FEATURE ARTICLE

Human Patient Simulators and Interactive Case Studies

A Comparative Analysis of Learning Outcomes and Student Perceptions

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Although human patient simulators provide an innovative teaching method for nursing students, they are quite expensive. To investigate the value of this expenditure, a quantitative, quasi-experimental, two-group pretest and posttest design was used to compare two educational interventions: human patient simulators and interactive case studies. The sample (N = 49) consisted of students from baccalaureate, accelerated baccalaureate, and diploma nursing programs. Custom-designed Health Education Systems, Inc examinations were used to measure knowledge before and after the implementation of the two educational interventions. Students in the human patient simulation group scored significantly higher than did those in the interactive case study group on the posttest Health Education Systems, Inc examination, and no significant difference was found in student scores among the three types of nursing programs that participated in the study. Data obtained from a questionnaire administered to participants indicated that students responded favorably to the use of human patient simulators as a teaching method.

KEY WORDS

Case studies • HESI • Human patient simulators • Quantitative research

Recent technological advances have enhanced the capability of human patient simulators (HPS) to duplicate clinical situations so that students can practice decision-making skills in a controlled environment. When using HPS, nursing students experience a real-life patient problem and follow the nursing process through interactions with the HPS. Students collect data from the HPS through the assessment process, analyze this information, and intervene based on the patient situation. Human patient simulators are programmed to respond by determining the outcome of the student's intervention—the simulated patient either recovers from the problem after receiving proper treatment or dies as the result of omitting a necessary intervention or implementing an inappropriate intervention. While nursing faculty are amazed and enthralled with the technology and innovativeness of this teaching method, HPS are expensive, costing between $30 000 and $150 000 each.[1,2] The time required for faculty training, as well as the time required to program the clinical scenarios, must also be considered when calculating the expenses associated with this teaching strategy. Additionally, physical space must be allocated for the storage and operation of the HPS, adding further to the cost of this instructional device.

Traditionally, case studies have been used successfully as a teaching strategy to promote students' learning and enhance their clinical decision-making skills. Many nursing textbooks provide subject-specific case studies as a faculty resource at no charge to schools that select these books as course textbooks. Faculties at the schools of nursing that participated in this study were

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well satisfied with the Evolve[3] case studies provided by Elsevier nursing textbooks and developed programs whereby faculty facilitators interacted with the students regarding the content and decision-making opportunities presented in the case studies. These faculty-facilitated interactions were referred to as *interactive case studies* (ICSs).

Because ICSs were highly regarded by the faculties as a teaching method, the authors decided to compare this teaching strategy with the technologically advanced HPS to determine if the costs associated with HPS were justified. Specifically, the purpose of this study was to compare students' learning and their perceptions regarding their learning using two educational interventions: HPS and ICS.

REVIEW OF LITERATURE

Rudimentary HPS were first introduced to healthcare education in 1969 and were primarily used to teach anesthesia residents how to insert endotracheal tubes.[4,5] More realistic HPS, created in 1988, were designed to teach medical and anesthesia practitioners crisis management and technical skills.[6] Recent technological advances enable HPS to duplicate scenarios that nursing students are likely to encounter in clinical practice and offer them the opportunity to safely practice decision-making skills in a controlled environment. The benefit of using simulations in nursing education is to expose students to high-risk, low-occurrence critical events so that they can practice in a safe environment and real patients incur no harm from the potential omissions or mistakes that students might make.[7,8]

Many healthcare educators have described the use of HPS as a teaching strategy. Trossman[9] reported on the successful use of HPS to orient new nurse graduates in a large medical center and suggested that the use of HPS was helpful in easing their level of anxiety when faced with high-risk situations. Vandrey and Whitman[10] described the use of HPS to train critical care nurses by recreating clinical events, such as shock, myocardial infarction, pneumothorax, airway emergencies, and cardiac arrest. Marsch et al[11] used HPS to conduct a study in a tertiary-level intensive care unit to evaluate first responders' adherence to the algorithms for cardiopulmonary resuscitation in simulated cardiac arrests. Yaeger et al[12] described the use of HPS to teach neonatal nursing skills to novice nurses. Medley and Horne[13] reported that students responded positively to the use of HPS in undergraduate nursing education. Bearnson and Wiker[14] found HPS to be effective in teaching medication administration and described positive student responses to this teaching strategy.

