected the same issues as those discussed in the simulation debriefing session. The posttest and learning practices scale were administered during a 30-minute period following the one-hour traditional learning assignment.

Procedures

The study was conducted at a private, Northern California university. Following discussions with course professors, the Dean of the School of Nursing and the Chair of the Adult Health Department provided approval to conduct research pending approval of IRBPHS. Access to junior-level nursing students occurred through their Nursing Research course. The Nursing Research course professor agreed to allow the researcher to contact students at the beginning of a class period in order to explain the study and recruit participants.

Following recruitment, volunteer participants completed an informed consent after which the researcher randomly assigned participants to either an experimental or comparison condition. Random assignment was achieved using a computer randomization program. After random assignment to one of the two conditions, the participants were assigned to session times scheduled over the course of one week. Care was taken to assign participants to sessions in a manner that accommodated each student's availability and that resulted in simulation sessions with a minimum of 2 and a maximum of 5 participants. The researcher notified participants of the date and time of their assigned session by email. During their assigned study session, participants met at the School of Nursing simulation center. Participants who were assigned to the experimental condition were taken to the simulation room, and those assigned to the comparison condition were taken to a separate room.

Participants from the experimental condition completed a one-hour simulation session. Following an orientation to simulation and the simulator, participants were presented with a patient case history, and asked to provide appropriate nursing care beginning with assessment. The patient case presented in the simulation scenario was of a patient presenting with acute respiratory distress related to asthma. The simulation scenario was presented and coordinated by a nurse with content expertise serving as facilitator. During the simulation, the facilitator was available to the participants in the role of a resource nurse. Participants were encouraged to consider alternatives, determine appropriate courses of actions, and implement desired interventions within their scope of practice. Participants were able to access physician's orders, seek assistance from a resource nurse, use appropriate nursing reference materials, and confer with other students involved in the simulation. Following completion of the simulation scenario, the facilitator conducted a debriefing session designed to provide feedback, encourage reflective thinking, and guide students in exploring the processes involved in determining appropriate care for the patient case. Approximately one-third of the time was spent interacting with the simulator and two-thirds of the time was spent in the debriefing session.

Participants in the comparison condition completed a traditional assignment designed to take the same length of time as the simulation session. A research assistant welcomed the participants, explained the assignment, and remained in the room with the participants as they completed the assignment. The assignment focused on the same topic as that presented in the simulation – asthma and respiratory distress. The participating students were first asked to read a written overview of the etiology, diagnosis, and management of asthma, and were then shown a 15-minute video on asthma. Following the video, the students were provided a case study that matched the case presented in the simulation group and were asked to review a related article on respiratory distress; students were directed to use the materials and work together on answering a set of discussion questions related to the case study. Approximately one-third of the time was spent with the overview and video and two-thirds of the time was spent with the case study and discussion questions.

At the conclusion of the one-hour session, participants in each condition were asked to keep the topic and nature of each session confidential through the end of the study period. The knowledge posttest and learning practices scale were administered, after which the participants were thanked and dismissed. Each knowledge posttest and learning practices instrument was identified by a unique study identification number; after matching participant pretest and SAT data to the posttest and learning practices data, individual participant names were removed from all data. Posttest items were graded and item-level data for both the posttest and the learning practices scale were entered into a computer program for statistical analysis.

Data Analysis

Research questions one through four were answered using multivariate and univariate analysis of variance and analysis of covariance techniques with six dependent variables and two covariates. Data obtained to measure the six dependent variables included posttest scores reflecting knowledge acquisition, near transfer, and far transfer, and scale scores reflecting participant ratings of active learning, collaboration, and engagement. Data obtained to measure the control variables prior academic achievement and prior academic ability included pretest and SAT scores, and these data served as covariates. Data collected to measure the control variables age, prior simulation experience, and prior healthcare work experience were analyzed to ensure the groups were sufficiently alike, and then were removed from further analysis.

Multivariate analysis of variance techniques allow testing of the significant differences between independent variables on multiple dependent variables (Vogt, 1999). Including a covariate reduces within-groups error by adjusting for individual differences on a pre-existing measure (Shavelson, 1996). If a significant difference is found on the multivariate F test, a post-hoc multiple comparisons test is used to determine where the difference in groups lies. The Bonferroni method is recommended when the number of groups is small (Garson, n.d.). The null hypothesis tested was that there were no differences between the groups on the dependent variables knowledge acquisition, near transfer, far transfer, active learning, collaboration, or engagement.

Pilot Test

Following IRBPHS approval, the posttest instrument was piloted on a group of very similar nursing students attending a private college other than the university where the study was to be conducted. The students were in a course that includes objectives and content at the same level as that of students in the intended study sample. The Institutional Review Board at the college waived the need for full IRBPHS approval, and the Nursing Department Chair provided permission to conduct the pilot test of the instrument. Permission of the professor was obtained and the instrument administered. Following analysis of item difficulty and discrimination, revision occurred with the goal of achieving a level of difficulty that would provide maximum variance in scores (p value of .40 to .60), and a point biserial correlation coefficient that would provide adequate item discrimination (r_{pb} of .30 or above; Popham, 2000).

Initial reliability for the 20 pilot knowledge items was .34. Item analysis resulted in elimination of eight items on the basis of very high or low difficulty, a negative point biserial correlation, or item content. Three items with negative point biserial correlations were left in the posttest because they were also on the pretest measure. Reliability on the final posttest knowledge measure was .53. Near and far transfer items were analyzed in a similar fashion; analysis of the 12 pilot case-based near transfer items indicated the items were rather difficult as evidenced by low p values (M = .23, range .09 to .50) and low reliability (r = .23). Analysis of the 29 pilot far transfer items (4 case-based and 25 script concordance) revealed a reliability of .42 and p values ranging from .04 to .74 (M = .41).

After review of the pilot items, four additional case-based items were added and response options were refined for each item.

A group of nine highly experienced adult-health nurses provided the expert responses for the script concordance far transfer items. Reliability for the expert panel scores was .87; the expert responses formed the basis for scoring the script concordance items (Charlin et al., 2000). The entire posttest was reviewed for content validity by three content experts, all nurses with advanced practice expertise in cardiopulmonary nursing (see Appendix F).

Descriptive Statistics

A summary of the descriptive statistics obtained for each of the dependent variables is presented in Table 1. Scores on the knowledge acquisition measure indicated a moderate level of difficulty ($M = 8.19$, $SD = 1.48$, $p = .69$), with item means ranging from .29 to 1.0. Scores on the measures for near transfer ($M = 9.19$, $SD = 2.39$, $p = .61$) and far transfer ($M = 9.82$, $SD = 1.63$, $p = .40$) indicated the transfer items were more difficult than the knowledge acquisition items ($p = .22$ to .88 and .03 to .74, respectively). An estimation of Cronbach’s alpha for each of the three cognitive measures revealed a problem with reliability on the knowledge acquisition measure. The issue of reliability will be addressed in Chapter 4 in the section presenting additional analysis.

Table 1

Means, Standard Deviations, and Reliability of Six Dependent Variables and Two Control Variables Used as Covariates

Variable	N Items	Range	*M*	*SD*	α
Knowledge Acquisition	12	4-12	8.19	1.48	.02
Posttest Items [a]	6	2-6	4.43	1.11	.21
Near Transfer	15	3-14	9.19	2.39	.49
Far Transfer	30	5.6-13.6	9.82	1.63	.45
Active Learning	9	18-34	26.02	2.84	.47
Collaboration	9	15-35	26.33	4.94	.86
Engagement	6	10-24	18.26	3.68	.87
Pretest [b]	6	1-6	4.66	.91	-.13
SAT		830-1390	1114.56	121.81	

Note: [a] Items 1-6 on the Knowledge Acquisition instrument are the same items measured on the Pretest; [b] Pretest items from the Nursing Therapeutics exam, a criterion referenced test.

The items that provided a pretest measure of achievement were included on the posttest as a subset of the items that measured knowledge acquisition. The mean scores for these six knowledge acquisition items decreased slightly but non-significantly from pretest ($M = 4.66$, $SD = .91$) to posttest ($M = 4.43$, $SD = 1.11$). Mean p values indicated that students did quite well on these items at both pretest ($p = .78$) and posttest measures ($p = .74$).

Correlations among the six dependent variables and two cognitive control variables are shown in Table 2. Consistent with findings that cognitive measures correlate with one another (Jensen, 1998), data analysis revealed small positive relationships between pretest and knowledge acquisition ($r = .28$, $p < .05$), and pretest and near transfer ($r = .10$). Small to moderate positive relationships were noted between SAT and knowledge acquisition ($r = .15$), SAT and near transfer ($r = .42$, $p < .01$), and SAT and far transfer (*r* = .29, *p* < .05). Among the dependent variables, a small positive relationship was noted between knowledge acquisition and near transfer (*p* = .20). No relationship was observed between far transfer scores and scores for either knowledge acquisition or near transfer, nor was a relationship observed between far transfer and pretest scores.

Table 2

Correlations Among Six Dependent Variables and Two Control Variables Used as Covariates

Variable	KA	NT	FT	AL	C	E	PT	SAT
Knowledge Acquisition	1.00							
Near Transfer	.20	1.00						
Far Transfer	-.08	-.01	1.00					
Active Learning	-.02	.16	.07	1.00				
Collaboration	-.05	-.13	.07	.55**	1.00			
Engagement	.22	.07	-.09	.31*	.37**	1.00		
Pretest	.28*	.10	-.07	-.07	-.15	-.04	1.00	
SAT	.15	.42**	.29*	.06	-.21	-.01	.13	1.00

Note: KA = Knowledge Acquisition; NT = Near Transfer; FT = Far Transfer; AL = Active Learning; C = Collaboration; E = Engagement; PT = Pretest; * *p* < 0.05; ** *p* < 0.01

Moderate to large positive relationships were observed among the three affective dependent variables, active learning and collaboration (*r* = .55, *p* < .01), active learning and engagement, (*r* = .31, *p* < .05), and collaboration and engagement (*r* = .31, *p* < .05). Small positive relationships were observed between near transfer and active learning, and between knowledge acquisition and engagement. Small negative relationships were noted between collaboration and both pretest and SAT scores.

CHAPTER FOUR

Results

This study used an experimental design to compare simulation with traditional methods of learning in promoting acquisition and transfer of learning, and development of clinical judgment, among prelicensure nursing students. In this chapter, the results of the study are presented in two sections. First, data resulting from the full measures are presented to address the four research questions. Second, because of problems with internal consistency reliability of the research instruments, data resulting from analysis of adjusted measures and individual items are presented.

Analysis Related to the Research Questions

A combination of multivariate and univariate techniques was used to explore the effect of simulation on cognitive and affective outcomes. The independent variable, learning method, included two levels, simulation and comparison. There were six dependent variables, knowledge acquisition, near transfer, far transfer, active learning, collaboration, and engagement. Scores from the measures for the two cognitive control variables were used as covariates. Pretest scores provided a measure of prior academic achievement and SAT scores provided a measure of prior academic ability. Data analysis was conducted using multivariate analysis of variance and analysis of covariance techniques for three reasons (Weinfurt, 1995). First, an analysis of covariance reduces within-groups error by adjusting for any individual differences on the control variables pretest and SAT. Analysis of covariance, invented by Fisher in order to control for known biases, is particularly useful in experimental designs (Armitage, 2003). Second, a multivariate analysis reduces the chance of a Type I error that might occur if multiple univariate tests were run for each dependent variable. Third, a multivariate analysis adjusts for potential redundancy found among multiple correlated dependent variables.

Assumptions

A preliminary analysis was conducted to evaluate assumptions underlying the multivariate and univariate tests such as the MANOVA and ANOVA. First, the assumption of independence of observations was assessed. Data on the control variables prior academic achievement (pretest) and prior academic ability (SAT) were collected prior to and independent of the study and therefore independence could not be assessed. Data on the dependent variables were collected through an individually completed posttest administered after each participant completed the learning session. Participants were observed throughout the data collection and did not discuss the items or their responses to the items, thus it appears that the assumption of independence was not violated.

