Effect of Sequence of Simulated and Clinical Practicum Learning Experiences on Clinical Competency of Nursing Students

Abstract
Although simulation has been increasingly used as a supplement to traditional clinical experiences, it is unknown if the order in which simulated and clinical practicum learning experiences occur affects nursing students’ clinical competency development. This study used a crossover design to compare the effects of two different blocked sequences of simulated and clinical practicum learning experiences on clinical competency development during participants’ first medical surgical practicum course. Participants were randomly assigned to a 7-week block of simulated learning experiences followed by a 7-week block of traditional clinical experiences in a health care setting or the reverse sequence. Using the Creighton Competency Evaluation Instrument (CCEI) students’ clinical competency was measured three times: At the completion of each 7-week block of learning experiences and at the end of the semester during a final high fidelity simulation. The key finding of this study was that there were no significant differences in the CCEI total scale or subscale scores across time points. The use of blocked sequences of simulated and clinical practicum learning experiences may help address barriers in delivery of traditional clinical education faced by schools of nursing such as increased student enrollment and lack of clinical site availability, however more research is needed.

Background
Providing quality clinical learning experiences (CLE) that foster the development of clinical competency in nursing students prior to entry into practice is a critical objective of all nursing education programs. The traditional model for clinical education in nursing involves faculty supervision of students who are providing patient care in a hospital or other clinical settings (Richardson, Goldsamt, Simmons, Gilmartin, & Jeffries, 2014). However, schools of
nursing have increasingly faced barriers in delivering clinical education using the traditional model due to factors such as increasing student enrollment numbers, a shortage of nursing faculty, increasing patient acuity, and decreasing clinical site availability (Bensfield, Olech, & Horsley, 2012; Ironside, Jeffries, & Martin, 2009; Jeffries, 2012).

The use of simulated learning experiences (SLE) as a substitute for a portion of traditional CLE has gained interest over the past decade, but nurse educators continue to seek evidence supporting such substitution. The National Council for State Boards of Nursing (NCSBN) recently conducted a National Simulation Study to explore student outcomes when traditional CLE were replaced 25 or 50% of the time with SLE (Hayden, Smiley, Alexander, Kardong-Edgren, & Jeffries, 2014). Results of the study revealed no difference in student outcomes when substituting up to 50% of traditional CLE with SLE. The NCSBN has since challenged state boards of nursing to develop specific guidelines for the use of simulation in undergraduate nursing programs (Alexander, et al., 2015). However, there is a need for continued research so such guidelines and new models of clinical education are built on evidence. In particular, since the NCSBN National Simulation Study did not control for the sequence of the CLE and SLE, this warrants further study.

Research in human learning suggests that the sequence of learning activities may have an effect on student outcomes (Ritter, Nerb, Lehtinen, & O’Shea, 2007; Rohrer & Pashler, 2010). The basic principles surrounding the sequence of learning activities is that knowledge is built on previous learning and possession of appropriate background knowledge is essential for success in new learning situations (Ritter et al., 2007). According to Harder, the purpose of SLE is to “prepare students for clinical situations they may encounter” (2010, p. 23). The belief that SLE should be used to prepare students for CLE has led schools of nursing to place SLE prior to CLE.
to allow greater knowledge gains and transfer of knowledge to the clinical setting compared to
the placement of SLE following traditional CLE. However, research has indicated that SLE may
produce equivalent student competency outcomes when compared to traditional lecture and CLE
alone (Alinier, Hunt, Gordon, & Harwood 2006; Blum, Borglund, & Parcells, 2010).

To date, few studies in the nursing literature address student outcomes and development
of competency using different sequences of traditional CLE and SLE (Curl, Smith, Chisholm,
McGee, & Das, 2016; Meyer, Connors, Hou, & Gajewski, 2011; Schlairet & Fenster, 2012;
Schlairet & Pollack, 2010). The majority of these studies have examined students’ outcomes and
clinical competencies following their intermittent participation in SLE during a semester rather
than large blocks of SLE within a semester. Providing blocks of SLE and CLE has the potential
to increase student enrollment and decrease the number of clinical units needed in a given
semester by up to 50% (Richardson et al., 2014). However, it is unknown if students’
development of clinical competency is equivalent when a block of SLE precedes or follows
CLE. Therefore, this study explores students’ clinical competency outcomes following a unique
model of clinical education delivery using two different sequences of blocks of SLE and CLE
during students’ first medical surgical nursing practicum rotation. The specific research
questions were: (1) Does the sequence of blocks of SLE and CLE affect clinical competency
development of nursing students? (2) Does the age of the student affect clinical competency
development in the two different blocked sequences of SLE and CLE?