Although the nursing literature is generally positive with respect to the value of HPS as a teaching strategy, some authors have described various problems associated with their use. Cioffi et al[15] reported that the effect of using HPS as a teaching strategy is currently inconclusive, which is largely, due to the lack of valid and reliable outcome assessment tools. Seropian et al[16] suggested that although the use of simulation products in nursing education has increased over the past few years, there has been little or no instruction related to their implementation or use within the curriculum. Ravert[17] reviewed the literature and found 513 studies that addressed some type of computer-based simulation, but only nine were quantitative studies. The author concluded that more research in nursing education is needed to validate the effectiveness of simulation as an educational intervention and to examine the cost-benefit ratio with respect to the integration of simulation into nursing curricula.

METHODOLOGY

A quantitative, quasi-experimental, two-group pretest and posttest design was used to compare the two teaching strategies: HPS and ICS. After receiving institutional review board approval, the primary investigator wrote two scenarios that were used to program the Laerdal HPS (Laerdal Medical, Wappingers Falls, NY). These scenarios were chosen because they covered course content that was currently being taught in both the BSN and diploma curricula. Both the HPS and ICS scenarios covered the same subject matter: care of the patient with acute coronary syndrome (ACS) and care of the patient with acute ischemic stroke. Student learning was measured by pretest and posttest Health Education Systems, Inc (HESI), custom examinations (Elsevier, Burlington, MA). Two parallel forms of these custom examinations were developed. One examination was used as the pretest and was administered before the educational interventions were begun, and the other was used as the posttest and was administered after the educational interventions were completed. Students' perceptions of their learning experience were measured by a questionnaire designed by the primary investigator.

Sample

The sample consisted of 49 senior nursing students, 13 (26.53%) baccalaureate (BSN) students, 13 (26.53%) accelerated baccalaureate (A-BSN) students, and 23 (46.94%) diploma students. The BSN and the A-BSN students attended the same private university in western Pennsylvania, and the diploma students attended a hospital-based school of nursing located approximately

60 miles northwest of the university. The sample included nine men and 40 women. Of the 49 participants, nine were between 18 and 24 years of age, 18 were between 25 and 31 years of age, 12 were between 32 and 38 years of age, seven were between 39 and 45 years of age, and three were older than 45 years. Table 1 presents the demographic data of the study's participants.

Students from each of the three nursing programs were randomly assigned to one of the two teaching strategy groups: HPS or ICS. Of the 13 BSN students, eight (61.54%) were assigned to the HPS group and five (38.46%) were assigned to the ICS group. Of the 13 A-BSN students, five (38.46%) were assigned to the HPS group and eight (61.54%) were assigned to the ICS group. Of the 23 diploma students, 12 (52.17%) were assigned to the HPS group and 11 (47.83%) were assigned to the ICS group.

Description of Instruments

HEALTH EDUCATION SYSTEMS, INC, CUSTOM EXAMINATIONS

Morrison et al[18] described the process for writing critical thinking test items, and this process is used by nurse educators to write test items for HESI examinations. Morrison et al[19] described the psychometric standards used to evaluate HESI test items and reported on the reliability and validity of HESI examinations. Numerous studies have investigated the validity of HESI Exit Exams and have found them to be highly predictive of NCLEX-RN success,[20–26] and numerous authors have reported on the validity of HESI examinations administered within nursing curricula.[27–34] Because the test items that are used to create custom HESI examinations originate from the same database that is used to design all HESI examinations, they must meet the same rigorous standards as the test items contained in any HESI examination, including exit examinations and specialty examinations.

