A FRAMEWORK *for*
Designing, Implementing, and Evaluating
Simulations Used as Teaching Strategies in Nursing

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DESPITE THE CHALLENGES PRESENTED BY THE SHORTAGE OF NURSING FACULTY, the diminishing availability of clinical sites, and an exponentially growing knowledge base, employers are asking educators to do a better job of preparing students for the real world of nursing. Employers who no longer have the luxury of offering lengthy and costly orientation programs for nurses expect new graduates to transition quickly into the role of independently functioning caregiver. > Innovative ways that teach students about the real world of nursing in a cost-effective, efficient, and high quality manner are needed to prepare nurses for safe and efficient practice. Immersing students in lecture content while providing limited clinical experience can impart technical knowledge but is inadequate to prepare nurses for the complexities of the workplace. While clinical simulation, combined with clinical experience and other teaching methods, is considered a powerful tool for this purpose (1), those attempting to use this new way of teaching and learning have questions:

> *What teaching and learning practices with simulation contribute to positive outcomes?*
> *What is the role of the teacher?*
> *How does the simulation design contribute to the overall teaching and learning experience?*

ANSWERS TO THESE QUESTIONS are being sought by professional organizations, staff educators, and students and faculty at academic institutions — schools of nursing as well as other health disciplines, including medicine. This article describes a proposed framework to guide the processes of designing, implementing, and evaluating simulations in nursing that will help answer these questions. This framework has been developed based on theoretical and empirical literature. It is the work of a national group organized by the National League for Nursing in partnership with the Laerdal Corporation that is currently leading efforts to guide the development and assessment of processes and outcomes for this type of innovative teaching strategy.

ABSTRACT This article presents a framework that can be used to design, implement, and evaluate simulations used for teaching strategies in nursing education. Components of the framework include best practices in education, student factors, teacher factors, simulation design characteristics, and outcomes. Variables are identified for each of the framework components.

The Proposed Framework In the past, educators believed that, to produce competent nurses, it was enough to provide students with a variety of clinical experiences in which learners could apply classroom content. Today, however, experienced nurses, managers, and staff development educators find that many students and new graduates lack the critical thinking skills needed to work in the increasingly complex clinical environment (2). Providing patient simulations is a relatively efficient method of teaching content and critical thinking skills safely and in collaboration with the instructor, without fear of causing harm to actual patients (3).

Simulations are defined as activities that mimic the reality of a clinical environment and are designed to demonstrate procedures, decision-making, and critical thinking through techniques such as role playing and the use of devises such as interactive videos or mannequins. A simulation may be very detailed and closely simulate reality, or it can be a grouping of components that are combined to provide some semblance of reality.