Second, normality was assessed for all variables. Histograms and boxplots for each of the dependent and control variables were inspected to evaluate univariate normality. Histograms demonstrated approximate normal distribution for each variable except engagement, which exhibited a slight negative skew. Skewness and kurtosis measures were computed for each dependent variable, and then divided by the corresponding standard error. The resulting values ranged from 1.60 to -1.22 with a mean of -.10, results falling within the generally accepted range of +2 to -2 for satisfying the assumption of normality (Garson, n.d.). Box's test of equality of covariance matrices provided a measure of multivariate normality. Box's M yielded non-significant results suggesting the assumption of normality was reasonably met (F = 1.267, p = .19).

Third, the homogeneity of variances was assessed. In addition to assessing multivariate normality, Box's M (as previously noted) provided evidence that the dependent variable data satisfied the homogeneity of covariance matrices assumption. Levene's test of equality of error variances was a second test used to evaluate whether the variances and covariances for the dependent variables were similar across the groups. The results of Levene's test were non-significant for each of the dependent variables, providing further evidence that the assumption of homogeneity of covariance had not been violated.

Two additional assumptions were assessed in relation to using covariates. First, the homogeneity of slopes assumption for the ANCOVA was tested by evaluating the interaction of learning method with both pretest ($F = .782$, $p = .59$) and with SAT ($F = .364$, $p = .90$). Results for both interactions were non-significant; thus the homogeneity of slopes assumption was met. Second, the relationships between the control variables and the dependent variables were evaluated. A significant, linear relationship was found only between pretest and knowledge acquisition ($r = .28$, $p < .03$), between SAT and near transfer ($r = .42$, $p < .00$), and between SAT and far transfer ($r = .29$, $p < .03$).

Because significant, linear relationships were found only for specific subsets of control and dependent variables, analysis related to the research questions was accomplished using three approaches, one for each subset of related scores. First, an ANCOVA was computed to explore the effects of simulation compared with traditional methods of learning on knowledge acquisition, with pretest scores serving as a covariate. Second, a MANCOVA was computed to explore the effects of simulation compared with traditional methods of learning on scores for near transfer and far transfer, with SAT scores serving as covariate. Third, a MANOVA was computed to explore the influence of learning method on active learning, engagement, and collaboration.

Findings

A comparison of the means and standard deviations for each of the dependent measures by learning method (Table 3) shows that participants in the simulation group scored higher on average than participants in the comparison group on five of the six dependent variables. Overall, participant scores for the three affective variables revealed a preference for learning methods that featured active learning (*M* = 26.02, *SD* = 2.84) and collaboration (*M* = 26.33, *SD* = 4.94), and indicated that the learning activities were engaging (*M* =18.26, *SD* = 3.68).

Table 3

Means and Standard Deviations of Six Dependent Variables by Learning Method

Variable	N Items	*M*	*SD*
Knowledge Acquisition	12		
Simulation		8.27	1.51
Comparison		8.11	1.47
Near Transfer	15		
Simulation		9.80	1.90
Comparison		8.54	2.72
Far Transfer	30		
Simulation		9.71	1.40
Comparison		9.93	1.87
Active Learning	9		
Simulation		27.00	2.55
Comparison		24.96	2.81
Collaboration	9		
Simulation		26.97	5.40
Comparison		25.64	4.37
Engagement	6		
Simulation		20.80	2.31
Comparison		15.54	2.82

Research questions one through three. The first three research questions addressed the effect of simulation on knowledge acquisition, near transfer, and far transfer. Because a significant, linear relationship among the dependent and control variables was found only for knowledge acquisition and pretest, for near transfer and SAT, and for far transfer and SAT, both an ANCOVA and a MANCOVA were used to explore the differences between the groups on the cognitive dependent variables. Results of these analyses indicated no significant between-group differences for any of the cognitive dependent variables of knowledge acquisition, near transfer, and far transfer. A summary of findings for each of the dependent variables is presented in Table 4.

Table 4

Summary of Findings for Six Dependent Variables

Test / Variable	*F*	*p*
ANCOVA [a]		
Knowledge Acquisition	.42	.52
MANCOVA [b]		
Near Transfer	3.17	.08
Far Transfer	.69	.41
MANOVA		
Active Learning	8.41	.00**
Collaboration	1.04	.31
Engagement	60.79	.00**

Note: [a] Pretest as covariate; [b] SAT as covariate; ** $p < 0.01$

Including pretest as a covariate had no effect on the posttest measure of knowledge acquisition ($M = 8.19$, $SD = 1.48$, F [1, 55] = .42, $p = .52$). A MANCOVA was non-significant ($T^2 = .058$, F [2, 54] = 1.560, $p = .22$) for differences in near transfer and far transfer after accounting for group differences on the SAT. An initial independent samples *t*-test had demonstrated a significant ($p = .04$) difference in the group scores for near transfer in favor of the simulation group. But after taking into account group differences on the SAT, the difference in scores became non-significant (*F* [1, 55] = 3.17, $p = .08$). Adjusted mean scores (Table 5) for both knowledge acquisition and near transfer favored the simulation group, but not at a statistically significant level. The difference in mean scores for far transfer favored the comparison group.

Table 5

Adjusted Means of Six Dependent Variables After Controlling for Pretest and SAT on the Cognitive Measures

Variable	Adjusted *M*	*SD*
Knowledge Acquisition [a]		
Simulation	8.27	1.51
Comparison	8.11	1.47
Near Transfer [b]		
Simulation	9.80	1.90
Comparison	8.54	2.71
Far Transfer [b]		
Simulation	9.71	1.40
Comparison	9.93	1.87
Active Learning		
Simulation	27.00	2.55
Comparison	24.96	2.81
Collaboration		
Simulation	26.97	5.40
Comparison	25.64	4.37
Engagement		
Simulation	20.80	2.31
Comparison	15.54	2.82

Note: [a] Pretest as covariate; [b] SAT as covariate

Research question four. The fourth research question considered whether simulation was effective in promoting learning practices of active learning, collaboration and engagement. A MANOVA was significant ($T^2 = 1.499$, F [3, 54] = 26.98, $p < .00$) for differences between the groups on the three affective dependent variables. Inspection of the group-level data revealed significantly higher scores for the simulation group than for the comparison group for two of the three affective variables, active learning (F [1, 56] = 8.42, $p < .00$) and engagement (F [1, 56] = 60.79, $p < .00$). Mean scores for collaboration were also higher in the simulation group, but not statistically significant (F [1, 56] = 1.04, $p < .31$).

Analysis Related to Adjusted Measures

Because reliability was poor for the three cognitive dependent variables ($\alpha = .02$ for knowledge acquisition, .49 for near transfer, and .45 for far transfer) and for one of the affective variables ($\alpha = .47$ for active learning), additional analyses were initiated to explore possible problem areas impacting reliability of the instruments. Although the pretest questions were taken from a criterion-referenced test, the instruments for the study were not designed as criterion-referenced, thus the factors impacting instrument reliability were investigated. Instruments with a low alpha coefficient may have items with little in common or items that are either too difficult or too easy. Cronbach's alpha provides a measure of the extent of internal consistency based on the average correlation among items (Nunnally & Bernstein, 1994), therefore investigation focused first on item correlations.

Item correlations for each of the three cognitive measures varied widely, with many low or negative values. Correlations ranged from -.31 to .59 for knowledge acquisition, -.41 to .43 for near transfer, and -.31 to .62 for far transfer, with many values close or equal to zero. Three factors were considered that could contribute to low item correlation: random participant response, item difficulty, and item domain. Items were inspected to see if a pattern emerged that suggested participants guessed or answered in a random manner. If this were the case, p values would be expected to average .25 for four-choice selected-response items. For each instrument, *p* values were high enough to rule out a random response pattern. Item *p* values also provided a measure of difficulty. Items in both the knowledge acquisition and near transfer instrument fell within a moderate to easy range of difficulty (*p* values .29 to 1.0, $M = .69$, and .22 to .88, $M = .62$ respectively). Items on the far transfer instrument were somewhat more difficult (*p* values .03 to .74, $M = .40$).

If participants guessed or responded randomly to questions, test scores would be expected to average 25% correct. This scoring pattern was not observed. For the knowledge acquisition measure, scores averaged 68% and ranged from 25 to 100% correct; only one student received a score of less than 50%. Scores on the near and far transfer measures averaged 61 and 54% correct respectively. Scores on the near transfer measure ranged from 20 to 87% correct and on the far transfer measure scores ranged from 31 to 75% correct. Most students (> 90%) answered at least 40% of the near and far transfer questions correctly.

A review of the knowledge acquisition items suggested that although the items all related to the same general domain, they were technically complex, leading to clusters of items that correlated highly with one another, but quite low with other items. The relatively low number of items in the measure and the multidimensional nature of the items may have contributed to low overall item correlation. A review of the items in both the near transfer and far transfer instruments reflected similar complexity. The item correlation problem suggested two additional exploratory analyses: first, a scale item analysis and adjustment of the measures, and second, an individual item analysis.

Scale Item Analysis

Because the items were not uniformly correlated within each instrument, a scale item analysis was performed using statistical software. Items with negative or low (r_{pb} < .10) corrected-item total correlations were eliminated. Three adjusted measures were created for the dependent variables; the knowledge acquisition measure included two items, the near transfer measure included nine items, and the far transfer measure included 15 items (combined $r = .70$). The active learning subscale measure was similarly adjusted. Means, standard deviations, and reliabilities for each of the adjusted measures are displayed in Table 6.

Table 6

Means, Standard Deviations, and Reliability of Three Cognitive Dependent Variables and One Affective Variable After Adjusting the Measures

Variable	N Items	*M*	*SD*	α
Knowledge Acquisition	2	1.72	.62	.74
Near Transfer	9	6.07	2.02	.63
Far Transfer	15	5.57	1.02	.65
Active Learning	4	13.22	1.86	.63

Procedures to ensure that univariate and multivariate assumptions were not violated were once again followed as previously described, and found to be reasonably met. A significant linear relationship was found only between SAT and near transfer (see Table 7), therefore two tests were run. An ANCOVA compared group performance on near transfer after accounting for group scores on the control variable SAT, and a MANOVA compared group performance on knowledge acquisition, far transfer, active learning, collaboration, and engagement.

Table 7

Correlations Among Six Dependent Variables and Two Control Variables After Adjusting the Measures

Variable	KA	NT	FT	AL	C	E	PT	SAT
Knowledge Acquisition [a]	1.00							
Near Transfer	.06	1.00						
Far Transfer	-.06	.15	1.00					
Active Learning	-.16	-.02	-.08	1.00				
Collaboration	-.09	-.11	-.11	.70**	1.00			
Engagement	.02	.14	-.11	.32*	.37**	1.00		
Pretest	-.11	.15	.10	.05	-.15	-.04	1.00	
SAT	-.01	.41**	.10	-.07	-.21	-.01	.13	1.00

Note: KA = Knowledge Acquisition; NT = Near Transfer; FT = Far Transfer; AL = Active Learning; C = Collaboration; E = Engagement; PT = Pretest; * $p < 0.05$; ** $p < 0.01$

Results of the analysis differed from the initial analysis primarily in two areas (see Table 8 for a summary). First, on the cognitive measures, the two groups differed significantly in near transfer with the simulation group achieving higher average scores (F [1, 55] = 7.06, p = .01). The between group differences remained non-significant for the other two cognitive dependent variables, but scores for the knowledge measure favored the comparison group and scores for the far transfer measure favored the simulation group. In the original analysis, this ordering of scores was reversed. Second, on the affective measures, adjusting the active learning subscale resulted in a slight diminishing of the difference between the groups for active learning, although the simulation group still scored significantly higher on the measure (p < .05).

Individual Item Analysis

A second analysis related to the item correlation problem investigated item-level differences by running significance tests comparing both treatment groups on each item.

One problem with running multiple significance tests is that the *p* values are no longer correct due to item correlations and the number of statistical tests. But since the items on the cognitive measures were not correlated, univariate tests were run to provide item-level information about group differences. Because of the number of statistical tests run, the *p* values reported for the individual items shown in Table 9 may be inflated.