Method

Design

This study used a randomized crossover design and was conducted at a large mid-western
school of nursing’s simulation center for the SLE and clinical units in metropolitan hospitals for
the CLE. Prior to the start of the semester students enrolled in their first medical-surgical nursing practicum course were randomly assigned by the course coordinator to one of two group sequences: SLE over the course of a 7-week period followed by CLE for 7 weeks (Group S-C) or CLE for 7 weeks followed by SLE over the course of a 7-week period (Group C-S). Students attended each block of SLE and CLE in the same group of 7-8 students. The ratio of simulation to clinical hours for the semester was 1:4.

Clinical and Simulated Learning Experiences

The CLE consisted of 2-eight hour clinical days/week in which participants provided direct patient for one patient under the supervision of a nursing faculty member. Participants planned, implemented, and evaluated nursing care, and participated in a post conference discussion. The SLE consisted of three high-fidelity simulation days, each lasting four hours over the course of a 7 week period and one medium-fidelity virtual simulation. Each high-fidelity simulation day followed the NLN/Jeffries’ framework for simulation (Jeffries, 2012) and included four vignettes on the topics of pain management, heart failure, and COPD/pneumonia. The medium-fidelity virtual simulation on the topic of diabetes mellitus was completed independently by students using a computer program and included preselected debriefing questions. Simulations were run by instructors who received training prior to the start of the semester along with a step-by-step manual with instructions to ensure all SLE and debriefing sessions were run as similarly as possible. A standardized debriefing tool was developed using the SimTRACT model for debriefing (Gum, Greenhill, & Dix, 2011) and was used following each high-fidelity simulation vignette.
For each high-fidelity simulation day students were assigned pre-work including readings, a quiz to prepare for the simulation day topic, development of a tentative plan of care, and review of scenario objectives, patient chart, laboratory results, and medication administration record. A pre-briefing session and orientation to the high-fidelity simulation room and manikin was conducted prior to the start of each simulation vignette. Each vignette included two active roles, the lead RN and the preceptor RN. During vignettes participants worked through patient assessments and nursing interventions followed by a standardized debriefing session conducted by the simulation instructor. The remaining students in the clinical group observed vignettes via a live video feed in a debriefing room with their instructor and took notes to provide feedback or to take notes to clarify any areas in question during debriefing. The medium-fidelity simulation included prebriefing, working through the patient scenario using the nursing process, and was followed by debriefing. Following completion of their SLE and CLE sequence participants were evaluated during a final high-fidelity simulation vignette approximately five weeks after the completion of the semester, but prior to the start of the subsequent semester. A unique type II diabetes mellitus vignette using the same format and with a similar level of complexity as the previous high-fidelity simulation vignettes was used for the final evaluation time point.

**Sample**

Sample size calculation was conducted *a priori* power using the software program G*Power version 3.0.10. The estimated required sample size for a between groups repeated measures ANOVA with two groups, three measurement time points, an α level of .05, a minimal statistical power of 0.8, and what is considered between a small to medium effect size, $d = 0.35$ (Cohen, 1988) was 46 participants (23 per group). This effect size was chosen based on those reported in the NCSBN study using the Creighton Competency Evaluation Instrument (Hayden,
Smiley et al., 2014). Oversampling to account for a potential 30% drop out rate brought the target sample to 60 participants.

All students enrolled in the practicum course were invited to participate in the study. A convenience sample of nursing students was recruited using the following inclusion criteria: (1) at least 18 years of age; (2) enrolled in their first medical-surgical nursing course; and (3) enrolled in the associated medical-surgical nursing theory course.

**Data Collection**

Following approval by the University’s’ Institutional Review Board and obtaining participant consent, demographic information was collected. Evaluation of participants’ clinical competency was measured using the Creighton Competency Evaluation Instrument (CCEI) at three time points: (1) During a designated simulation vignette at the end of participants’ SLE rotation; (2) During a preselected clinical day/single patient encounter occurring in the final week of participants’ CLE rotation; and (3) After completion of the semester during a follow up simulation vignette. For study purposes participants were evaluated when they were assigned to the lead RN role in a simulation vignette.