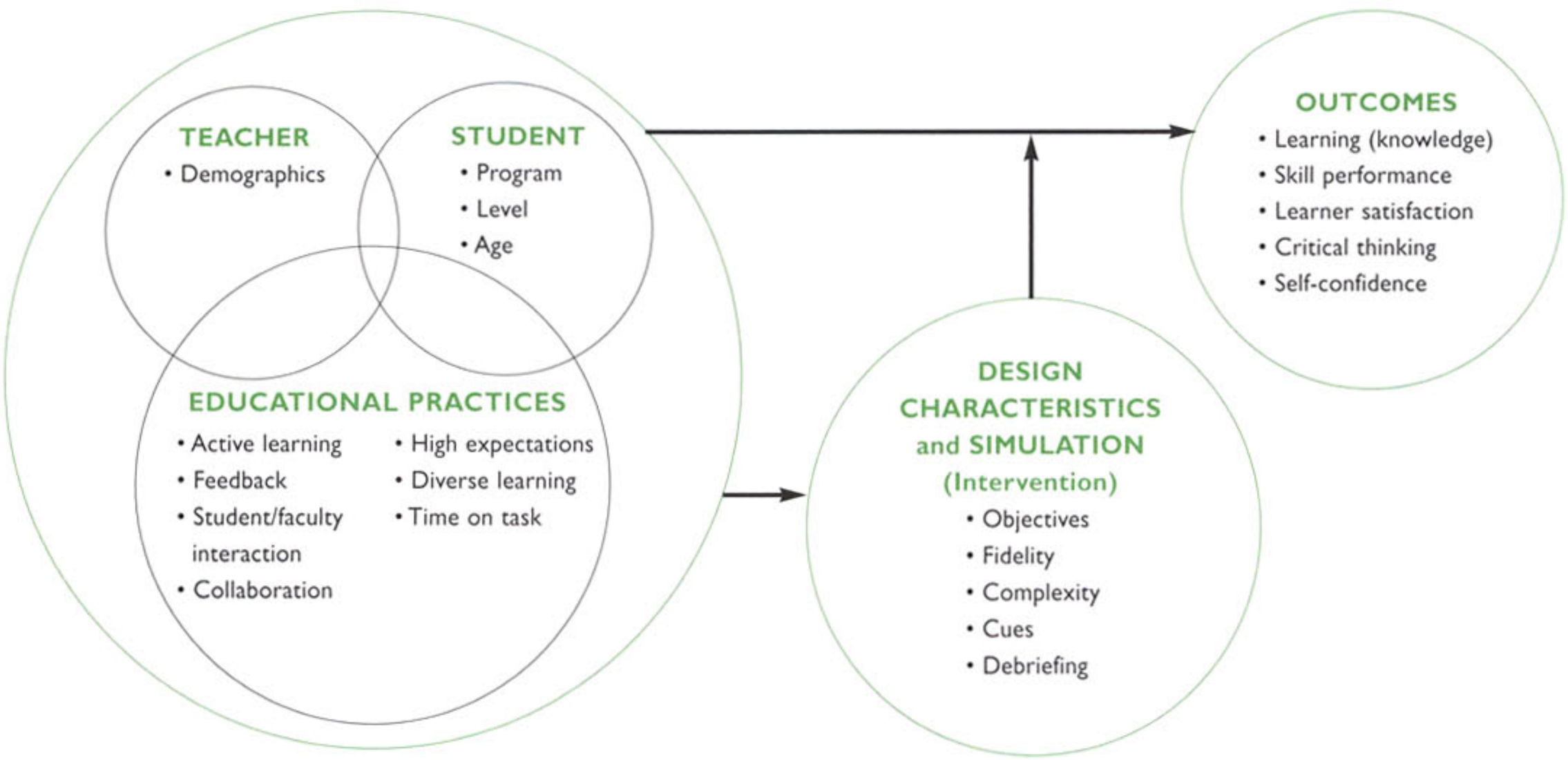
Computer-based simulations, which rely on two-dimensional, screen-based experiences, and part-task training devices can provide a certain degree of real-world application. These focus on specific skills or selected areas of human anatomy. High-fidelity patient simulators can provide real physical inputs and real environmental interactivity. To recreate all elements of a clinical situation, a full-scale or high-fidelity simulation would be used. Costs of simulators will vary widely depending on purchasing costs, salaries (laboratory technician), how faculty time is accounted for, and other factors. The proposed model is intended for all types of simulations, high or low fidelity, that are designed for use in nursing education today.

The need for a consistent and empirically supported model to guide the design and implementation of simulations and to assess outcomes has been urged by nurse educators as well as by leaders in medical education (4,5). Furthermore, a simulation framework that specifies relevant variables and their relationships is needed to conduct research in an organized, systematic fashion. When simulation is conducted in an unorganized manner, it is difficult to pinpoint effective and ineffective development and practice.

The simulation model in Figure 1 has five major components with associated variables. All variables may not be relevant to all studies; however, the framework is intended to provide a context for relating a variety of likely variables. The outcomes presented in the framework are proposed to be influenced by the degree to which best practices in education are incorporated in the design and implementation of the simulations. Effective teaching and learning using simulations are dependent on teacher and student interactions, expectations, and roles of each during these experiences. Thus, two components of the model are teacher factors and student factors.

Successful learning from the use of simulations requires proper simulation design and the appropriate organization of students in the simulation. The final component of the model, which serves as

Figure 1. Simulation Model



the intervention in teaching-learning practices, is the simulation itself. Each of the variables is discussed in the following sections. A review of nursing and other health care literature, including medicine, as well as related literature from non-health-care disciplines, guided the development and is integrated into the text.