Table 8

Summary of Findings for Six Dependent Variables After Adjusting the Measures

Test / Variable	*F*	*p*
MANOVA		
Knowledge Acquisition	.54	.47
MANCOVA [a]		
Near Transfer	7.06	.01*
Far Transfer	.13	.72
MANOVA		
Active Learning	4.99	.03*
Collaboration	1.04	.31
Engagement	60.78	.00**

Note: [a] SAT as covariate; * $p < 0.05$; ** $p < 0.01$

An ANCOVA with pretest as covariate was run for each item in the knowledge acquisition measure, and with SAT as covariate for each item in the near transfer and far transfer measures. When running tests at the .05 level of significance one would expect 5 out of 100 tests to be statistically significant even when there were no differences between the two groups in the population. Out of 57 cognitive items, significant differences were found for eight items: two knowledge acquisition items ($p < .05$), two near transfer items ($p < .01$), two far transfer selected-response items ($p < .01$), and two far transfer script concordance items ($p < .05$). For each of the knowledge acquisition and near transfer items, scores were higher for the simulation group. For the far transfer items, scores were higher for the comparison group on the two selected-response items and higher for the simulation group on the two script concordance items. Table 9 provides summary data for these items.

Table 9

Adjusted Means and ANCOVA Summary for Significantly Different Items from the Three Cognitive Dependent Variables

Measure	Sim		Comp			
Item	*M*	*SD*	*M*	*SD*	*F*	*p*
Knowledge Acquisition [a]						
Item 8	.84	.38	.57	.50	5.036	.03*
Item 11	.87	.35	.64	.49	4.462	.04*
Near Transfer [b]						
Item 21	.73	.45	.33	.48	10.456	.00**
Item 31	.78	.41	.48	.51	6.547	.01*
Far Transfer [b] (Selected-Response)						
Item 23	.00	.00	.22	.42	7.743	.00**
Item 27	.11	.34	.45	.50	10.107	.00**
Far Transfer [b] (Script Concordance)						
Item 34 Asthma She reports ...	.43	.50	.15	.36	5.790	.02*
Item 34 Asthma She uses ...	.42	.50	.12	.32	7.432	.00**

Note: Sim = Simulation, Comp = Comparison, [a] Pretest as covariate; [b] SAT as covariate; * $p < .05$; ** $p < .01$

An inspection of the items with significant differences between the groups provided no consistent pattern for interpretation. The two knowledge items focused on assessment of hypoxia in acute asthma, and both near transfer items assessed recognition of underlying hypoxia in a situation involving restriction of blood flow to cardiac muscle. The two selected-response far transfer items were related to recognition and treatment of a restriction in blood flow from placenta to fetus. The two script-concordance items focused on considering asthma as a potential diagnosis for a scenario involving a woman with dyspnea. With the exception of the far transfer items related to pregnancy, each of the item topics was addressed in the simulation scenario (students interacted with the simulator to assess hypoxia) or during the debriefing following the simulation scenario (student discussion of other possible considerations for clinical manifestations of hypoxia).

Summary

A review of the data analysis revealed four findings. First, no statistically significant differences were observed between the groups on any of the original cognitive measures. Second, the simulation group scores were significantly higher for two of the three affective measures, active learning and engagement. Third, scores on the cognitive variable measures were found to have poor internal reliability. Fourth, after adjusting the measures to address reliability, the simulation group scores for near transfer were significantly higher than those of the comparison group ($p < .05$).

CHAPTER FIVE

Summary, Findings, Limitations, Discussion, and Implications

The purpose of this study was to investigate the effectiveness of a simulation intervention on knowledge acquisition, near and far transfer of learning, and to investigate the role of simulation in supporting effective learning practices that might lead to improved knowledge and transfer. This chapter presents a summary and conclusion to the study in five parts. First, the study is summarized, providing an overview of the problem, purpose, theoretical rationale, research questions, and methods. The second and third sections present findings and limitations of the study. A discussion of the findings in light of the limitations is presented in the fourth section. The fifth section discusses implications for research and practice.

Summary of Study

Student nurses begin developing the theoretical basis for competent practice during their prelicensure educational programs. Over time, and with experience gained on the job, student nurses will transition from novice to competent nurses (Benner, 1984). And yet, the reality of the healthcare environment is such that new nurses do not have the luxury of time to gain needed skills of clinical judgment. From their first weeks on the job, these new nurses are expected to competently and quickly solve problems for which they have had no practical experience. Nursing education must find a way to better prepare student nurses for the realities of clinical practice that await them upon graduation.

Traditional approaches to clinical education have focused on allowing nursing students to practice providing patient care in actual healthcare settings. In these settings, student nurses work with patients under the guidance of each patient's nurse or with a clinical instructor to learn how to recognize and address problems. Real clinical practice with real patients makes sense, however, when a patient care situation turns critical, the student nurse is typically limited to observing or is excluded altogether. Limited access to patients for reasons such as these, or simply due to the types of patients available on a given day, reduces the range of exposure student nurses have to the experiences that will require them to independently assess, communicate, and make critical patient care decisions.

Simulated clinical experience has been suggested as a means of helping student nurses develop clinical judgment skills by applying their knowledge in situations not readily available in the real clinical setting (Feingold et al., 2004; Nehring et al., 2001; Rhodes & Curran, 2005; Weller, 2004). Simulated clinical experience involves immersion of the student in a representative patient-care scenario, created in a setting that mimics the actual environment with sufficient realism to allow the learner to suspend disbelief (Halamek et al., 2000). This study focused on simulation using human patient simulators that allow students to assess, interpret, and initiate a course of action based upon their findings (Seropian, Brown, Gavilanes, & Driggers, 2004).

The objective in using simulation is to improve the application and integration of knowledge and skills, and to foster the development of clinical judgment among student nurses. Of particular importance is the need for nurses to be able to transfer knowledge gained in one setting to a problem presented in a new or novel setting. Simulation seems well suited to this purpose, but research is unclear on the efficacy of simulation in supporting the transfer of learning and development of clinical judgment for several reasons. First, much of the simulation research has focused on affective aspects of simulation (e.g., Bearnson & Wiker, 2005; Lasater, 2007, Schoening et al., 2006). Student perceptions of increased self-confidence, clinical reasoning abilities, and self-efficacy all speak to the motivational aspects of learning through simulation, but perceptions do not provide evidence regarding knowledge acquisition and transfer of knowledge. Second, another body of the simulation research has focused primarily on skill performance (e.g., Alinier et al., 2006; Morgan et al., 2006; Radhakrishnan et al., 2007; Wayne et al., 2005). Many studies have found gains in skill performance following practice with a simulator; however these studies do not address transfer of knowledge or skill to novel situations. Finally, of the simulation research addressing cognitive measures of learning, only one study evaluated the impact of simulation on cognitive learning among prelicensure nursing students (Alinier et al., 2006). Because Alinier et al. included both skills and cognitive items in their outcome measure, the study left unanswered the question of whether gains were found in relation to skills, cognitive measures, or both. None of the studies reviewed specifically addressed transfer of learning.

Purpose of the Study

The purpose of this study was to investigate the effectiveness of a simulation intervention on knowledge acquisition and transfer of learning. Transfer of learning was differentiated as near transfer, applying knowledge in a new, but similar situation, and far transfer, applying knowledge in a new and novel situation requiring clinical judgment. The study also investigated the role of simulation in facilitating effective learning practices, including active learning, collaboration, and engagement, and the relationship between these practices and measures of knowledge.

Significance of the Study

This study is important for three reasons. First, it responded to a need for research evaluating the effectiveness of simulation in promoting knowledge acquisition and transfer. Second, it addressed the need for research on the use of simulation in nursing education. And third, it sought to improve on methodological weaknesses found in much of the simulation research by using a rigorous, experimental design.

Theoretical Rationale

This study was grounded in the literature on situated cognition that suggests learning cannot be separated from context – that learning is a result of interactions between individuals and everyday situations (Brown et al., 1989; Greeno et al., 1993). Nursing has traditionally embraced a framework of using the everyday clinical environment to help nursing students develop their knowledge and skills. Nursing educators are increasingly challenged to optimize the exposures students have to clinical situations and improve the ability to provide authentic situations for student learning (Taylor & Care, 1999). Simulation offers a unique method of helping students to learn by providing controlled, deliberate practice, in an authentic context, in keeping with the principles of situated learning.

Research Questions

This study addressed the following questions:

1. What is the effect of simulation on knowledge acquisition among prelicensure nursing students?
2. To what extent does simulation promote near transfer among prelicensure nursing students?

3. To what extent does simulation promote far transfer among prelicensure nursing students?

4. To what extent are the learning practices active learning, collaboration, and engagement promoted by simulation?

Method

The study used a two-group, pretest-posttest experimental design with one independent variable, learning method (two levels, simulation and comparison), and six dependent variables, knowledge acquisition, near transfer, far transfer, active learning, collaboration, and engagement. Participating prelicensure nursing students (N = 58) were randomly assigned to one of the two learning methods. Students in the simulation group (n = 30) were provided with a one-hour learning session that included a scenario-based simulation followed by a facilitated discussion. Students in the comparison group (n = 28) were provided with a one-hour learning session using traditional methods of instruction including written material, a video presentation, and group discussion. Following the learning session, all students completed posttest instruments providing data for measurement of the dependent variables.

Following data collection and scoring, all data were entered into a statistical software program, descriptive statistics were obtained, and group scores were analyzed to determine if student outcomes differed by learning method. Univariate and multivariate analysis of variance procedures, controlling for prior academic achievement and prior academic ability where appropriate, were used to evaluate performance and differences between the groups.

Findings

Data analysis revealed four findings. First, there were no differences between the groups for any of the three cognitive dependent variables. An initial independent samples *t*-test revealed a significant ($p = .04$) difference in the mean group scores for near transfer in favor of the simulation group, but after accounting for group differences on SAT using a MANCOVA, the difference became non-significant ($p = .08$). Second, there was a significant difference ($p < .01$) between the groups for two of the three affective dependent variables, active learning and engagement, with higher mean scores noted for the simulation group. Third, scores for four of the dependent variables measures were found to have poor internal reliability ($\alpha = .02$ to $.49$). Fourth, after adjusting the measures for knowledge acquisition, near transfer, far transfer, and active learning to improve reliability, and once again accounting for group differences on SAT using a MANCOVA, the mean group scores for near transfer were noted to be significantly higher ($p < .05$) for the simulation group than for the comparison group.

Limitations

Several limitations were identified. First, due to time and practical constraints, the study treatment was provided only one time per student and for only one hour. Students participating in the study were doing so outside of their normal course requirements and schedule. In addition, the study sessions required use of a simulation lab, which created challenges in scheduling the space at times available to the students. Because of these constraints, the overall time commitment, including study treatment and completion of the research instruments, was limited to 1.5 hours per student. Just as repeated, deliberate practice is necessary for development of expertise (Ericsson, 2004), repeated exposure and practice is likely necessary for development of higher-order thinking skills.

Second, far transfer and clinical judgment are difficult concepts to measure; it is unknown the extent to which the measures used in this study reflected far transfer. Bransford and Schwartz (1999) note that although prevailing methods for measuring transfer are effective when studying expertise, they may be ineffective when studying the progress in learning that leads to eventual expertise. Similarly, measuring far transfer using a method such as the script concordance method to evaluate a student's ability to apply prior knowledge to a situation requiring clinical judgment may work well for comparing a novice to an expert learner, but work less well when determining differences between the thinking of two groups of novice learners.

Third, the reliability of the measures limits the ability to interpret the findings. The measures were designed to assess subject knowledge and application of subject knowledge to new and novel situations. Students demonstrated a high level of achievement on the knowledge application items, a factor that influences internal consistency reliability. Near and far transfer items were substantially more difficult and much more open to interpretation, factors that again influence reliability.

Finally, because this was a convenience sample, it is unknown whether the findings generalize to other nursing student populations. Efforts were made to ensure the sample was representative of the broader nursing student population. Students participating in the study were students attending a private, four-year university with a nursing curriculum similar to other four-year universities. It is possible that students in a two-year program or attending a four-year university with a different curriculum would respond differently. Even cohorts of students within the same university are exposed to varying perspectives and experiences that would influence their responses. These limitations are discussed in relation to the results of the study in the next section.