The CCEI is a 23-item tool with four subscales: assessment, communication, clinical judgment, and patient safety which incorporates the Quality and Safety Education for Nurses (QSEN) competencies and components of the *Essentials of Baccalaureate Education for Professional Nursing Practice* (AACN, 2008; Hayden, Keegan, Kardong-Edgren, & Smiley, 2014). Items on the tool are scored by assigning items a score of zero or one depending if a specific behavior is demonstrated (scored as one), not demonstrated (scored as zero), or not
applicable. Prior studies have demonstrated acceptable reliability estimates with Cronbach’s alpha ranging from .97-.98 (Adamson, et al., 2011; Hayden, Keegan et al., 2014).

To ensure reliability of the instrument for this study, 16 instructors received training on the use of the CCEI tool prior to the start of data collection. During the training session, each instructor viewed a series of training videos that provided an orientation to the tool, and discussion of how to properly score participants expected behaviors for each item on the instrument. Instructor then viewed and independently scored an archived video scenario using the CCEI to establish interrater reliability. Each item on the tool was translated into a list of specific expected student behaviors which was provided to instructors during the viewing of the video to promote interrater reliability (Franklin, Sideras, Gubrud-Howe, & Lee, 2014). The researcher, who was deemed an expert rater, previously scored the same archived video. If scores differed by more than four points (<80% consensus) additional instructor training was to be conducted by the researcher, however no additional training was needed.

In this study Cronbach’s alpha for total scale was .94-.96 and subscales ranged from .94-.99. Interrater reliability of the CCEI in this study demonstrated an overall percent agreement with the researcher of 92%. To account for the amount of agreement expected due to chance Kappa statistics were also calculated and suggested moderate to almost perfect agreement ($K = .481-1$) (Landis & Koch, 1977; Waltz, Strickland, & Lenz, 2010).

**Data Analysis**

Descriptive and inferential statistical methods were utilized to analyze the data. All analyses were conducted using SPSS version 23.0. To ensure that the two groups were equivalent at baseline, pertinent demographic variables were compared using chi square analysis
for categorical variables and independent $t$ tests for continuous variables. To determine if clinical competency using the CCEI differed over the three measurement time points within and between the two groups repeated-measures analysis of variance (RM-ANOVA) were calculated. To establish statistical significance an alpha level of .05 was used. Significant main effects of group, time or interaction were explored further through post hoc comparison using simple main effects analysis. All analyses included only the participants who participated in all three measurement time points.

**Results**

*Sample Demographic Characteristics*

Of the 120 students initially invited to participate in the study 71 enrolled, for a 41% refusal rate. Of the 71 originally enrolled, 48 participated in all three data collection time points, for a 32.3% attrition rate. The final sample consisted primarily of Caucasian females with a mean age of 22.2 years (SD =3) as presented in Table 1. No statistically significant differences between groups were identified for any of the variables describing the sample characteristics.

*Differences between Groups: Group S-C vs. Group C-S*

The primary aim of this study was to determine if sequences of blocks SLE and CLE impacted clinical competency development in nursing students participating in their first medical-surgical practicum course. As summarized in Table 3 results showed that there were no significant differences in CCEI total ($F [1, 46] =.05, p = .811$) or subscale scores between the two groups across the three data collection points. Consequently, there was no significant effect on clinical competency based on the group participants were assigned to.

*Differences within Groups*
As illustrated in Table 2 there was a significant time by group interaction for CCEI total scores. Simple main effects analysis revealed that Group S-C had significantly higher CCEI total scores at Time 2 compared to Times 1 and 3, whereas Group C-S demonstrated significantly higher total CCEI scores at Time 1 compared to Time 3. Of note there were significant time by group interactions among the CCEI subscales. Mauchly’s test indicated that the assumption of sphericity for the patient safety subscale was violated, \( p = .009 \), therefore the degrees of freedom were corrected using Huynh-Feldt (\( \epsilon = .925 \)). Simple main effects analyses revealed that Group S-C demonstrated significantly higher scores for the assessment and patient safety subscales at Time 2 compared to Times 1 and 3 and significantly higher scores for the communication and clinical judgment subscales at Time 2 compared to Time 1. Group C-S demonstrated significantly higher assessment subscale scores at Time 1 compared to Time 2, significantly higher clinical judgment subscale scores at Time 3 compared to Time 2, and significantly higher patient safety subscale scores at Time 1 compared to Times 2 and 3.

**Age, Sequence and Clinical Competency Development**

The secondary aim of the study was to determine if the age of the learner affected clinical competency development in the different blocked sequences of SLE and CLE. There was no significant effect of age and group on CCEI total scores (\( F[2, 88] = .800, p = .452 \)), nor the subscale scores.