PRETEST AND POSTTEST

The same pretest and posttest were administered to all students, regardless of which educational intervention they received. Two 20-item custom examinations were designed by HESI, each based on the same test blueprint that was provided to the company by the primary investigator. One custom examination served as the pretest and the other served as the posttest. Approximately 75 test items were submitted to the primary investigator for review, and the pretest and posttest examinations were designed based on the primary investigator's evaluation of these test items. The questions included in the custom examinations were judged by the primary investigator to be valid measures of the students' knowledge of the content presented by the two teaching strategies and their ability to apply that content to clinical problems. The average point biserial correlation coefficient (PBCC) for test items contained in the pretest was 0.13, and the average PBCC for the posttest was 0.15. The average difficulty level for the pretest was 0.70, and average difficulty level for the posttest was 0.69. The estimated reliability coefficient for the pretest was 0.93, and the estimated reliability coefficient for the posttest was 0.94. Therefore, the pretest and posttest examinations used to measure student learning were similar, in terms of not only the test blueprint but also the examinations' psychometric properties.

SIMULATION AND CASE STUDY EVALUATION SURVEY

To measure students' perceptions of the educational intervention they received, either HPS or ICS, the Simulation and Case Study Evaluation Survey was administered to participants following completion of the posttest. This questionnaire was designed by the primary investigator, reviewed by a group of nurse educators who were content experts, revised by the primary investigator based on the nurse educators' suggestions, and then pilot tested with a group of five students. Final approval of the questionnaire was provided by the same group of nurse educators before it was administered to the study participants. Internal consistency was determined by Cronbach α (.87), suggesting that the instrument was reliable. A four-point Likert scale was used to obtain the students' perceptions regarding their experiences with the teaching strategy they encountered, either the HPS or the ICS.

Program Type		Sex		Age	
BSN	13 (26.53%)	Male	9 (18.37%)	18–24 y	9 (18.37%)
A-BSN	13 (26.53%)	Female	40 (81.63%)	25–31 y	18 (36.73%)
Diploma	23 (46.94%)			32–38 y	12 (24.49%)
				39–45 y	7 (14.29%)
				>45 y	3 (6.12%)
Total	49 (100%)	Total	49 (100%)	Total	49 (100%)

Data Collection

The BSN, A-BSN, and diploma students received their assigned educational intervention within a 6-month data collection period. The procedure for conducting the study was identical for all participating nursing programs. The same pretest was administered to both the HPS and the ICS students at the same time on the day that they received their educational intervention. In an effort to control for extraneous variables such as additional clinical experience or instruction, the same posttest was administered to both groups of students immediately after each group finished their assigned educational intervention. Additionally, the pretest and posttest were designed based on the same test blueprint, but they contained different test items in an effort to control for effects related to familiarity with test items. Following the posttest, all students completed the Simulation and Case Study Evaluation Survey.

DESCRIPTION OF EDUCATIONAL INTERVENTION: HUMAN PATIENT SIMULATOR

After viewing a 10-minute Microsoft PowerPoint presentation (Microsoft, Redmond, WA) that described care of the patient with ACS and care of the patient with an acute ischemic stroke, students in the HPS group received a 15-minute orientation to the HPS in the simulation laboratory. Students blindly chose index cards to determine the role they would play in the ACS scenario: primary nurse, secondary nurse, family member, or nursing assistant. After receiving a verbal patient report from the instructor, students began caring for the simulated patient. To document a patient history, students asked the HPS questions, performed a head-to-toe assessment, analyzed the data, and intervened with the critically ill simulated patient. Following the scenario, which lasted approximately 15 minutes, the primary investigator held a debriefing session with students in which a videotape of the simulation experience was reviewed. The primary investigator served as the faculty facilitator for all students who received the HPS educational intervention. After a 5-minute break, students were once again assigned roles by choosing index cards, and the simulation experience was repeated with the acute ischemic stroke scenario. Both simulation experiences were completed in approximately 2.5 hours.