Teacher Factors Teachers are essential to the success of using alternative learning experiences such as simulation activities. Unlike the traditional classroom setting where instruction is teacher-centered, instruction using simulation is student-centered, with the teacher playing the role of facilitator in the student's learning process. Depending on whether the simulation is conducted for learning or evaluation purposes, the teacher's role during the process will vary.

In the teaching or facilitating context, the teacher provides learner support as needed throughout the simulation and the debriefing that concludes the experience. Teachers may require assistance with simulation design, use of technology, and setting up equipment for the activity, but they must be prepared and feel comfortable with the simulations they are using. Johnson, Zerwic, and Theis (6) found that a faculty development workshop allowed teachers to experience feelings similar to those of students, enabling them to identify with students' anxiety and discomfort in participating in the new experience.

If the simulation is being conducted for evaluation purposes, the teacher's usual role would be that of observer. Although other roles for faculty have been proposed (7), the current literature lacks specific detail. Further research in this area is needed to define best practices for teachers and their roles in simulation.

Student Factors Although simulation experiences differ, students are generally expected to be responsible for their own learning to at least some degree. They must be self-directed and motivated during the simulation, which is more likely to happen if they know the ground rules for the activity. Competition during a simulation experience, although a common human motivator, is usually detrimental to learning because it may increase anxiety and stress. Therefore, competition should be discouraged in this context.

If the simulation involves role-playing, the instructor should inform students about the specific roles they are to play, particularly if the students are to work in groups. Roles vary with the case scenario. For example, one student may play the patient, another the nurse. The other students could play any additional roles, be in charge of videotaping, or act as observers. To learn different role perspectives, the students can rotate through assigned roles and talk about the various roles during debriefing.

Cioffi (4) discussed two student roles (response-based and process-based) when simulations are implemented in clinical practice. In the response-based role, the learner is not an active participant and has no control over the material presented. An example of this type of presentation would involve giving complete written case notes of a real patient to the learner. This format standardizes the information given across learners.

In the process-based method, the learner is an active participant, selecting the information presented and its sequence over time. Examples of this format are patient role-plays, vignettes, and simulator/simulation activities.

Progress toward attaining designated learning outcomes is judged during student evaluations. Gibbons and colleagues (8) described students' evaluating themselves while viewing a videotaped performance in private. These students completed the same critical skills checklist that was used by the faculty during their "live" patient scenarios. Self-evaluations ranged 5 percent to 10 percent higher than those of faculty.

Nehring, Lashley, and Ellis (9) recommended measuring student comfort with simulation experiences. More research is needed in the overall area of best practices and roles required by students to achieve optimal learning outcomes.

Educational Practices Research regarding good teaching has shown the importance of incorporating educational practices with certain pedagogical principles, that, when used consistently, result in student learning and satisfaction. Chickering and Gamson's seven principles (10), explained in the following paragraphs, are active learning, prompt feedback, student/faculty interaction, collaborative learning, high expectations, allowing diverse styles for learning, and time on task. These principles can be used to guide simulation design and implementation.

ACTIVE LEARNING Students are assumed to learn best through activities that require their active participation (11). Through simulation, learners are directly engaged in the activity and obtain immediate feedback and reinforcement of learning. Learning activities can range from simple to complex. For example, in a case scenario in which an intubated patient is restless, agitated, and coughing, affecting his oxygenation status, students can be asked to select the most appropriate intervention and describe the rationale for the intervention.

The human patient simulator (HPS) can be used to support more complex active learning strategies since the opportunity

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allows the student to assess a critical health incident (e.g., collapsed lung or status asthmaticus) through the measurement of physiological parameters and communication with the "patient," on-the-spot planning for quick and appropriate nursing interventions, and real-time response by the HPS for realistic evaluation and further intervention (9). Case scenarios, simulations of real-life clinical problems requiring assessment and decision-making skills, use of catheter simulators, role-playing with actors, and critiquing one's own or a peer's videotape of a selected skill performance are examples of methods used to promote active learning (1,4,9,12,13). Such active and interactive learning environments encourage students to make connections between and among concepts and engage students in the learning process.