Discussion

This study was designed to address the gap in the literature related to the effects of simulation on knowledge acquisition and transfer. The study also considered whether simulation promotes knowledge acquisition and transfer by stimulating effective learning practices such as active learning, collaboration, and engagement. In the sections to follow, study findings are discussed in light of the limitations. Findings related to the cognitive dependent variables are discussed first, followed by those related to the affective dependent variables. Discussion concludes with a review of the findings related to reliability of the data.

Knowledge Acquisition, Near Transfer, and Far Transfer

The finding of no clear difference between the groups for any of the three cognitive dependent variables is not surprising for two primary reasons. First, the lack of a difference between the groups suggests that simulation is at least as effective as traditional methods of learning. Much of the simulation research has explored the influence of simulation on affective or psychomotor aspects of learning, but not much research has explored cognitive outcomes. Although simulation has been proposed as a learning method well suited for promoting higher-order skills of application and synthesis (Binstadt, 2007; Lammers, 2007), little is known about the role of simulation in promoting knowledge acquisition or transfer. Second, the historical difficulty of measuring transfer is well documented (Detterman, 1993). In a discussion on measurement of transfer, Bransford and Schwartz (1999) note “methods of measuring transfer work well for studying full-blown expertise, but they represent too blunt an instrument for studying the smaller changes in learning that lead to the development of expertise" (p. 66). This study measured far transfer by asking students to respond to patient care situations requiring the use of clinical judgment, a concept that has also proven difficult to measure (Tanner, 2006). A discussion of these issues follows.

Content knowledge includes knowledge related to facts, concepts, procedures, or metacognition that is important to the understanding of a specific discipline (Anderson & Krathwohl, 2001). Nursing students must remember, understand, and make use of what they have learned in order to pass the nursing licensure exam and, more importantly, to provide safe nursing care. Making use of knowledge includes both a cognitive and a behavioral component. Simulation has been shown to be an effective means of learning and demonstrating behavioral knowledge as measured through observation of performance checklists. Research in medicine has demonstrated the effectiveness of simulation compared with other learning methods in helping medical students improve their skills in performing ACLS procedures (Wayne et al., 2005), manage critical events in anesthesia (Morgan et al., 2002), and manage the care of patients who are experiencing respiratory distress (Steadman et al., 2006). Similar findings have been noted in the nursing literature; of note is a study comparing two groups of nursing students on their performance of 11 skills and 4 theoretical measures (Alinier et al., 2006). Students in the simulation group performed significantly better than students in the control group.

Two studies reviewed for this study included cognitive measures, but either found no differences on the knowledge measure (Morgan et al., 2002) or provided no separate analysis of the cognitive and behavioral components of the outcome measure (Alinier et al., 2006). A third study (Euliano, 2001) included a measure of cognitive knowledge administered before and after a simulation session designed to provide medical students with an understanding of select principles of cardiovascular physiology. Mean scores increased from pretest to posttest, but the difference was not statistically significant.

Because of the lack of evidence supporting knowledge acquisition on cognitive measures, the current study included a measure of knowledge acquisition, evaluating gains from pretest to posttest, as well as differences in knowledge acquisition between the groups. Similar to the findings demonstrated by Morgan et al. (2002) and Euliano (2001), no significant difference was noted between the simulation and comparison groups, although the mean score for knowledge acquisition was higher in the simulation group. This study differed from the previously cited findings in that mean scores from pretest to posttest decreased slightly. This finding might be explained as a function of the poor reliability of the knowledge acquisition measure; reliability will be discussed in a later section.

The short duration of the learning session presented in this study may also have limited the findings related to knowledge acquisition and transfer of learning. One of the benefits of simulation is that of providing deliberate, repetitive practice related to the area of study (Kneebone, 2005). Expertise and competence are acquired as a result of time, practice, and exposure to contextual variations (Ericsson, 2004). Demonstrating gains from pretest to posttest on a measure of behavioral knowledge may be quite simple, even if the intervention is of short duration, if the knowledge measured is procedural and has been practiced in the learning intervention. Further improvements would be noted with repetitive practice as the participants gain skill over time. Gains on a measure of cognitive knowledge may also be readily achieved if the measure primarily requires the participant to remember, understand, or apply principles specifically taught during the intervention. In order to demonstrate gains with a measure of cognitive knowledge that requires participants to analyze, evaluate, or judge in situations of uncertainty, participants must be exposed to variations of a situation over time with evaluation and feedback related to the results of their decisions (Rhodes & Curran, 2005). Despite the limitation of time, participating students in this study performed similarly between the two learning methods, providing evidence that simulation was as effective as traditional methods of learning in aiding students in knowledge acquisition and transfer of learning.

The value in simulation seems to be in supporting learning at the higher levels of cognitive processing that foster problem-solving skills (Lammers, 2007). For imparting factual or conceptual information, Lammers notes that simulation is less efficient than traditional methods of learning that provide information in a concentrated manner. In addition, novice learners approach learning from a rule-based perspective and can become confused when presented with too much variance or uncertainty (Benner, 1984). As novice learners become advanced beginners, they begin to benefit from exposure to experiences that provide opportunities to learn in increasingly varied situations and settings. Building on a base of foundational knowledge, varied practice helps the learner begin to see structural similarities in problems, and over time the learner begins to become more adept at using prior knowledge to solve new and unique problems.

The shift in optimal approaches to learning as a student nurse progresses from novice to advanced beginner suggests an interaction between the level of learner knowledge and the learning method, similar to Cronbach and Snow's (1977) concept of aptitude-treatment interaction. It may be that for simulation to have an effect on knowledge or transfer, the learner must possess sufficient prior knowledge to begin to differentiate between surface and structural similarities presented in a scenario. If true, then the expertise level of the learner must be considered when selecting the appropriate learning method.

Simulation offers opportunities to present varied learning situations that have structural similarity, provides the learners with an opportunity to reflect on the experience, and encourages self-evaluation of performance. Varied practice, self-evaluation, reflection, review of prior knowledge, and active learning are all features of simulation; all also promote transfer (Salomon & Perkins, 1989). Inherent in each of these attributes is the element of time. Kneebone, Scott, Darzi, and Horrocks (2004) suggest that the single most important factor influencing development and retention of knowledge and skill is "the amount of 'overlearning' or additional training beyond that required for initial proficiency" (p. 1097). Research on transfer has been criticized for its emphasis on isolated measures of problem solving (Bransford & Schwartz, 1999). The viewpoint reflected in this criticism is that a single exposure to a problem-solving situation does not allow the student the benefit of applying learning gained in that situation to the next presentation of the problem. These perspectives suggest that any evidence supporting transfer of learning would be unlikely to appear after a single learning intervention.

Active Learning, Collaboration, and Engagement

The finding of a statistically significant difference between the groups for two of the three affective dependent variables is consistent with the literature. Simulation research from both the medical and nursing literature consistently reports positive results for satisfaction, confidence, enjoyment, and value. In a study comparing outcomes following simulator and video learning sessions, medical students indicated that both learning experiences were interesting and valuable, but their ratings for the simulation sessions were significantly higher than ratings for the video sessions (Morgan et al., 2002). Euliano's (2001) medical students rated their confidence in knowledge of cardiovascular physiology significantly higher following a simulator workshop than before. Shapiro et al. (2004) noted that although behavioral ratings between teams of healthcare providers were similar, the teams that participated in a simulation experience rated the experience as excellent, indicating a high level of satisfaction with the learning method. Nursing researchers noted similar findings of increased confidence (Bearnson & Wiker, 2005), increased confidence, knowledge, skills, and overall value of simulation (Schoening et al., 2006), and effective learning afforded through active learning in a risk-free setting (Bremner et al., 2006).

Somewhat different findings were noted by Alinier et al. (2006) who found no difference between the simulation and control groups on measures of confidence and stress, with both groups unsure about their ability to work in a technologically challenging work environment. One explanation offered for this finding is that the realism afforded in simulation exposes students to the challenges they will face in the clinical environment, and thus their level of stress does not decrease, nor does their confidence increase, until they develop proficiency in the actual clinical setting. In the current study, student comments reflected anxiety over the need to respond to a critical situation presented in the simulation. Several stated that it was their first time seeing a patient in an acute asthma exacerbation. Reflecting on the simulation experience during the debriefing that followed the scenario, one student commented that she had "never seen a nebulizer before, so it was good we had a chance to see it first here." Another student stated, "we should do this more often – now I know if my patient rolls in with an asthma attack, I'll know what the nebulizer looks like and how it works." Student comments suggested that although the scenario presented a challenging situation, it made them aware of the need to develop proficiency in skills needed in the real clinical setting.

Familiarity with the method of learning and proficiency in accomplishing the outcome task influence affective outcome measures. Students in Jeffries and Rizzolo's (2007) traditional learning group provided higher ratings of their performance and level of collaboration than students in the simulation group, suggesting that familiarity with the type of learning experience (a paper-pencil case study) influenced their ratings. In the same study, significantly higher levels of satisfaction, self-confidence, and perceived value of active learning reported by the simulation group suggests that simulation incorporates effective learning practices and that students value these practices when they encounter them. The current study similarly found that students in the simulation group provided significantly higher ratings related to active learning and engagement, with little difference between the group ratings for collaboration. Both learning methods encouraged group interaction and collaboration, however the realism of the patient care scenario afforded more opportunity for active learning and was more effective in engaging student interest.

Although not specifically measured in the present study, the importance of reflection and feedback was noted by students who commented on the effectiveness of spending time in reflective conversation following the simulation scenario. When asked if having participated in the simulation scenario would help the next time the students encountered a patient with asthma, the students stated it would, and one student noted "debriefing is almost as important as the simulation." Lasater (2007) and others note the importance of debriefing in helping students to begin making connections between prior knowledge and problems presented in new situations. Debriefing also allows students to realize what they have done well and what they have learned, boosting their confidence. Confidence was not measured in this study, but student comments provided indication that confidence was enhanced through the simulation experience.

Results from this study support the claim that simulation incorporates principles of effective learning practices including active learning, collaboration, and engagement. Simulation also includes features that promote learning such as the provision of feedback, repetitive practice, and contextual scenarios (Bradley, 2006). Lammers (2007) notes the propensity of simulation to "animate the curriculum" (p. 505). By allowing learners to try out their growing cognitive and behavioral skills, they begin to see relationships and underlying similarities not previously understood. Scenarios may be presented specifically to illustrate underlying similarities in physiology or management, helping students begin to differentiate structural from surface similarities. During the debriefing process, the facilitator can help students practice cognitive skills of selecting relevant information, organizing the information into a coherent structure, and integrating the information with relevant prior knowledge (Mayer & Wittrock, 1996). Developing effective learning skills is essential to the development of cognitive processes that result in meaningful learning; meaningful learning in turn, is a requirement of transfer (Mayer & Wittrock, 1996; Salomon & Perkins, 1989).

This study builds on prior research supporting the affective and psychomotor benefits of simulation. Students performed similarly on cognitive measures of knowledge acquisition, near transfer, and far transfer, whether they learned through simulation or through a traditional learning method. In addition, students in the simulation group were more actively engaged in the learning process. The results of this study suggest that simulation supports learning through its ability to engage the learners, helping them integrate theoretical and behavioral knowledge through experience and reflection. It may be that simulation offers its greatest advantage in areas that are difficult to measure, such as helping students to form networks of knowledge and develop an understanding of the relevance of individual aspects of information to the whole clinical picture. Developing these skills is necessary to the development of expertise and clinical judgment (Greenwood, 2000; Tanner, 2006).

Reliability of the Measures

The finding of poor internal reliability for four of the dependent variable measures is problematic. Two issues are explored relative to the reliability of the measures: first, the complex nature of the questions and the broad approach to the learning interventions, and second, the difficulty of measuring for transfer in general.