DESCRIPTION OF EDUCATIONAL INTERVENTION: INTERACTIVE CASE STUDY

Students in the ICS group viewed the same 10-minute Microsoft PowerPoint presentation that the students in the HPS group viewed on care of the patient with ACS and care of the patient with an acute ischemic stroke. Following this presentation, students in the ICS group were provided with three medical-surgical nursing textbooks and a copy of the ACS and stroke case studies. Using group discussion to analyze the content presented in each of the case studies, students answered the case study questions as a group. After these questions were completed, the instructor provided additional guidance and teaching as indicated by students' responses to the case study questions and the discussion that ensued during the review of the questions. Clinical nursing faculty and graduate student assistants received an orientation to the ICS instructional method from the primary investigator. Following this orientation, they served as the faculty facilitators for the ICS group. The ICS experience was completed in approximately 2 hours.

FINDINGS

A one-way, between-subjects analysis of covariance (ANCOVA) was used to compare HPS and ICS posttest HESI scores. The mean posttest scores were adjusted to statistically control for differences in pretest scores, thus reducing the amount of unexplained error. The adjusted mean posttest HESI score for the HPS group was significantly higher ($P \leq .05$) than the adjusted mean posttest HESI score for the ICS group (Table 2). An ANCOVA was also used to determine if posttest HESI scores were different among program types. No significant difference was found in posttest scores by program type: BSN, A-BSN, and diploma (Table 3).

Responses to the Simulation and Case Study Evaluation Survey were described using means and SDs, and differences between the HPS group and the ICS group were analyzed using independent-samples t tests. Data were obtained from students' responses to statements provided in the survey using a Likert scale. The scale ranged from 1 to 4, with 1 representing "strongly disagree"; 2, "disagree"; 3, "agree"; and 4 "strongly agree." Findings indicated that students in the HPS group agreed significantly more than did students in the ICS group with the following statements: helped to stimulate critical thinking; was a valuable learning experience; knowledge gained can be transferred to the clinical setting; should be included in our undergraduate education; helped me better understand concepts; experienced nervousness during the educational intervention; because of the educational intervention, I will be less nervous in the clinical setting when providing care for similar patients; and can be a substitute for clinical experiences in the hospital. There was no significant difference between the HPS and ICS groups' responses to the statement that the educational intervention was realistic. Table 4

Table 2

ANCOVA Comparison of Pretest and Posttest HESI Scores by Educational Intervention

	Pretest HESI Scores		Posttest HESI Scores		
	Mean	SD	Mean	SD	Adjusted Mean Scores
HPS (simulation group)	713.12	153.56	738.00	131.01	750.42[a]
ICS (case study group)	786.17	184.81	670.08	181.83	657.14[a]

The HPS group scored significantly higher on the posttest than the ICS group did.
[a]$P \leq .05$.

describes the findings provided by the Simulation and Case Study Evaluation Survey.