FEEDBACK Whether the information is from the instructor, a peer, an HPS, or a computer-based tool, students believe that feedback is helpful, informative, and encouraging. Simulations provide students the opportunity to learn and practice nursing concepts with immediate feedback about how their performance, knowledge, and decision-making guide them toward desired learning outcomes (2,14-19).

In simulations, students' feedback to faculty is also important for assessing their understanding of the concepts and their performance skills. Aronson and colleagues (2) provide time after simulation experiences in the laboratory for learners to provide feedback about the experience. Students are instructed to write at least one nursing note describing one of the scenarios; these notes are reviewed by faculty at the designated station. Faculty believe that the exercise of providing feedback on the essential elements of the problem or intervention provides a valuable experience for the student. As Jones (20) noted, the spectrum of feedback takes students through a real-time representation of their interactions. Informed feedback sessions are used constructively to build on students' existing knowledge and to help them gain in confidence.

STUDENT-FACULTY INTERACTION This interaction can include discussion about course content and learning processes, as well as personal and professional goal setting. Simulation experiences have been found to facilitate discussions between faculty and students that helped promote the achievement of course goals (21). When setting up simulation experiences, Aronson and colleagues (2) had faculty members remain with one clinical scenario during two days of teaching. Students moved through the scenarios in small groups of three or four and interacted with the faculty member at each station.

O'Conner and colleagues (22) conducted a small seminar one week after the simulation experience so that students could discuss their experiences and reflect on the activities and learning with their instructor. Weis and Guyton-Simmons (3) developed a computer-assisted learning program and evaluated its impact on the critical-thinking skills of their nursing students. They discovered that the students solved problems better when a faculty member was in the room to answer questions while the program was being used. The importance of the faculty member should not be underestimated in whatever the learning situation may be.

COLLABORATIVE LEARNING With collaborative learning, participants work together to solve problems in a situation and share in the decision-making process. Gibbons and colleagues (8) found that collaborative learning with simulations increased a sense of collegiality and teamwork in learning and resulted in faculty-student bonding. Simulations can promote collaborative learning among students, instructors, and other health professionals to provide an environment in which everyone works together, mimicking what is actually done in real life.

Klein and Doran (23) found that students who used a small-group structure extensively during computer simulation assignments contributed significantly more to discussion and provided more answers to their partners' questions than students who used an occasional group structure. In a simulation experience set up by Aronson and colleagues (2), student groups gathered data related to the patient situation, made decisions about what they thought was going on with the scenario, and then chose appropri-

ate nursing interventions to meet the patient's needs. Each group appointed a spokesperson who reported the group's assessments and decisions to the faculty; then the group was debriefed on those judgments. Students' evaluation comments were overwhelmingly positive. Three major benefits identified from the study were sharing different ideas in a group, bringing course content to life without the stress of a real patient, and increasing confidence by giving opportunities for critical thinking and decision-making within their groups.

Rauen (24) suggested another mode of collaborative learning in which the novice worked together in a simulation session with a preceptor or other mentor. Witnessing a more experienced nurse apply rules and guidelines added to the experience base and gave the novice more knowledge to draw from.

Johnson and colleagues (6) required students to review and critique their own and other students' actions and behaviors, something they rarely would have the opportunity to do in a traditional clinical setting. Use of simulation scenarios allowed students to see other approaches to clinical problems that might be correct but different. Students began to realize there is not always a single correct course of action.

HIGH EXPECTATIONS High teacher expectations are important during a learning experience. Expecting the student to do well tends to become a self-fulfilling prophecy. It is important for students to set goals with faculty and seek advice on how to achieve them. When both faculty and students have high expectations for the simulation process and outcomes, positive results can be achieved. Vandrey and Whitman (12) asserted that nurses can be pushed to expand their competency levels and empowered to achieve greater learning in a safe learning environment using simulations where the instructor feels free to intervene.