Questions for the measure of knowledge acquisition reflected a broad range of content knowledge related to assessment, intervention, and evaluation of patients experiencing respiratory distress related to asthma. Half of the items were selected because they were existing items on one of the students' course exams that would provide a pretest measure of student knowledge and could be used to assess change in knowledge following the intervention. The remaining items were selected from a pool of questions related to the subject in accordance with the test blueprint. Inclusion in the final measure was determined after content validation and pilot testing. Due to student access issues, reliability testing of the pilot instrument occurred with a similar group of students from a different campus. Different instructor presentations of the concepts may have accounted for the variation in response patterns demonstrated in the pilot population and the study population. These issues related to instructor variation, student access, and time constraints created limitations that may have influenced the reliability of the final knowledge acquisition measure.

Near and far transfer items were designed to reflect underlying structural similarities and to evaluate clinical judgment. Each set of case-based items shared a similar structural similarity – a physiologic restriction in blood flow. The students had previously received instruction related to the near-transfer situations presented in three of the cases: pulmonary embolism, unstable angina, and myocardial infarction. A fourth case presented a far-transfer situation of umbilical cord compression, a topic not yet presented in the students' curriculum. Two sets of far transfer script-concordance items each provided students with case presentation of a challenging, authentic situation, followed by possible conclusions and new information (assessment or diagnostic findings) about the case (Charlin et al., 2000). Students were asked to make a clinical judgment as to the likelihood that each conclusion was true based upon the presented findings.

Near transfer items were more difficult than knowledge acquisition items, and far transfer items were more difficult than near transfer items. Although within acceptable ranges, the level of difficulty may have influenced the reliability of the transfer measures. The relatively small number of items present in each measure may also have contributed to the low reliability values. Nunnally and Bernstein (1994) note that a low coefficient alpha is the result of a test containing few items or items that have little in common. In studies investigating the reliability and validity of the script concordance test, 50 to 60 items provided a sufficient number of items to achieve coefficient alphas of .80 or higher (Charlin et al., 2000). Constraints related to the time available for posttest administration and the number of dependent variables limited the overall number of items included on the posttest for this study. The posttest was comprised of 57 cognitive items including 12 knowledge acquisition, 15 near transfer, and 30 far transfer (script concordance) items.

Among the research reviewed for this study, only Alinier et al. (2006), Euliano (2001), and Jeffries and Rizzolo (2007) included a cognitive knowledge measure, and none of these provided information about the internal consistency reliability of the measure. Group differences reported by Alinier et al. were from a posttest that included 11 skills and 4 theoretical items. It is unknown the extent to which the measure evaluated differences in cognitive knowledge. Euliano demonstrated significant knowledge gains from pretest to posttest on seven items measuring content illustrated through the simulation intervention. Jeffries and Rizzolo reported no group differences on a measure of content knowledge. No additional information was available to provide an understanding of the type of knowledge or cognitive processes targeted or the number of items in the measure.

Even less information is available regarding the reliability of transfer measures. Traditional studies of transfer typically focus on presentation of an illustrative problem and subsequent presentation of a problem with a structural similarity. Participants are taught to solve the first problem and then are presented with the second problem. Transfer is thought to occur when the participant discovers and uses the knowledge applied to solving the first problem, to solving the second problem. The problems presented do not lend themselves to traditional measurement of internal reliability, in part because the focus is on the process used to solve the problem. This study attempted to measure transfer using a script concordance approach that has been validated and used reliably in the field of medicine (Charlin et al., 2000). The less-than optimal reliability level evident in this study may reflect the combination of a relatively low number of items, a relatively high difficulty level, the unique nature of the script concordance scoring method, and the inherent difficulty of measuring transfer.

In summary, results of this study suggest that simulation is an effective learning method for prelicensure nursing students. The lack of a significant difference in performance between the groups on measures of cognitive knowledge and transfer suggests that simulation is at least as effective as traditional methods of learning; there is some indication that simulation may be more effective than traditional methods of learning in promoting near transfer. Simulation also offers advantages in terms of effective learning practices; students in the simulation group reported significantly higher levels of active learning and engagement than students in the traditional learning group.

The difficulty of measuring higher-order cognitive processes was illustrated in this study, consistent with previous research that yields little objective evidence of transfer and clinical judgment. It is likely that one problem in this study was the lack of time necessary to provide the repetitive and varied practice needed to develop sufficient depth and breadth of knowledge to support problem-solving transfer. The study also encountered difficulties developing an instrument sensitive enough to measure transfer.

Implications

The results of the study support continued development of simulation as a learning method. Despite the significant use of simulation in aviation and medicine, research supporting cognitive learning outcomes remains limited. Precisely because simulation is interesting and engaging, it is being widely adopted despite the high cost in terms of both dollars and time. Additional research is needed to demonstrate if and how simulation fosters better learning and safer practice. This section explores the implications of this study for future research and practice.

Research

It is no surprise that much of the simulation literature addresses affective or psychomotor outcomes. This study illustrates the difficulty of demonstrating the effect of a contextually based learning session on discrete cognitive outcomes. Nursing students frequently state that they learn much better through practical experience than from theoretical instruction. Rather than suggesting that practical learning is superior to theoretical learning, student comments support the idea that theory and practice should not be separated. And yet, learning is measured through achievement tests designed to evaluate understanding and application of knowledge. The literature provides evidence that simulation is effective in promoting psychomotor skills; no such evidence exists for cognitive outcomes. It may be that the measures used to assess cognitive knowledge have not measured outcomes well. It may be that simulation is no more effective than traditional methods for cognitive learning.

This study included only theoretical measures of knowledge. If theoretical understanding and competent performance cannot be dissociated, then future research should include both behavioral and theoretical measures of higher-order cognitive skills. Developing clinical expertise requires translation of cognitive knowledge into behaviors, and it is through the application of their knowledge that students refine their clinical skills and understanding. Simulation may have little effect on the direct acquisition of knowledge, but it promotes knowledge application by providing contextual, deliberate practice in a safe environment. It also provides a means of evaluating individual behaviors that provide evidence of clinical judgment. Additional research is needed to develop tools that measure transfer of knowledge and clinical judgment.

One limitation in this study was the single simulation session. Students need to experience multiple situational variations in order to begin to differentiate between surface and structural similarities in patient presentations. The realistic, deliberate practice afforded through simulation may provide a link between theoretical knowledge and the complexity of actual clinical practice by helping students to experience variations in patient presentations (Lammers, 2007). Future studies that include multiple learning sessions before cognitive outcomes are measured could account for the need for repetitive and varied practice in achieving meaningful learning.

The instruments used in this study show promise for measuring near transfer and far transfer. Following a traditional approach to transfer, the instrument simply measures whether students can apply their prior knowledge in answering questions about a new situation or problem. A more useful approach may be to first instruct students on strategies for applying prior knowledge to new situations or problems, and then measuring their ability to do so. This later approach follows the preparation for future learning approach to transfer advocated by Bransford and Schwartz (1999). Future research could evaluate the effectiveness of using the instruments from this study to facilitate strategy instruction and measure subsequent transfer. Research along these lines would also contribute to research on learning strategies and metacognition.

Due to access and time constraints, the instrument used in this study was piloted with a group of very similar students from another institution. Even though the students were in programs following similar curricula, differences in emphasis as presented by teachers of different backgrounds and experience, different clinical protocols, and different textbooks may all have contributed to the finding in this study of a diminished reliability for the posttest scores. Where feasible, future studies should obtain reliability information with students from the same institution or with students from many institutions.

Attending to institution-specific features may be viewed as both a limitation and a necessity. In this study, the researcher's lack of familiarity with the clinical protocols used in the institution's clinical sites and with the teaching faculty's emphasis may have contributed to lack of clarity in either the teaching method or the measurements. Ensuring continuity among content taught in the classroom, clinical setting, and intervention would provide better control of the subject domain being measured. Ensuring continuity brings an attendant risk of "teaching to the test." A critique of the studies attempting to measure transfer is that the researcher may explicitly tell the subjects to transfer or use some other device to draw the subjects' attention to the similarity between the original and the new problem (Detterman, 1993). Care must be taken to avoid bias.

Along with refinement of the instrument and allowing for repeated learning sessions, replication of this study would add to the body of knowledge regarding the effectiveness of simulation in nursing education and allow for greater generalization of results. The students participating in this research were enrolled in a traditional baccalaureate nursing program at a private university. Simulation had not been widely implemented in courses the students took – most had no prior experience with simulation. Results may be different in associate degree nursing programs, programs where simulation has been more widely implemented, or in programs with older students or students who have more healthcare work experience.

Exploring the potential interaction between level of expertise (e.g., novice, advanced beginner) and method of learning holds promise for future research. In this study, participants possessed a similar level of expertise. Including students from two levels of expertise in future research would provide additional information about a possible expertise by method interaction. With reliable measures and a longer implementation of the treatment, the relationship between simulation and the development of expertise and clinical judgment may become evident.

Practice

Nursing students in this study quickly noted the potential benefits of a simulation experience relative to patient safety. Student comments reflected a desire to practice caring for a critically ill patient in simulation before having to assume responsibility for a similar patient in the real clinical setting. This recognition of the need for rehearsal and practice in order to develop essential skills is one of the primary motivations for incorporating simulation into nursing curricula.

Efforts to improve patient safety have pushed adoption of simulation in healthcare education. Among the problems most commonly associated with medical errors are lapses in communication, orientation and education, and patient assessment (JCAHO, 2005). Specific strategies identified by the JCAHO to improve patient safety include encouraging healthcare providers to develop skills of critical thinking and clinical judgment, and providing team training to help healthcare providers develop effective communication skills. Simulation offers opportunities to focus on developing skills that are difficult to practice in isolation – those that are typically developed in the "real world" of trial and error, with time and experience a necessary but insufficient factor. The need to protect patients calls for a method that allows practitioners to practice skills without risk of harm to patients. Simulation allows trial and error in a safe environment, one that is realistic enough to provide the contextual cues that support learning. Simulation also encourages learners to consider the thought processes and prior knowledge that informed their decisions and actions. Because simulation is believed to support effective communication, improve teamwork, and help develop clinical judgment, it has become an expected part of education. Additional research is needed to determine the effect of simulation on skills of communication, teamwork, and clinical judgment.

In summary, the evidence does not support the short-term efficacy of simulation over traditional methods of cognitive learning for undergraduate nursing students. In the long-term, however, simulation offers significant learning advantages with multiple outcomes. Simulation is ideally suited to support development of clinical judgment, by providing students with experiences designed to provide practice in noticing aspects of a situation, interpreting relevance of the aspects, responding to the situation, and reflecting on the outcome (Tanner, 2006). Reflection is essential to the development of competence and expertise (Benner, 1984), and simulation provides the opportunity and impetus for reflective learning. Finally, simulation offers opportunities for students to integrate knowledge and behavior, and practice psychosocial skills of communication and teamwork, in an engaging, active learning environment where they can apply and develop their knowledge without fear of harming patients.

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APPENDIX A

INFORMED CONSENT FORM
UNIVERSITY OF SAN FRANCISCO

CONSENT TO BE A RESEARCH SUBJECT

Purpose and Background

Ms. Shana Ruggenberg, a graduate student in the School of Education at the University of San Francisco, is doing a study on the effects of simulation on student learning and development of clinical judgment. The researcher is interested in understanding if simulation offers learning advantages over traditional types of instruction in an undergraduate nursing education program.

I am being asked to participate because I am over 18 years of age and am enrolled in an undergraduate, prelicensure nursing program.

Procedures

If I agree to be a participant in this study, the following will happen:

1\. I will participate in a randomly assigned experience at the end of one of my clinical shifts. The researcher will determine which experience I participate in, by using a method (such as flipping a coin) that gives me an equal chance of participating in either a simulation experience, or a traditional learning experience.

   a. If I am assigned to the simulation experience, I will participate in a simulated patient care situation in the simulation lab.

   b. If I am assigned to the traditional learning experience, I will participate in a traditional learning experience, such as a reading assignment. This experience will occur in a room adjacent to the simulation lab.

3\. I will complete a posttest and an educational practices scale.

4\. The researcher may have access to my college SAT scores and to my Nursing Therapeutics midterm test scores.

Risks and/or Discomforts

1. My individual responses and performance during the simulation or comparison session will remain as confidential as possible and will not affect my course standing. No individual identities will be used in any reports or publications resulting from the study. Study information will be coded and kept in locked files at all times. Only study personnel will have access to the files.