DISCUSSION

This study used a quantitative, quasi-experimental, two-group pretest and posttest design to evaluate HPS as an educational intervention in nursing curricula. The independent variable was educational intervention (HPS or ICS), and the dependent variable was the student's score on a custom HESI medical-surgical examination, which measured knowledge and critical thinking abilities. The same HESI custom examinations were administered to student participants in both groups before and after the implementation of the teaching strategy to which they were assigned, either the HPS or the ICS. The pretest and posttest were parallel forms of the same examination in that they used the same test blueprint and possessed almost identical psychometric properties. The average posttest HESI score for the HPS group *increased* over the average pretest score by 24.88 points (3.49%), whereas the average posttest HESI score for the ICS group *decreased* from the average pretest score by 116.09 points (17.32%). The decrease in posttest scores for the ICS group is a puzzling finding because it is highly unlikely that unlearning took place with the implementation of the ICS. Several conjectures may explain this finding. Because the ICS intervention was a more passive activity than the HPS intervention was, students in the ICS group may have experienced more fatigue at the end of the session when the posttest was administered than did the students in the HPS group, who were quite active during the intervention. The fact that HPS is a newer technological educational intervention may have increased the students' interest in the project, thereby increasing their interest in completing the posttest, whereas the use of ICSs is an older educational intervention, and students in this group may have had less interest in completing the posttest. Also, the primary investigator served as the faculty facilitator for the HPS group, whereas faculty with less classroom experience, including graduate student assistants, served as the faculty facilitators for the ICS group. These differences could have influenced the posttest findings. Regardless of the reason for the decrease in the ICS group's posttest scores, the ANCOVA, which controls for differences in pretest findings, indicates that the HPS group scored significantly higher ($P \leq .05$) than the ICS group did on the posttest HESI custom examination.

Qualitative data obtained from the Simulation and Case Study Evaluation Survey indicated that students who participated in the HPS educational intervention responded more positively toward the educational intervention than did students who participated in the ICS educational intervention. Students reported that the HPS assisted them in understanding concepts, provided a valuable learning experience, helped to stimulate critical thinking abilities and decrease anxiety, and should be included in undergraduate education. The findings of this study regarding students' positive perceptions of HPS as a teaching strategy are consistent with data reported throughout the health education literature.

Although these findings describe the value of implementing the use of HPS into nursing curricula, faculty and administrators must consider that simply purchasing an HPS for a nursing school does not ensure its effective

Table 3

ANCOVA Comparison of Posttest HESI Scores by Program Type

Educational Intervention	Program Type	No.	Mean	SD
HPS	BSN	7	719.29	139.389
	A-BSN	6	775.67	135.870
	Diploma	12	730.08	131.892
	Total	25	738.00	131.013
ICS	BSN	6	649.50	148.569
	A-BSN	7	624.57	214.604
	Diploma	11	710.27	184.095
	Total	24	670.08	181.828
Total	BSN	13	687.08	142.207
	A-BSN	13	694.31	192.005
	Diploma	23	720.61	155.580
	Total	49	704.73	160.002

No significant difference was found in posttest HESI scores by program type: BSN, A-BSN, and diploma.

Table 4

Independent *t* Tests on Survey Data

Survey Statement	HPS		ICS		Significance	
	Mean[a]	SD	Mean[a]	SD	t	P
Helped to stimulate critical thinking	3.84	0.37	3.50	0.83	1.85	.070[b]
Was a valuable learning experience	3.80	0.41	3.13	0.68	4.23	.0004[c]
Knowledge gained can be transferred to the clinical setting	3.80	0.41	3.46	0.78	1.93	.059[b]
Should be included in our undergraduate education	3.76	0.44	3.29	0.75	2.68	.010[c]
Helped me better understand concepts	3.72	0.46	3.25	0.74	2.69	.010[c]
Experienced nervousness during the educational intervention	3.56	0.51	1.67	0.82	9.78	.0004[c]
Were realistic	3.56	0.51	3.46	0.72	0.57	.569
Because of the educational intervention, I will be less nervous in the clinical setting when providing care for similar patients	3.00	0.82	2.58	0.78	1.83	.074[b]
Can be a substitute for clinical experiences in the hospital	2.56	0.92	1.92	1.10	2.28	.027[c]

[a]Scores are based on a Likert scale, where 1 indicates "strongly disagree" and 4 indicates "strongly agree." Scores higher than 2.5 indicate agreement with the statement.
[b]$P \leq .01$.
[c]$P \leq .05$.

use. Resources must be allocated for faculty development so that this teaching strategy can be effectively implemented within nursing curricula. Time and money must be spent to educate faculty about the technology required to operate an HPS. Additionally, faculty release time should be provided for designing effective simulations, which includes writing the objectives, programming the scenarios, pilot testing the scenarios, and revising the scenarios as needed. The HPS scenarios used in this study were created by the primary investigator, who acted as the faculty facilitator for the students who participated in the HPS group. As a result, a personal bias on the part of the primary investigator may have existed, and if it did exist, it may have influenced the findings of this study. Furthermore, future studies should use larger samples sizes, and the population should include associate degree nursing programs.