DIVERSE LEARNING Nursing students in classrooms today are a diverse group with a range of learning needs and expectations. It is common to find traditional college-aged students and nontraditional adult learners in the same classroom setting (25). This increasing diversity of the student population has implications for faculty as they develop their teaching strategies, curriculum, and program development. Simulations can accommodate diverse learning styles and teaching methods and allow students and groups with varying cultural backgrounds to benefit from the experience.

TIME ON TASK Learning to use one's time well is important for faculty and students alike. Time on task can be increased with clear and realistic time frames for assignments, both verbal and written, as well as clear and focused objectives. It is helpful if only a few key concepts are taught or reinforced at each session.

While it is acknowledged that mistakes are part of the process, the establishment of ground rules relating to specific simulations will keep the learning focused. Thus, a detailed orientation to the technology that is part of the simulation experience is essential. An initial investment of time, during which the learner operates the mannequin before beginning a simulation session, will allow the learner to focus on the objectives of the session without distraction.

Shearer and Davidhizar (26) stated that the first steps in setting up simulation activities should be identifying learning objectives and providing a time frame so that students can plan and execute their activities efficiently. Even if role play or simulation is spontaneous and the instructor asks students to play a part on the spot, it is helpful to allow students time to warm up to the role and prepare for the experience. Van Ments (27) identified briefing, running, and debriefing as three components of role play that can be transferred to any simulated experience. He suggested that equal time be spent on each of the three parts.

Simulation Design The design for creating the teaching activities must be appropriate and support course goals, skill competencies, and learning outcomes. Specifically, attention must be paid to five areas discussed in the following sections: objectives, planning, fidelity, complexity, cues, and debriefing.

OBJECTIVES Clearly written objectives are needed when simulations are used to guide the students' learning and outcome achievements. Rauen (24) pointed out that objectives for the experience should match the learners' knowledge and experience. Shearer and Davidhizar (26), when implementing their role-play simulation, emphasized careful planning, identifying objectives for the experience, identifying a time frame, specifying roles for the experience, and disseminating information to the students prior to the activity.

Simulation is typically a new learning experience for students. In addition to objectives, students need information about the activity, process, amount of time required, role expectations, and outcome expectancies (24,26). Use of well-planned strategies provides the necessary structure for the achievement of learning objectives. Planning activities include: identifying objectives for the experience and providing students with a time frame, guidelines for role specifications, how the simulation experience would be monitored, and how the role is related to the theoretical concepts.

FIDELITY (REALISM) Clinical simulations need to mimic clinical

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reality, be process based, and have established validity (4). They must be authentic and include as many realistic environmental factors as possible (2,4,5,14,15,20). Hotchkiss and colleagues (5) noted a lack of systematic study regarding authenticity of the simulation experience, particularly with anesthesia. Noting that a completely realistic simulation is rare, they recommended as close an approximation as possible to promote better learning outcomes.

Barrow and Feltovich (28) stated that the structure of a realistic simulated clinical situation requires three elements: 1) relatively little information should be available initially; 2) the student should be allowed to investigate freely, employing questions in any sequence; and 3) the student should be given the clinical information over time during the simulation.

COMPLEXITY Simulations range from simple to complex. Simple simulations involve decision environments with low-level uncertainty that can be constructed with high or low levels of relevant information. Information at a high level is easily obtainable and relationships among the key decision variables are highly predictable and very stable.

Complex decision environments with high levels of uncertainty can also be constructed with high or low levels of relevant information. An environment with a high level of relevant information has easily obtainable information, but underlying relationships are not easy to identify (4). Nursing studies have interpreted task complexity to be present if the patient has a number of problems (e.g., confusion, ineffective airway clearance, depression) (29), patient problems are in relationship with one another (30), and clinical information is available but is irrelevant (29).

CUES During a simulation, faculty or other designated persons may help the student progress through the activity by providing information about the step the student is on or is approaching. Although cueing is often found in simulations reported in the literature, how and when the cues were delivered were inconsistent and often lacked clarity.