**Discussion**

The results of this study provide evidence regarding the effects of blocked sequences of SLE and CLE on clinical competency development. When using the NLN/Jeffries Simulation Framework it is suggested that researchers consider the impact of student demographic factors
such as age on simulation based competency outcomes (Ironside, et al., 2009). In this study, regardless of the group participants were assigned to age was found to not have a significant influence on CCEI total scores or subscales. This is similar to previous reports in the simulation literature regarding age and simulation outcomes (Ironside, et al., 2009; Lasater, 2005). These insignificant findings may have been due to the fact that there was little variation in the age of participants for this study. Despite these insignificant findings, student demographic factors should continue to be investigated in studies exploring simulation based competency outcomes particularly using a sample compromised of a more diverse student population as suggested by Ironside, et al. (2009).

Findings revealed that there were no between group differences noted over the study period for CCEI total or subscale scores, suggesting that the sequence of SLE and CLE did not impact participant’s CCEI scores over time. Of interest, there were several notable within group differences for this sample. Regardless of group assignment, participants had higher total CCEI scores at the end of their CLE portion of the semester. The CCEI is a recently modified tool that was initially developed for use exclusively in the simulation environment. Although the current version of the tool has been reported to be reliable and valid in both the clinical and simulation environments (Hayden, Keegan, et al., 2014) no studies to date have compared faculty ratings of students between the clinical and simulation environments using the tool. Therefore, it is possible that higher scores following participants CLE for this study are a function of the environment in which they were evaluated. Further study of the CCEI tool is warranted to determine if scored derived in the clinical environment are significantly different than those derived in the simulation environment.
Further examination of clinical competency through analysis of the CCEI subscales revealed significant within group changes over time. Clinical judgment subscale scores were significantly higher for each group post-SLE and in group C-S it was the only score that was significantly higher at the final measurement point. Previous reports have suggested that simulation contributes to the development of clinical judgment (Fisher & King, 2013; Lasater, 2007). Alternately, the significant increase in clinical judgment behaviors in Group C-S may have been due to the proximity of the measurement points following completion of the SLE portion of their sequence and the final data collection.

A surprising finding was that participants’ demonstration of patient safety behaviors was scored the lowest during the final simulation vignette regardless of group assignment. Previous studies have indicated significant improvements in patient safety competencies following simulation (Ironside, et al., 2009; Sears, Goldsworthy, & Goodman, 2010). Decreases in demonstration of behaviors included in this subscale may have been attributed to an approximately five week gap between the second and final measurement points, during which participants were between semesters and not attending classes. This gap could have ultimately impacted retention of items included in this subscale such as medication administration and correct performance of procedures. Prior studies have reported significant declines in skills performance using high-fidelity simulation following gaps of time between evaluations (Aqel & Ahmad, 2014; Ross, 2012). These findings warrant further study of retention of patient safety behaviors following the use of alternative models of clinical education delivery.

Limitations

This study explored the influence of a blocked sequence of SLE and CLE on clinical competency in only one medical surgical practicum course at one university limiting the
generalizability of the results to other courses, student levels, or nursing programs. Additional limitations of this study included the lack of a control group and no baseline measurement of participants to compare findings to.

**Implications for Nursing Education**

This study provides evidence that participation in a block of SLE preceding or following a block of CLE may produce similar student outcomes regardless of the sequence of these learning experiences. This unique model of clinical education delivery in nursing may aid in addressing the barriers faced by nurse educators such as lack of clinical site availability and increases in student enrollment. There is a need for additional appraisal of the CCEI comparing use in the clinical and simulation environment to determine if differences exist in student evaluation in each environment. Continued evaluation of student outcomes using alternative formats of simulation and clinical hours, in additional courses, and over longer periods of time is necessary before nurse educators can determine the optimal clinical education delivery model for prelicensure nursing programs.

**Acknowledgements**

This study was funded by a grant from Sigma Theta Tau International.
References


replacing clinical hours with simulation in prelicensure nursing education. *Journal of Nursing Regulation, 5*(2), C1-S64.