CONCLUSIONS

Numerous publications that describe the use of HPS in healthcare education and students' perceptions of this educational technology exist in the nursing literature. However, few quantitative studies have addressed the outcomes associated with the implementation of HPS as a teaching strategy.[17] Although nursing faculty should continue to qualitatively assess students' perceptions of HPS, as well as other teaching strategies, more quantitative research is needed to scientifically investigate learning outcomes associated with the implementation of various teaching strategies. Schools of nursing should further explore the integration of HPS as an educational strategy into nursing curricula and, most importantly, evaluate learning outcomes related to the implementation of HPS within their particular curriculum.

The findings of this study indicate that students who participated in the HPS educational intervention learned more than did those in the ICS group. Additionally, there was no significant difference in posttest HESI custom examination scores among the three program types tested: BSN, A-BSN, and diploma. Therefore, despite the costs associated with implementing HPS as a teaching strategy in nursing curricula, the authors conclude that such an expense is warranted in view of the greater learning outcomes that were achieved by students from all types of programs who participated in the HPS group. The qualitative findings of this study support previously published reports regarding positive responses from students about their experience using HPS as an educational intervention. More importantly, these findings also support the use of the HPS as an effective teaching strategy in enhancing students' learning outcomes.

REFERENCES

1. Laerdal. Patient simulator cost information. http://www.laerdal.com/document.asp?subnodeid=7320252. Accessed January 21, 2008.
2. Medical Education Technologies, Inc. Sales contacts. http://www.meti.com/about_contact_na.htm. Accessed January 21, 2008.
3. Lewis S, Heitkemper M, Obrien P, Bucher L. Instructor resources for medical-surgical nursing assessment and management of clinical problems. Evolve Web site. http://evolvels.elsevier.com/section/default.asp?id=0247%5Fglobal%5F0001. Accessed April 21, 2006.
4. Abrahamson S, Denson JS, Wolf RN. Effectiveness of a simulator in training anesthesiology residents. *J Med Educ*. 1969;44:515–519.
5. Gaba DM. Improving anesthesiologists' performance by simulating reality. *Anesthesiology*. 1992;76:491–494.
6. O'Donnell J, Fletcher J, Dixon B, Palmer L. Planning and implementing an anesthesia crisis resource management course for student nurse anesthetists. *CRNA*. 1998;9(2):50–58.