Weis and Guyton-Simmons (3) developed their nursing simulation in six sections, each with an introductory scenario requiring the student to determine if sufficient information was given to assess the patient's status adequately or to perform what he or she considered appropriate actions. Every question asked by the student either resulted in additional cues or directed the simulation to progress to the next response or scenario. A time limit was incorporated into each section to prevent participants from becoming "stranded." When the time limit was reached, a response was activated that gave suggestions on appropriate clinical judgments. Students then progressed to the next section.

To reinforce that patients in real life rarely exhibit all of the textbook signs and symptoms for a particular problem, Aronson and colleagues (2) designed simulation situations that included obvious signs and symptoms as well as cues indicative of the problem, complication, or need. They also purposefully included irrelevant or confusing data. In simulations done by Johnson and Zeric (6), faculty were available to provide cues if a students became stuck and did not know what to do next. Often, just providing a prompt helped students continue to process the situation.

DEBRIEFING A valuable tool when used with simulation, debriefing is sometimes overlooked. A debriefing activity reinforces the positive aspects of the experience and encourages reflective learning, which allows the participant to link theory to practice and research, think critically, and discuss how to intervene professionally in very complex situations (20,22,24,31,32). Debriefing takes place at the end of the session. The group discusses the process, outcome, and application of the scenario to clinical practice and reviews the relevant teaching points (24).

Jenkins and Turick-Gibson (31) discussed how the last step in their simulation activity was to share and generalize information with the students. The class discussed the events and degree of realism of the experience, leading the researchers to note that nursing implications emerged during lively interactions. Bruce, Bridges, and Holcomb (32) reported that in the United States Air Force Nursing Warskills Simulation Laboratory, debriefing is conducted after each scenario to support the development of critical thinking.

As with any teaching strategy, faculty and student feedback about the session is essential. The Laerdal SimMan™ patient simulator and good computer-based programs provide logs of students' actions and answers. In some programs the time of the action is indicated, which helps remove subjectivity from the teacher's appraisal of the student's performance.

Outcomes Course and activity outcomes typically associated with undergraduate and graduate nursing knowledge, skill performance, learner satisfaction, critical thinking, and self-confidence constitute the final component of the simulation model. Each is discussed below.

KNOWLEDGE Research has shown that didactic knowledge gained from simulations is retained longer than knowledge gained through lectures (33). The few studies measuring knowledge gained from simulations generally have found learning outcomes to be as good as those from traditional classroom learning, regardless of the type of simulation (e.g., CD-ROM, HPS, catheter simulator) (32,34-37).

SKILL PERFORMANCE Procedural skills are receiving increased attention because of their importance to patient care and the more rigorous competency standards being required by national organizations, credentialing bodies, and certification groups. The few studies evaluating skills using simulators and/or simulations have found that this mode of teaching will sometimes lead to quicker acquisition of the skill than conventional training methods (38). Simulation experiences also allow for the use of checklists as measures of skill competencies (36). Overall, a simulation experience or laboratory is an ideal setting for students to develop psychomotor skills without risk of inflicting harm on patients. To become comfortable and competent with technology usually requires repeated exposure to that technology, and this is easily accomplished in the simulated environment.

LEARNER SATISFACTION The simulation activity can be evaluated using quantitative or qualitative measures of students' responses to the experience. Studies by Johnson, Zerwic, and Theis (6), Engum and Jeffries (34), and Jeffries, Woolf, and Linde (35) used Likert scales (5 to 6 points) to ask students to rate various aspects of an interactive computer experience. Overall, the studies showed that students were very satisfied with this learning experience. Typical responses indicated that the experience provided opportunities to "think on your feet," "apply critical thinking skills," and "realize how much I really knew."

CRITICAL THINKING Many studies have looked at the outcome of critical thinking when using simulations. Although the measure of critical thinking has varied across studies, most have found that critical thinking occurs (3,6,15,24,31,32,39,40). Several studies used the Facione (41) California Critical Thinking Skills Tests (CCTST) (39), the California Critical Thinking Disposition Inventory (CCTDI) (40), or an instructor-developed critical thinking inventory and student journals (31) to assess students' critical thinking abilities.