Table 1. Sample Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All Participants (N = 48)</th>
<th>Group S-C (n = 22)</th>
<th>Group C-S (n = 26)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age: Mean (SD)</td>
<td>22.2 (3.0)</td>
<td>21.9 (1.9)</td>
<td>22.4 (3.7)</td>
</tr>
<tr>
<td>Female Gender: % (n)</td>
<td>79.2 (3)</td>
<td>72.7 (16)</td>
<td>84.6 (22)</td>
</tr>
<tr>
<td>Caucasian: % (n)</td>
<td>83.3 (40)</td>
<td>77.3 (17)</td>
<td>88.5 (23)</td>
</tr>
<tr>
<td>Prior Degree: % (n)</td>
<td>47.9 (23)</td>
<td>50 (11)</td>
<td>46.1 (12)</td>
</tr>
<tr>
<td>Work in healthcare: % (n)</td>
<td>27 (13)</td>
<td>22.7 (5)</td>
<td>30.8 (8)</td>
</tr>
<tr>
<td></td>
<td>Time 1 Mean (SD)</td>
<td>Time 2 Mean (SD)</td>
<td>Time 3 Mean (SD)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------</td>
<td>------------------</td>
<td>------------------</td>
</tr>
<tr>
<td><strong>Total Scale (N = 48)</strong></td>
<td>20.17 (3.4)</td>
<td>20.81 (3.0)</td>
<td>19.15 (2.5)</td>
</tr>
<tr>
<td>Assessment</td>
<td>2.31 (.88)</td>
<td>2.31 (.95)</td>
<td>2.00 (.77)</td>
</tr>
<tr>
<td>Communication</td>
<td>4.46 (.85)</td>
<td>4.75 (.70)</td>
<td>4.65 (.57)</td>
</tr>
<tr>
<td>Clinical Judgment</td>
<td>8.13 (1.5)</td>
<td>8.42 (.87)</td>
<td>8.54 (.94)</td>
</tr>
<tr>
<td>Patient Safety</td>
<td>5.27 (1.1)</td>
<td>5.33 (1.1)</td>
<td>3.96 (1.5)</td>
</tr>
<tr>
<td><strong>Group S-C (n = 22)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>19.05 (3.3)</td>
<td>21.73 (3.1)</td>
<td>19.14 (2.7)</td>
</tr>
<tr>
<td>Assessment</td>
<td>2.09 (.75)</td>
<td>2.64 (.90)</td>
<td>1.86 (.71)</td>
</tr>
<tr>
<td>Communication</td>
<td>4.18 (.91)</td>
<td>4.73 (.70)</td>
<td>4.55 (.67)</td>
</tr>
<tr>
<td>Clinical Judgment</td>
<td>8.05 (1.2)</td>
<td>8.73 (.77)</td>
<td>8.36 (1.2)</td>
</tr>
<tr>
<td>Patient Safety</td>
<td>4.73 (1.3)</td>
<td>5.64 (1.0)</td>
<td>4.36 (1.4)</td>
</tr>
<tr>
<td><strong>Group C-S (n = 26)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>21.12 (3.3)</td>
<td>20.01 (2.8)</td>
<td>19.15 (2.6)</td>
</tr>
<tr>
<td>Assessment</td>
<td>2.50 (.95)</td>
<td>2.04 (.92)</td>
<td>2.12 (.82)</td>
</tr>
<tr>
<td>Communication</td>
<td>4.69 (.74)</td>
<td>4.77 (.71)</td>
<td>4.73 (.45)</td>
</tr>
<tr>
<td>Clinical Judgment</td>
<td>8.19 (1.7)</td>
<td>8.15 (.88)</td>
<td>8.69 (.68)</td>
</tr>
<tr>
<td>Patient Safety</td>
<td>5.73 (.53)</td>
<td>5.08 (1.2)</td>
<td>3.62 (1.6)</td>
</tr>
</tbody>
</table>

Post-hoc analysis

- a = Significant Differences between Time 1 & Time 2
- b = Significant Differences between Time 1 & Time 3
- c = Significant Differences between Time 2 & Time 3
Table 3. Between Groups ANOVA Table

<table>
<thead>
<tr>
<th>Source</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total CCEI Scores between Groups</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>(1, 46) = .058</td>
<td>.811</td>
</tr>
<tr>
<td><strong>CCEI Subscales between Groups</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assessment</td>
<td>(1, 46) = .182</td>
<td>.671</td>
</tr>
<tr>
<td>Communication</td>
<td>(1, 46) = 3.132</td>
<td>.084</td>
</tr>
<tr>
<td>Clinical Judgment</td>
<td>(1, 46) = .059</td>
<td>.809</td>
</tr>
<tr>
<td>Patient Safety</td>
<td>(1, 46) = .298</td>
<td>.588</td>
</tr>
</tbody>
</table>