2. Because the time required for my participation may be up to 1 1/2 hours, I may become bored.

Benefits

There will be no direct benefit to me from participating in this study. A potential benefit of this study to me is a possible increase in knowledge associated with additional exposure to the topic presented in the simulation or the reading assignment. I may also gain a better understanding of the role of research and evidence-based practice in nursing.

Costs/Financial Considerations

There will be no financial costs to me as a result of taking part in this study.

Payment/Reimbursement

I will receive no reimbursement for participation in this study.

Questions

I have been given the opportunity to talk with Ms. Ruggenberg about this study and have my questions answered. If I have further questions about the study, I may call her at [redacted], or I may email her at [redacted].

If I have any questions or comments about participation in this study, I should first talk with the researcher. If for some reason I do not wish to do this, I may contact the IRBPHS, which is concerned with protection of volunteers in research projects. I may reach the IRBPHS office by calling (415) 422-6091 and leaving a voicemail message, by e-mailing IRBPHS@usfca.edu, or by writing to the IRBPHS, Department of Psychology, University of San Francisco, 2130 Fulton Street, San Francisco, CA 94117-1080.

Consent

I have been given a copy of the "Research Subject's Bill of Rights" and I have been given a copy of this consent form to keep.

PARTICIPATION IN RESEARCH IS VOLUNTARY. I am free to decline to be in this study, or to withdraw from it at any point. My decision as to whether or not to participate in this study will have no influence on my present or future status as a student or employee at USF.

My signature below indicates that I agree to participate in this study.

____

Subject's Signature | Date of Signature

____

Signature of Person Obtaining Consent | Date of Signature

RESEARCH SUBJECTS' BILL OF RIGHTS

The rights below are the rights of every person who is asked to be in a research study. As a research subject, I have the following rights:

1. To be told what the study is trying to find out;
2. To be told what will happen to me and whether any of the procedures, drugs, or devices are different from what would be used in standard practice;
3. To be told about the frequent and/or important risks, side effects, or discomforts of the things that will happen to me for research purposes;
4. To be told if I can expect any benefit from participating, and, if so, what the benefit might be;
5. To be told of the other choices I have and how they may be better or worse than being in the study;
6. To be allowed to ask any questions concerning the study both before agreeing to be involved and during the course of the study;
7. To be told what sort of medical or psychological treatment is available if any complications arise;
8. To refuse to participate at all or to change my mind about participation after the study is started; if I were to make such a decision, it will not affect my right to receive the care or privileges I would receive if I were not in the study;
9. To receive a copy of the signed and dated consent form; and
10. To be free of pressure when considering whether I wish to agree to be in the study.

If I have other questions, I should ask the researcher or the research assistant. In addition, I may contact the Institutional Review Board for the Protection of Human Subjects (IRBPHS), which is concerned with protection of volunteers in research projects. I may reach the IRBPHS by calling (415) 422-6091, by electronic mail at IRBPHS@usfca.edu, or by writing to USF IRBPHS, Department of Counseling Psychology, Education Building, 2130 Fulton Street, San Francisco, CA 94117-1080.

APPENDIX B

Posttest

Research Data Collection

Part I: Demographic Information

Directions: Please provide the following information about yourself by writing in the answer or checking the box next to the best response.

1. How old are you?

   ________ *Please write your age in years.*

2. Which description best describes the amount of time you have worked with clinical simulation in the past?

   ☐ No experience (0)
   ☐ One prior experience (1)
   ☐ Two prior experiences (2)
   ☐ Three prior experiences (3)
   ☐ Four or more prior experiences (4)

3. Which best describes the amount of time you have worked in either an acute, sub-acute, or long-term healthcare setting in a role that involved patient care (not including student clinical experience)?

   ☐ None (0)
   ☐ Up to 1 year (1)
   ☐ More than 1 and up to 2 years (2)
   ☐ More than 2 and up to 3 years (3)
   ☐ More than 3 years (4)

Please turn the page to begin the posttest.

Part II: Posttest
Directions: Select the best answer for each of the following items. Circle the letter of your choice.

1. You are caring for a patient who is four hours postoperative, and the following arterial blood gas values are reported by the lab. What is the nurse's best first action?

   pH 7.22, $PaCO_2$ 65 mm Hg, PaO_2 58 mm Hg, HCO_3^- 21 mEq/L

   a. Notify the physician.
   b. Increase the oxygen flow rate.
   c. Assess the patient's airway.
   d. Request the ABG be repeated to verify.

2. Which of these assessment findings is characteristic of a patient experiencing an exacerbation of asthma?

   c. Narrowing pulse pressure and PVCs
   d. Diaphoresis and accessory muscle use
   e. Audible pleural friction rub and JVD
   f. Peak flow of 94% and hypotension

3. For a patient who has just been medicated during an asthma attack, which finding indicates that the therapy is not effective?

   a. Peak expiratory rate flow 10% above patient's baseline
   b. Presence of bilateral tactile fremitus
   c. Suprasternal retractions on inhalation
   d. Heart rate increase of 10 beats per minute

4. Which of the following diagnostic tests is most effective to evaluate the adequacy of both oxygenation and ventilation in a patient with respiratory dysfunction?

   a. Forced vital capacity parameters
   b. Arterial blood gas analysis
   c. Transcutaneous oxygen saturation values
   d. Peak flow comparative analysis

5. A 22-year-old patient presents to the emergency department with acute asthma exacerbation. His respiratory rate is 44 breaths/minute; he is diaphoretic, using accessory muscles, tachycardic, and extremely anxious. Which of the following is the priority action to respond to the patient's current condition?

   a. Quickly obtain information from the patient about the initiating stimulus to determine treatment approach.
   b. Administer a bronchodilator by oxygen-driven nebulizer.
   c. Apply a cardiac monitor to the patient to obtain a baseline rhythm analysis before treatment.
   d. Provide emotional support and administer an anti-anxiety medication immediately.

6. You are the only licensed health care professional assigned to a small medical-surgical unit with 12 beds. Two unlicensed assistive personnel are also working on this unit. Which of these four patients with respiratory problems should be assigned to you rather than to the unlicensed assistive personnel?

   a. 82-year-old woman receiving steroid therapy for pulmonary fibrosis whose pulse oximetry is 92%
   b. 35-year-old woman receiving intravenous aminophylline for asthma whose pulse oximetry is 92% and whose FEV_1 is 50% of expected
   c. 55-year-old man with chronic obstructive lung disease whose pulse oximetry is 90% and ABG values: PO_2, 78 mm Hg; pH, 7.35; PCO_2, 56 mm Hg; HCO_3^-, 36 mEq/L
   d. 50-year-old man two days postoperative from a thoracotomy for lung cancer whose pulse oximetry is 95% and whose chest tube is draining 70 mL/8-hour shift

7. On assessment the nurse determines that the patient has severe obstruction and impending respiratory failure based on the findings of

   a. markedly diminished breath sounds with no wheezing.
   b. inspiratory and expiratory wheezing with an unproductive cough.
   c. use of accessory muscles of respiration and a feeling of suffocation.
   d. a respiratory rate of 34 breaths per minutes and increased pulse and blood pressure.

8. On auscultation of a patient's lungs, the nurse hears short, high-pitched sounds just before the end of inspiration in the right and left lower lobes. The nurse records this finding as

   a. crackles in the right and left lower lobes.
   b. inspiratory wheezes in both lungs.
   c. pleural friction rub in the right and left lower lobes.
   d. rales in the bases of both lungs.

9. The nurse is admitting a patient who has a diagnosis of an acute asthma attack. Which information obtained by the nurse indicates that the patient may need teaching regarding medication use?

   a. The patient has been using the albuterol (Proventil) inhaler more frequently over the last 4 days.
   b. The patient became very short of breath an hour before coming to the hospital.
   c. The patient has been taking acetaminophen (Tylenol) 650 mg every 6 hours for chest-wall pain.
   d. The patient says there have been no acute asthma attacks during the last year.

10. A patient in respiratory distress is admitted to the medical unit at the hospital. During the initial assessment of the patient, the nurse should

    a. complete a full physical assessment to determine the systemic effect of the respiratory distress.
    b. complete a respiratory system assessment and ask questions about this episode of respiratory distress.
    c. delay the physical assessment and ask family members about any history of respiratory problems.
    d. obtain a comprehensive health history to determine the extent of any prior respiratory problems.

11. While caring for a patient with respiratory disease, the nurse observes that the patient's SpO_2 drops from 94% to 85% when the patient ambulates in the hall. The nurse determines that

    a. arterial blood gas analysis should be done to verify the patient's SpO_2.
    b. supplemental oxygen should be used whenever the patient exercises.
    c. the patient activity should be limited until the disease process is resolved.
    d. the response is normal and the patient should continue at this activity level.

12. A 19-year-old patient comes to the ED with acute asthma. His respiratory rate is 44 breaths/minute, and he appears to be in acute respiratory distress. Which of the following actions should you take first?

    a. Give a bronchodilator by nebulizer.
    b. Obtain a full medical history.
    c. Obtain ABGs and pulmonary function tests.
    d. Provide emotional support.

Please turn the page to continue the posttest.

Part III: Posttest
Directions: Following each of the next four scenarios are five questions that relate to the scenario. Read each question, and then select the one best response from among the choices provided. Circle the letter of your choice.

Scenario A: **Ann**, 37-years-old, is on bedrest for phlebitis when she suddenly develops dyspnea and chest pain.

13. What human response to illness best describes the underlying problem described in the scenario about Ann?

    a. Hypertension due to vasospasm
    b. Hypotension due to vasodilation
    c. Hypovolemia due to blood loss
    d. Hypoxia due to hypovolemia
    e. Hypoxia due to obstruction
    f. Obstruction due to hypertension
    g. Vasoconstriction due to hypovolemia

14. What is the primary clinical manifestation of the underlying problem described in the scenario about Ann?

    a. Hypertension
    b. Hypotension
    c. Hypoxia
    d. Pain

15. Which ordered treatment or intervention most directly addresses the underlying problem described in the scenario about Ann?

    a. Administer analgesic
    b. Administer smooth muscle relaxant
    c. Administer vasoconstrictor
    d. Administer vasodilator
    e. Administer diuretic
    f. Administer thrombolytic agent

16. What is the aim of the treatment or intervention that most directly addresses the problem described in the scenario about Ann?

    a. Decrease blood pressure
    b. Increase blood pressure
    c. Decrease cardiac preload
    d. Increase O_2 delivery to the lungs
    e. Increase O_2 delivery to the bloodstream
    f. Increase O_2 delivery to the heart

17. What is the most important thing you will do after learning the information in the scenario about Ann? After selecting your response, write what you would ask, give, request, assess, or (other) in the space provided.

    a. Ask a question:______________________________
    b. Give a medication: ______________________________
    c. Request a diagnostic test:______________________________
    d. Assess the patient's:______________________________
    e. Other:______________________________

Scenario B: **Bob**, 46-years-old, appears short of breath and diaphoretic, complains of a heavy pressure in his chest, and states that he is weak.

18. What human response to illness best describes the underlying problem described in the scenario about Bob?

a. Hypertension due to vasospasm
b. Hypotension due to vasodilation
c. Hypovolemia due to blood loss
d. Hypoxia due to hypovolemia
e. Hypoxia due to obstruction
f. Obstruction due to hypertension
g. Vasoconstriction due to hypovolemia

19. What is the primary clinical manifestation of the underlying problem described in the scenario about Bob?

a. Hypertension
b. Hypotension
c. Hypoxia
d. Pain

20. Which ordered treatment or intervention most directly addresses the underlying problem described in the scenario about Bob?

a. Administer analgesic
b. Administer smooth muscle relaxant
c. Administer vasoconstrictor
d. Administer vasodilator
e. Administer diuretic
f. Administer thrombolytic agent

21. What is the aim of the treatment or intervention that most directly addresses the problem described in the scenario about Bob?

a. Decrease blood pressure
b. Increase blood pressure
c. Decrease cardiac preload
d. Increase O_2 delivery to the lungs
e. Increase O_2 delivery to the bloodstream
f. Increase O_2 delivery to the heart

22. What is the most important thing you will do after learning the information in the scenario about Bob? After selecting your response, write what you would ask, give, request, assess, or (other) in the space provided.

a. Ask a question:______________________________
b. Give a medication: ______________________________
c. Request a diagnostic test:______________________________
d. Assess the patient's:______________________________
e. Other:______________________________

Scenario C: **Carol**, 19-years-old, pregnant and in active labor, complains of long, painful uterine contractions with practically no relief between the end of one and the start of the next. The fetal heart rate shows tachycardia.