SELF-CONFIDENCE Studies have shown that simulations can equip learners with skills that can be directly transferred into the clinical setting leading to increased self-confidence and improved clinical judgments (2,4,6,15,42). Overall, studies show that simulation activities tend to increase students' confidence in their critical thinking and problem-solving abilities (6).

Summary The process of teaching and learning using simulations in nursing is complex, multifaceted, and challenging. A framework for identifying the components of this process and their relationships can serve to guide the design, implementation, and evaluation of these activities. The conceptual framework for simulation design, implementation, and evaluation as described in this article should be helpful to nursing educators and researchers as they attempt to develop and evaluate the most cost-effective teaching methods. NLN

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References

1. Morton, P. (1997). Using a critical care simulation laboratory to teach students. *Critical Care Nurse, 17*(6), 66-68.

2. Aronson, B., Rosa, J., Anfinson, J., & Light, N. (1997). A simulated clinical problem-solving experience. *Nurse Educator, 22*(6), 17-19.

3. Weis, P., & Guyton-Simmons, J. (1998). A computer simulation for teaching critical thinking skills. *Nurse Educator, 23*(2), 30-33.

4. Cioffi, J. (2001). Clinical simulations: Development and validation, *Nurse Education Today, 21*, 477-486.

5. Hotchkiss, M., Biddle, C., & Fallacaro, M. (2002). Assessing the authenticity of the human simulation experience in anesthesiology. *AANA Journal, 70,* 470-473.

6. Johnson, J, Zerwic, J., & Theis, S. (1999). Clinical simulation laboratory: An adjunct to clinical teaching. *Nurse Educator, 24*(5), 37-41.

7. Seropian, M. (2003). General concepts in full scale simulation: Getting started. *Anesthesiology Analog, 97,* 1695-1705.

8. Gibbons, S., Adamo, G., Padden, D., Ricciardi, R., Graziano, M., Levine, E., & Hawkins, R. (2002). Clinical evaluation in advanced practice nursing education: Using standardized patients in health assessment. *Journal of Nursing Education, 41,* 215-221.

9. Nehring, W. M., Lashley, F. A., & Ellis, W. E. (2002). Critical incident nursing management using human patient simulators. *Nursing Education Perspectives, 23,* 128-132.

10. Chickering, A., & Gamson, Z. (1987, March). Seven principles of good practice in undergraduate education. *AAHE Bulletin.*

11. Tomey, A. (2003). Learning with cases. *Journal of Continuing Education in Nursing, 34*(1), 34-37.

12. Vandrey, C., & Whitman, M. (2001). Simulator training for novice critical care nurses. *American Journal of Nursing, 101*(9), 24GG-24LL.

13. Lee, C., & Lamp, J. (2003). The use of humor and role-playing in reinforcing key concepts. *Nurse Educator, 28*(2), 61-62.

14. Hample, J., Herbold, N., Schneider, M., & Sheeley, A. (1999). Using standardized patients to train and evaluate dietetics students. *Journal of the American Dietetic Association, 99,* 1094-1097.

15. Peterson, M., & Bechtel, G. (2000). Combining the arts: An applied critical thinking approach in the skills laboratory. *Nursing Connections, 13*(2), 43-49

16. Gates, D., Fitzwater, E., & Telintelo, S. (2001). Using simulations and standardized patients in intervention research. *Clinical Nursing Research, 10,* 387-399.

17. Gordon, J., & Pawlowski, J. (2002). Education on-demand: The development of a simulator-based medical education service. *American Medicine, 77*(7), 751.

18. Pugh, C., & Youngblood, P. (2002). Development and validation of assessment measures for a newly developed physical examination simulator. *Journal of Medical Informatics Association, 9,* 448-460.

19. Byrne, A., Sellen, A., Jones, J., Aitkenhead, A., Hussain, S., Smith, T., & Ribes, P. (2002). Effect of videotape feedback on anaesthetists' performance while managing simulated anaesthetic crises: A multicentre study. *Anaesthesia, 57*(2), 176-179.

20. Jones, N. (2002). *The facilitation of interactive simulation.* [On-line]. Available: http://www.patientsimulation.co.uk/4653/7006.html.