7. Chopra V, Gesink BJ, deJong J, Bovill JG, Spierdijk J, Brand R. Does training on an anaesthesia simulator lead to improvement in performance? *Br J Anaesth*. 1994;73:293–297.
8. Haskvitz LM, Koop EC. Students struggling in clinical? A new role for the patient simulator. *J Nurs Educ*. 2004;43(4):181–184.
9. Trossman S. Bold new world: technology should ease nurses' jobs, not create a greater workload. *Am J Nurs*. 2005;105(5):75–77.
10. Vandrey CI, Whitman KM. Simulator training for novice critical care nurses: preparing providers to work with critically ill patients. *Am J Nurs*. 2001;101(9):24GG–24LL.
11. Marsch SC, Tschan F, Semmer N, Spychiger M, Breuer M, Hunziker PR. Performance of first responders in simulated cardiac arrests. *Crit Care Med*. 2005;33(5):963–967.
12. Yaeger KA, Halamek LP, Coyle M, et al. High-fidelity simulation-based training in neonatal nursing. *Adv Neonatal Care*. 2004;4(6): 326–331.
13. Medley CF, Horne C. Using simulation technology for undergraduate nursing education. *J Nurs Educ*. 2005;44(1):31–34.
14. Bearnson CS, Wiker KM. Human patient simulators: a new face in baccalaureate nursing education at Brigham Young University. *J Nurs Educ*. 2005;44(9):421–425.
15. Cioffi J, Purcal N, Arundell F. A pilot study to investigate the effect of a simulation strategy on the clinical decision making of midwifery students. *J Nurs Educ*. 2005;44(3):131–134.
16. Seropian MA, Brown K, Gavilanes JS, Driggers B. Simulation: not just a manikin. *J Nurs Educ*. 2004;43(4):164–169.
17. Ravert P. An integrative review of computer-based simulation in the education process. *Comput Inform Nurs*. 2002;20(5):203–208.
18. Morrison S, Nibert A, Flick J. *Critical Thinking and Test Item Writing*. 2nd ed. Houston, TX: Health Education Systems, Inc; 2006.
19. Morrison S, Adamson C, Nibert A, Hsia S. HESI exams: an overview of reliability and validity. *Comput Inform Nurs*. 2004;22(4): 220–226.
20. Lauchner K, Newman M, Britt R. Predicting licensure success with a computerized comprehensive nursing exam: the HESI Exit Exam. *Comput Nurs*. 1999;17(3):120–128.
21. Newman M, Britt R, Lauchner K. Predictive accuracy of the HESI Exit Exam: a follow-up study. *Comput Nurs*. 2000;18(3):132–136.
22. Nibert A, Young A. A third study on predicting NCLEX success with the HESI Exit Exam. *Comput Nurs*. 2001;19(4):172–178.
23. Nibert A, Young A, Adamson C. Predicting NCLEX success with the HESI Exit Exam: fourth annual validity study. *Comput Inform Nurs*. 2002;20(6):261–267.
24. Lewis C. *Predictive Accuracy of the HESI Exit Exam on NCLEX-RN Pass Rates and Effects of Progression Policies on Nursing Student Exit Exam Scores* [dissertation]. Houston: TX Woman's University; 2005.
25. Daley L, Kirkpatrick B, Frazier S, Chung M, Moser D. Predictors of NCLEX-RN success in a baccalaureate nursing program as a foundation for remediation. *J Nurs Educ*. 2003;42(9):390–398.
26. Adamson C, Britt R. Repeat testing with the HESI Exit Exam—sixth validity study. *Comput Inform Nurs*. 2009;27(6):393–397.
27. Higgins B. Strategies for lowering attrition rates and raising NCLEX-RN pass rates. *J Nurs Educ*. 2005;44(12):541–547.
28. Hardin J. *Predictors of Success on the National Council Licensing Examination Computerized Exam (CAT-NCLEX-RN) in Associate Degree Nursing Programs: A Logistic Regression Analysis* [dissertation]. Commerce, TX: Texas A&M University; 2005.
29. Frith K, Sewell J, Clark D. Best practices in NCLEX-RN readiness preparation for baccalaureate student success. *Comput Inform Nurs*. 2005;23(6):322–329.
30. Yoho M, Young A, Adamson C, Britt R. The predictive accuracy of HESI exams for associate degree nursing students. *Teach Learn Nurs*. 2007;2:80–84.
31. Hamner J, Bentley R. Lessons learned from 12 years of teaching second-degree BSN students. *Nurse Educ*. 2007;32(3):126–129.
32. Morton A. Improving NCLEX scores with structured learning assistance. *Nurse Educ*. 2006;31(4):163–165.
33. Bentley R. Comparison of traditional and accelerated baccalaureate nursing graduates. *Nurse Educ*. 2006;31(2):79–83.
34. Nibert A, Young A, Britt R. The HESI Exit Exam: progression benchmark and remediation guide. *Nurse Educ*. 2003;28(3):141–145.