23. What human response to illness best describes the underlying problem described in the scenario about Carol?

    a. Hypertension due to vasospasm
    b. Hypotension due to vasodilation
    c. Hypovolemia due to blood loss
    d. Hypoxia due to hypovolemia
    e. Hypoxia due to obstruction
    f. Obstruction due to hypertension
    g. Vasoconstriction due to hypovolemia

24. What is the primary clinical manifestation of the underlying problem described in the scenario about Carol?

    a. Fetal hypertension
    b. Fetal hypotension
    c. Hypertension
    d. Hypotension
    e. Hypoxia
    f. Pain

25. Which ordered treatment or intervention most directly addresses the underlying problem described in the scenario about Carol?

    a. Administer analgesic
    b. Administer diuretic
    c. Administer smooth muscle relaxant
    d. Administer thrombolytic agent
    e. Administer vasoconstrictor
    f. Administer vasodilator

26. What is the aim of the treatment or intervention that most directly addresses the problem described in the scenario about Carol?

    a. Decrease blood pressure
    b. Decrease cardiac preload
    c. Increase blood pressure
    d. Increase O_2 delivery to the bloodstream
    e. Increase O_2 delivery to the heart
    f. Increase O_2 delivery to the lungs
    g. Increase O_2 delivery to the placenta
    h. Increase O_2 delivery to the uterus

27. What is the most important thing you will do after learning the information in the scenario about Carol? After selecting your response, write what you would ask, give, request, assess, or (other) in the space provided.

    a. Ask a question:____________________

    b. Give a medication: ____________________

    c. Request a diagnostic test:____________________

    d. Assess the patient's:____________________

    e. Other:____________________

Scenario D: **Dave,** 49-years-old, becomes nauseated and develops dyspnea and a squeezing pressure in his chest after running two miles.

28. What human response to illness best describes the underlying problem described in the scenario about Dave?

    a. Hypertension due to vasospasm
    b. Hypotension due to vasodilation
    c. Hypovolemia due to blood loss
    d. Hypoxia due to hypovolemia
    e. Hypoxia due to obstruction
    f. Obstruction due to hypertension
    g. Vasoconstriction due to hypovolemia

29. What is the primary clinical manifestation of the underlying problem described in the scenario about Dave?

    a. Hypertension
    b. Hypotension
    c. Hypoxia
    d. Pain

30. Which ordered treatment or intervention most directly addresses the underlying problem described in the scenario about Dave?

    a. Administer analgesic
    b. Administer diuretic
    c. Administer smooth muscle relaxant
    d. Administer thrombolytic agent
    e. Administer vasoconstrictor
    f. Administer vasodilator

31. What is the aim of the treatment or intervention that most directly addresses the problem described in the scenario about Dave?

    a. Decrease blood pressure
    b. Decrease cardiac preload
    c. Increase blood pressure
    d. Increase O_2 delivery to the bloodstream
    e. Increase O_2 delivery to the heart
    f. Increase O_2 delivery to the lungs

32. What is the most important thing you will do after learning the information in the scenario about Ann? After selecting your response, write what you would ask, give, request, assess, or (other) in the space provided.

    a. Ask a question:____________________
    b. Give a medication: ____________________
    c. Request a diagnostic test:____________________
    d. Assess the patient's:____________________
    e. Other:____________________

Please turn the page to continue the posttest.

Part IV: Posttest

Directions: After reading the scenario below, you are to determine the effect of each piece of clinical information (from column 2) on the problem you think William has (from column 1). Decide whether the clinical information from William's history *rules out* (-2) the problem you think William has, makes it *less probable* (-1), makes it *neither less nor more probable* (0), makes it *more probable* (+1), or makes it *certain or almost certain* (+2). Treat each piece of clinical information as a separate item independent from the others. There are 12 items.

Select and circle the number corresponding to the response that best describes your understanding.

33. William, a 52-year-old man, arrives in your emergency department complaining of tightness in his chest and difficulty breathing. You begin to obtain William's history of his present complaint.

If you are thinking that William has this problem	**And from William's history you learn that**	**The problem you think William has becomes**				
		Ruled out or almost ruled out	Less probable	Neither less nor more probable	More probable	Certain or almost certain
Congestive heart disease	He experiences dyspnea at night	-2	-1	0	+1	+2
COPD	He experiences dyspnea during rest	-2	-1	0	+1	+2
Asthma	He experiences dyspnea upon exertion	-2	-1	0	+1	+2
Asthma	He has a history of allergies	-2	-1	0	+1	+2
COPD	He has a history of coronary artery disease	-2	-1	0	+1	+2
Congestive heart disease	He has been lightheaded and his fingers feel "tingly"	-2	-1	0	+1	+2
Hyperventilation	He has been worried about his job	-2	-1	0	+1	+2
Congestive heart disease	He has high blood pressure	-2	-1	0	+1	+2
Asthma	He recently had a motor vehicle accident	-2	-1	0	+1	+2
COPD	He smokes	-2	-1	0	+1	+2
Hyperventilation	He takes a beta blocker	-2	-1	0	+1	+2
Asthma	He works in construction	-2	-1	0	+1	+2

Directions: After reading the scenario below, you are to determine the effect of each piece of clinical information (from column 2) on the problem you think Mary has (from column 1). Decide whether the clinical information from Mary's history *rules out* (-2) the problem you think Mary has, makes it *less probable* (-1), makes it *neither less nor more probable* (0), makes it *more probable* (+1), or makes it *certain or almost certain* (+2). Treat each piece of clinical information as a separate item independent from the others. There are 13 items.

Select and circle the number corresponding to the response that best describes your understanding.

34. Mary, a 42-year-old woman who delivered a baby three weeks ago, is in the emergency department complaining of fatigue and difficulty breathing with exertion over the past several days, but worse today. She has a non-productive cough. You are the student nurse and have been asked to complete an assessment on Mary while her nurse is with another patient.

If you were thinking that Mary has this problem	**And from your assessment of Mary you learn that**	**The problem you think Mary has becomes**				
		Ruled out or almost ruled out	Less probable	Neither less nor more probable	More probable	Certain or almost certain
Asthma	Her ABGs are: pH 7.46, $PaCO_2$ 35 mm Hg, PaO_2 80 mm Hg	-2	-1	0	+1	+2
Congestive heart disease	Her ECG shows normal sinus rhythm	-2	-1	0	+1	+2
Asthma	Her VS are: 141/89, T, 99.1, P 126, R34	-2	-1	0	+1	+2
Pulmonary edema	She had hypertension during her pregnancy	-2	-1	0	+1	+2
Congestive heart disease	She has a prominent third heart sound (S_3)	-2	-1	0	+1	+2
Pulmonary edema	She has expiration wheezes on auscultation	-2	-1	0	+1	+2
Asthma	She has jugular vein distention	-2	-1	0	+1	+2
Pulmonary edema	She has peripheral edema	-2	-1	0	+1	+2
Congestive heart disease	She has postnasal discharge	-2	-1	0	+1	+2
Pulmonary edema	She is dizzy and lightheaded	-2	-1	0	+1	+2
Asthma	She reports her chest hurts when she coughs	-2	-1	0	+1	+2
Congestive heart disease	She uses an inhaler	-2	-1	0	+1	+2
Asthma	She uses her intercostals muscles to assist her in breathing	-2	-1	0	+1	+2

Please turn the page to complete the learning practices scale.

APPENDIX C

Learning Practices Scale

Directions: Please circle the number that best describes the extent to which you agree with each of the following statements.

	Strongly Disagree	Disagree	Agree	Strongly Agree
1. I learn best by doing.	1	2	3	4
2. During this activity, I was motivated to learn.	1	2	3	4
3. I learn best by attending a lecture.	1	2	3	4
4. I learn best when I can relate the topic to an experience I have had.	1	2	3	4
5. This activity was a good way for me to learn.	1	2	3	4
6. I learn best when I can work on solving problems with other students.	1	2	3	4
7. I learn best when I study in a group.	1	2	3	4
8. I learn best by thinking quietly.	1	2	3	4
9. This learning activity sparked my curiosity to learn more about some aspect of the topic.	1	2	3	4
10. I learn better when I can understand others' points of view.	1	2	3	4
11. I prefer to learn by observing and then trying a new skill.	1	2	3	4
12. I prefer to make clinical decisions independently.	1	2	3	4
13. Talking about issues with other people helps me make better clinical decisions.	1	2	3	4
14. I learn best by manipulating the subject material with my own hands.	1	2	3	4
15. I rarely ask for help when working on a problem with other students.	1	2	3	4
16. I really enjoy explaining things.	1	2	3	4
17. I learn best when I study independently.	1	2	3	4
18. I would rather get information from people than from books.	1	2	3	4
19. This learning activity kept me really engaged.	1	2	3	4
20. If I don't understand a concept, I would rather independently research the issue than ask for help.	1	2	3	4
21. My mind kept wandering during this activity.	1	2	3	4
22. I learn best by reading books or articles.	1	2	3	4
23. This activity offered me a variety of ways in which to learn the material.	1	2	3	4
24. When I am unsure about a concept, I talk with other students to help me understand.	1	2	3	4

Thank you for participating in this research project!

APPENDIX D

Simulation Scenario

<table>
<tr><th>Scenario</th><th colspan="2">Course Level</th></tr>
<tr><td>Acute Asthma [1]</td><td colspan="2">Junior Level</td></tr>
<tr><th>Prerequisite Knowledge and Skills</th><th colspan="2">Scenario Objectives and Outcomes</th></tr>
<tr><td>Student participants should demonstrate an understanding of standard precautions, communication skills, clinical prioritization skills, knowledge of cardio-respiratory anatomy and physiology, cardio-respiratory assessment, and pharmacology management of acute respiratory distress.

Student participants should demonstrate basic clinical skills, including obtaining vital signs, performing a physical exam including auscultation of heart and lung sounds, and administering oral, parenteral, intravenous, and inhaled medications.</td><td colspan="2">Given a simulated asthma patient in acute respiratory distress, student participants will demonstrate proper assessment, therapy, and patient education.

With appropriate assessment and therapy, the patient will demonstrate improved physiologic condition.

With delayed or inappropriate assessment or therapy, the patient will demonstrate deteriorating physiologic condition.</td></tr>
<tr><th>Presenting Situation</th><th colspan="2">Presenting Patient State and Trends</th></tr>
<tr><td>Patient Information: Adult patient, normal ht/wt

History of Present Complaint: Patient with a history of bronchial asthma arrives at the emergency department in acute respiratory distress.

Past Medical History: Asthma since childhood

Medications: Beclovent, Intal, Serevent, and Proventil inhaler

Allergies: Seasonal hay fever</td><td>T
P/Rhythm
R
BP
O2 Sats
Heart Sounds
Lung Sound
Bowel Sound
Initial Trend

Future Trends</td><td>WNL
Tachycardia, SR
Tachypnea
Mild hypertension
Borderline hypoxia
WNL
Wheezes bilaterally
WNL
Asthma hypoxia: increase in P, R; decrease in BP, O2 Sats

Asthma deterioration: worsening of Asthma hypoxia trend

Asthma recovery: decrease in P, R; increase in BP, O2 Sats</td></tr>
<tr><th>Time Needed/Orders</th><th colspan="2">Props/Roles</th></tr>
<tr><td>20 min

MD orders appropriate to acute asthma including oxygen, albuterol, ipratropium bromide, methylprednisolone</td><td colspan="2">IV pole, fluids,

Primary, secondary, charge nurse (as necessary)
Family member
Physician or nurse practitioner for orders</td></tr>
</table>

[1] NLN Acute Severe Asthma scenario, © 2007; run on a Laerdal SimMan™ human patient simulator.