21. Roberts, J. D., While, A., & Fitzpatrick, J. M. (1992). Simulation: Current status in nurse education. *Nurse Education Today, 12,* 409-415.

22. O'Connor, F., Albert, M., & Thomas, M. (1999). Incorporating standardized patients into a psychosocial nurse practitioner program. *Archives of Psychiatric Nursing, 8*(5), 240-247.

23. Klein, J., & Doran, M. (1999). Implementing individual and small group learning structures with a computer simulation. *Educational Technology, Research and Development, 47*(1), 97-110.

24. Rauen, C. (2001). Using simulation to teach critical thinking skills. *Critical Care Nursing Clinics of North America, 13*(1), 93-103.

25. Richardson, V. (1998). The diverse learning needs of students. In D. Billings & J. Halstead (Eds.), *Teaching in nursing: A guide for faculty* (pp. 17-34). Philadelphia: W. B. Saunders.

26. Shearer, R., & Davidhizar, R. (2003). Using role play to develop cultural competence. *Journal of Nursing Education, 42,* 273-276.

27. Van Ments, J. (1983). *The effective use of role play: A handbook for teachers and trainers.* London: Kogan Press.

28. Barrow, H. S., & Feltovich P. J. (1987). *The clinical reasoning process. Medical Education, 21*(2), 86-91.

29. Hughes, K., & Youngblood, W. B. (1990). The relationship between task complexity and decision-making consistency. *Research in Nursing and Health, 13,* 189-197.

30. Corcoran, S. (1987). Task complexity and nursing expertise as factors in decision-making. *Nursing Research, 35,* 107-112.

31. Jenkins, P., & Turick-Gibson, T. (1999). An exercise in critical thinking using role playing, *Nurse Educator, 24*(6), 11-14.

32. Bruce, S., Bridges, E. J., & Holcomb, J. B. (2003). Preparing to respond: Joint trauma training center and USAF Nursing Warskills Simulation Laboratory. *Critical Care Nursing Clinics of North America, 15,* 149-152.

33. Fuszard, R. (1995). *Innovative teaching strategies in nursing* (2nd ed.). Gaithersburg, MD: Aspen Publishers.

34. Engum, S., & Jeffries, P. R., (2003). Intravenous catheter training system: Computer-based education vs. traditional learning methods. *American Journal of Surgery, 186*(1), 67-74.

35. Jeffries, P. R, Woolf, S., & Linde, B. (2003). Technology-based vs. traditional instruction: A comparison of two methods for teaching the skill of performing a 12-lead ECG. *Nursing Education Perspectives, 24,* 70-74.

36. Jones, T., Cason, C., & Mancini, M. (2002). Evaluating nurse competency: Evidence of validity for a skills re-credentialing program. *Journal of Professional Nursing, 18,* 22-28.

37. Hsu, Y. S. (2003). *The development of an exploratory simulation for constructivist learning: An example of Java application.* [On-line]. Available: http:www.pals.iastate.edu/simulations/library/papers/mountainsim_development.html.

38. Ost, D., DeRosiers, E., Britt, J., Fein, A., Lesser, M., & Mehta, A. (2001). Assessment of a bronchoscopy simulator. *American Journal of Respiratory Critical Care Medicine, 164,* 2248-2255.

39. Chau, J., Chang, A., Lee, I., Ip, W., Lee, D., & Wootton, Y. (2001). Effects of using videotaped vignettes on enhancing students' critical thinking ability in a baccalaureate nursing programme. *Journal of Advanced Nursing, 36,* 112-119.

40. Ravert, P. (2003). Human patient simulator use by nursing students: Effects on critical thinking. *Community Nursing Research, 36,* 352.

41. Facione, P. (1990). *The California Critical Thinking Skills Test: Forms A and B.* Millbrae, CA: California Academic Press.

42. Thiele, J., Holloway, J., Murphy, D., Pardavis, J., & Stuckey, M. (1991). Perceived and actual decision making by novice baccalaureate students. *Western Journal of Nursing Research, 13,* 616-626.