APPENDIX E

Discussion questions

Simulation Group

Jennifer Hoffman is a 33-year-old female who arrived to the Emergence Department by ambulance. She has a history of asthma with several visits to the emergency room this past year. She is pale and alert, is profusely diaphoretic, and appears anxious. She is using her accessory muscles to breath and her speaking is limited to one or two words at a time. EMS services has started an IV of Normal Saline at a keep open rate.

Debriefing Questions: After completing the simulation, lead the students in a discussion centered around the following questions. Please encourage discussion among the participants in the session.

1. Talk to me about the problem Jennifer was having? What is the underlying problem – the pathophysiology?

2. What particular issues seemed significant to pay attention to? What clinical manifestations are a result of Jennifer's underlying problem?

3. What was your main goal in caring for Jennifer? Which treatment most directly addressed Jennifer's underlying problem?

4. How did you know that your actions or the interventions were working? What was the intended result of the treatment and how did you know it was working?

5. Talk to me about how you knew what to do during this situation? What is the most important thing you should do when you care for a patient like Jennifer? (What questions would you ask, what would you assess?)

6. What other possible problems did you consider for this situation? How would you approach the situation differently if your patient did not have a history of asthma?

7. What would have made you more seriously consider [the other problem you considered]? How would you have made your decision about one problem as opposed to another?

8. What factors influenced the way you felt, thought, or responded in this situation?

Traditional Group:

Jennifer Hoffman is a 33-year-old female who arrived to the Emergence Department by ambulance. She has a history of asthma with several visits to the emergency room this past year. She is pale and alert, is profusely diaphoretic, and appears anxious. She is using her accessory muscles to breath and her speaking is limited to one or two words at a time. EMS services has started an IV of Normal Saline at a keep open rate.

Study Questions: After reading the case scenario, watching the video presentation, and reviewing the articles, consider the following questions. Please discuss the questions with the other participants in your session.

1. What problem is Jennifer having? What is the underlying problem – the pathophysiology?

2. What issues seem significant for you to pay attention to? What clinical manifestations are a result of Jennifer's underlying problem?

3. What is your main goal in caring for Jennifer? What treatment will most directly address Jennifer's underlying problem?

4. How will you know that your actions or the interventions were working? What is the intended result of the necessary treatment and how will you know it is working?

5. How do you know what to do during a situation like this? What is the most important thing you should do when you care for a patient like Jennifer?

6. What other possible problems might you consider for this situation? How would you approach the situation differently if your patient did not have a history of asthma?

7. What would have made you more seriously consider the problems you identified in question 6? How would you have made your decision about one problem as opposed to another?

APPENDIX F

Content Expert Rating Sheet

The questions on this sheet are intended for a dissertation posttest. Four areas are being measured:

- Content knowledge (asthma, acute respiratory assessment)
- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, and underlying structural similarity)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

Three item types are provided.

a. Standard multiple-choice items with four possible responses, and one best choice
b. Case-based multiple-choice items with seven to ten possible responses; the four cases are repeated in each of the four items
c. Case-based likert-type items that ask the reader to choose a response that reflects their certainty in a decision after learning some information

A copy of the full instrument has also been provided for your reference on items 13 through 34 – you are welcome to mark it up if corrections are suggested. Please return both the rating sheets and the full instrument to Shana Ruggenberg ([redacted]). Thank you.

Instructions for content experts:
Please select the best answer to the following questions, supplementing your answer with comments as you deem necessary. If you have any questions about the rating sheets, please contact Shana Ruggenberg (707-965-2862 or slrugg@mac.com) immediately.

1. You are caring for a patient who is four hours postoperative, and the following arterial blood gas values are reported by the lab. What is the nurse's best first action? pH 7.22, $PaCO_2$ 65 mm Hg, PaO_2 58 mm Hg, HCO_3^- 21 mEq/L a. Notify the physician. b. Increase the oxygen flow rate. c. **Assess the patient's airway.** d. Request the ABG be repeated to verify.	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

2. Which of these assessment findings is characteristic of a patient experiencing an exacerbation of asthma? a. Narrowing pulse pressure and PVCs **b. Diaphoresis and accessory muscle use** c. Audible pleural friction rub and JVD d. Peak flow of 94% and hypotension	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No

6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

3. For a patient who has just been medicated during an asthma attack, which finding indicates that the therapy is not effective? a. Peak expiratory rate flow 10% above patient's baseline b. Presence of bilateral tactile fremitus **c. Suprasternal retractions on inhalation** d. Heart rate increase of 10 beats per minute	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

4. Which of the following diagnostic tests is most effective to evaluate the adequacy of both oxygenation and ventilation in a patient with respiratory dysfunction? a. Forced vital capacity parameters **b. Arterial blood gas analysis** c. Transcutaneous oxygen saturation values d. Peak flow comparative analysis	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No

5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

5. A 22-year-old patient presents to the emergency department with acute asthma exacerbation. His respiratory rate is 44 breaths/minute; he is diaphoretic, using accessory muscles, tachycardic, and extremely anxious. Which of the following is the priority action to respond to the patient's current condition? a. Quickly obtain information from the patient about the initiating stimulus to determine treatment approach. b. **Administer a bronchodilator by oxygen-driven nebulizer.** c. Apply a cardiac monitor to the patient to obtain a baseline rhythm analysis before treatment. d. Provide emotional support and administer an anti-anxiety medication immediately.	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

6. You are the only licensed health care professional assigned to a small medical-surgical unit with 12 beds. Two unlicensed assistive personnel are also working on this unit. Which of these four patients with respiratory problems should be assigned to you rather than to the unlicensed assistive personnel? a. 82-year-old woman receiving steroid therapy for pulmonary fibrosis whose pulse oximetry is 92% **b. 35-year-old woman receiving intravenous aminophylline for asthma whose pulse oximetry is 92% and whose FEV_1 is 50% of expected** c. 55-year-old man with chronic obstructive lung disease whose pulse oximetry is 90% and ABG values: $PO_{2,}$ 78 mm Hg; pH, 7.35; $PCO_{2,}$ 56 mm Hg; HCO_3^-, 36 mEq/L d. 50-year-old man two days postoperative from a thoracotomy for lung cancer whose pulse oximetry is 95% and whose chest tube is draining 70 mL/8-hour shift	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

7. On assessment the nurse determines that the patient has severe obstruction and impending respiratory failure based on the findings of **a. markedly diminished breath sounds with no wheezing.** b. inspiratory and expiratory wheezing with an unproductive cough. c. use of accessory muscles of respiration and a feeling of suffocation. d. a respiratory rate of 34 breaths per minutes and increased pulse and blood pressure.	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No

5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

8.	On auscultation of a patient's lungs, the nurse hears short, high-pitched sounds just before the end of inspiration in the right and left lower lobes. The nurse records this finding as	
a.	crackles in the right and left lower lobes.	
b.	**inspiratory wheezes in both lungs.**	
c.	pleural friction rub in the right and left lower lobes.	
d.	rales in the bases of both lungs.	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

9.	The nurse is admitting a patient who has a diagnosis of an acute asthma attack. Which information obtained by the nurse indicates that the patient may need teaching regarding medication use?	
a.	**The patient has been using the albuterol (Proventil) inhaler more frequently over the last 4 days.**	
b.	The patient became very short of breath an hour before coming to the hospital.	
c.	The patient has been taking acetaminophen (Tylenol) 650 mg every 6 hours for chest-wall pain.	
d.	The patient says there have been no acute asthma attacks during the last year.	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No

2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

10. A patient in respiratory distress is admitted to the medical unit at the hospital. During the initial assessment of the patient, the nurse should a. complete a full physical assessment to determine the systemic effect of the respiratory distress. **b. complete a respiratory system assessment and ask questions about this episode of respiratory distress.** c. delay the physical assessment and ask family members about any history of respiratory problems. d. obtain a comprehensive health history to determine the extent of any prior respiratory problems.	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

11. While caring for a patient with respiratory disease, the nurse observes that the patient's SpO_2 drops from 94% to 85% when the patient ambulates in the hall. The nurse determines that a. arterial blood gas analysis should be done to verify the patient's SpO_2. **b. supplemental oxygen should be used whenever the patient exercises.** c. the patient activity should be limited until the disease process is resolved. d. the response is normal and the patient should continue at this activity level.	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

12. A 19-year-old patient comes to the ED with acute asthma. His respiratory rate is 44 breaths/minute, and he appears to be in acute respiratory distress. Which of the following actions should you take first? **a. Give a bronchodilator by nebulizer.** b. Obtain a full medical history. c. Obtain ABGs and pulmonary function tests. d. Provide emotional support.	

- Content knowledge (asthma, acute respiratory assessment)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No

8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

Please refer to the complete item.

13.	What <u>human response to illness</u> best describes the underlying problem described in the scenario about Ann?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

14.	What is the <u>primary clinical manifestation</u> of the underlying problem described in the scenario about Ann?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No

7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

15.	Which ordered <u>treatment or intervention most directly addresses</u> the underlying problem described in the scenario about Ann?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

16.	What is the <u>aim of the treatment or intervention</u> that most directly addresses the problem described in the scenario about Ann?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No

6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

Please refer to the complete item.

18.	What human response to illness best describes the underlying problem described in the scenario about Bob?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

19.	What is the primary clinical manifestation of the underlying problem described in the scenario about Bob?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No

4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

20.	Which ordered <u>treatment or intervention most directly addresses</u> the underlying problem described in the scenario about Bob?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

21.	What is the <u>aim of the treatment or intervention</u> that most directly addresses the problem described in the scenario about Bob?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No

3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

Please refer to the complete item.

23.	What <u>human response to illness</u> best describes the underlying problem described in the scenario about Carol?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

24.	What is the <u>primary clinical manifestation</u> of the underlying problem described in the scenario about Carol?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

25.	Which ordered <u>treatment or intervention most directly addresses</u> the underlying problem described in the scenario about Carol?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

26.	What is the <u>aim of the treatment or intervention</u> that most directly addresses the problem described in the scenario about Carol?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

Please refer to the complete item.

28.	What <u>human response to illness</u> best describes the underlying problem described in the scenario about Dave?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

29.	What is the <u>primary clinical manifestation</u> of the underlying problem described in the scenario about Dave?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

30.	Which ordered <u>treatment or intervention most directly addresses</u> the underlying problem described in the scenario about Dave?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes ☐ No
2	Is the intent of the question clear? Comment:	☐ Yes ☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes ☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes ☐ No
5.	Is there only one correct answer? Comment:	☐ Yes ☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes ☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes ☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

31.	What is the aim of the treatment or intervention that most directly addresses the problem described in the scenario about Dave?	

- Near transfer (applying knowledge about nursing care of a patient with asthma to other patients with similar surface presentations, but different problems)
- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

1.	Does the question clearly relate to one of the four areas being measured? Comment:	☐ Yes	☐ No
2	Is the intent of the question clear? Comment:	☐ Yes	☐ No
3.	Is the language of the question clear and unambiguous? Comment:	☐ Yes	☐ No
4.	Is the question clear and unambiguous in its content? Comment:	☐ Yes	☐ No
5.	Is there only one correct answer? Comment:	☐ Yes	☐ No
6.	Is the question written at an appropriate level for undergraduate nursing students? Comment:	☐ Yes	☐ No
7.	Is the format of the question (e.g. use of terms, specific situation cited, grammar) clear and understandable? Comment:	☐ Yes	☐ No
8.	Do you suggest a change in format? Comment:	☐ Yes	☐ No

Please refer to the complete item.

33.	William, a 52-year-old man, arrives in your emergency department complaining of tightness in his chest and difficulty breathing. You begin to obtain William's history of his present complaint.	

- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
- Far transfer (applying knowledge to make clinical decisions in situations of uncertainty)

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8.	Do you suggest a change in format? Comment:	☐ Yes ☐ No

34.	Mary, a 42-year-old woman who delivered a baby three weeks ago, is in the emergency department complaining of fatigue and difficulty breathing with exertion over the past several days, but worse today. She has a non-productive cough. You are the student nurse and have been asked to complete an assessment on Mary while her nurse is with another patient.	

- Far transfer (applying knowledge of underlying pathology about asthma to other patients with dissimilar surface presentations, but underlying structural similarity)
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