Remembering to Resume: Using Simulation-based Education to Teach Nursing Students to Manage Interruptions

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REMEMBERING TO RESUME: USING SIMULATION-BASED EDUCATION TO TEACH NURSING STUDENTS TO MANAGE INTERRUPTIONS

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Nursing at the University of Central Florida Orlando, Florida

Spring Term 2021

Major Professor: Steven Talbert
ABSTRACT

Introduction: Since nurses are expected to be constantly available and responsive, their workflow is interrupted about 85 times each shift. As nursing students socialize to the profession, they need to learn how to adapt to an interruption fraught practice environment.

Background: While some interruptions are important to patient care, dealing with conflicting demands can lead to mental fatigue, increased task time, and enhanced propensity for errors. Some experienced nurses learn to create strategies that facilitate remembering to resume an interrupted task, but they are often adopted through trial and error. When simulation-based education (SBE) is used according to industry standards, it is an excellent modality to teach interruption management.

Methods: The purpose of this dissertation was to explore the optimal use of SBE to facilitate the adaptation of nursing students to an interruption-fraught practice environment. An integrative literature review (ILR) was performed to explore the use of SBE to teach interruption management. A between-subjects randomized trial using checklist guided observations and the NASA-Task Load Index facilitated determining the impact of purposeful training combined with SBE. To understand how to best facilitate adaptation, the Roy Adaptation Theory was explored.

Results: The ILR showed that most SBE studies used to teach interruption management are not predicated on purposeful training. The randomized trial demonstrated that combining purposeful training with SBE was more beneficial than SBE alone.

Discussion: The results from this research can inform nursing education about the need to combine purposeful interruption management training with SBE to facilitate coping with interruptions.

Keywords: Simulation-based education, pre-licensure nursing students, interruption management, Adaptation
This work is dedicated to my husband, Barry, for his unwavering love and support. Thank you for sacrificing weekends and evenings and being my biggest cheerleader! To my children: Petria, Jayce, Ariel, and Joey, who have always been my reason to seek further education. This work is also dedicated to my mother, “Nita”, for making me a bookworm and instilling in me a love for lifelong learning, and my mother-in-law “Sis” who prized education and was one of the strongest women I have ever known.
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Lastly, I would like to thank my PhD cohort, Sharon, Val, Chris, Melissa, Jake, Kim, Pitch, Angie, Shar and Charitta. Thank you for the brainstorm sessions, get-togethers, reminders, laughter, and support. We have truly been a family and I am eternally grateful for your encouragement throughout this program.
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There is a shared belief among healthcare professionals that nurses should be continuously available and immediately responsive to all requests (Laustsen & Brahe, 2018; Sitterding, 2014). Consequently, nurses are interrupted an average of 85 times during a typical shift (Forsyth et al., 2018), with interruptions comprising nearly 10% of the workday (Prates & Silva, 2016). Interruptions are internal or external stimuli that trigger pausing or stopping of a current task before shifting attention to another issue (Wickens & McCarley, 2008). Frequent interruptions have been linked to a variety of potentially deleterious effects including increased time on task (Campoe & Giuliano, 2017; Cole et al., 2016; Cooper et al., 2016), enhanced stress and mental demand (Forsyth et al., 2018; Thomas et al., 2017), and omitted steps and procedural failures (Johnson et al., 2017; Thomas et al., 2017). Shifting focus or switching tasks can also increase cognitive load, which is the perceived mental demand associated with concentration or task performance (Banich & Compton, 2018; Plass et al., 2010; Sewell et al., 2017).

Attention is a multi-faceted process of noticing cues, quickly determining which are salient, and alerting the corresponding area of the brain to begin information processing (Banich & Compton, 2018; Wickens & McCarley, 2008). Attention is modulated by two features: specific factors of a stimulus that capture focus, and the purposeful intent to notice (Wickens & McCarley, 2008). Bright colors, blinking lights, and sudden alarms all quickly activate specific brain regions and facilitate attention capture. Intent to notice involves what a person is currently looking for, and noticing an item is more likely when it is being specifically sought. For this reason, professional educational programs teach students the most salient aspects of their professional focus. For example, in nursing education, students are taught about signs and
symptoms of disease so these stimuli will gain salience and be more likely to capture attention. Attention capture is also influenced by personal factors like age, experience, prior knowledge, and training (Banich & Compton, 2018; Wickens & McCarley, 2008).

Novices of any profession are vulnerable to the impact of interruptions on their attention because they lack the complex mental schema needed to solve problems (Wickens & McCarley, 2008). During the learning process, the brain combines individual units of related content into mental schema, which are bundles of information that are stored in long-term memory (Merriam & Bierema, 2014; Plass et al., 2010). These bundles are accessed during problem-solving and are refined based on performance-related feedback. To solve problems before complex schemata are developed, novices must access individually stored information and attempt to combine it in a meaningful way (Merriam & Bierema, 2014). This process requires far more mental demand than the use of complex schemata, so interrupting a novice is more likely to result in error and cognitive strain (Getnet & Bifftu, 2017; Plass et al., 2010; Wickens & McCarley, 2008).

Gaining awareness of how interruptions impact error risk often results in implementation of measures to minimize their deleterious effects (Getnet & Bifftu, 2017; Laustsen & Brahe, 2018). While it is important for all healthcare workers to learn to manage interruptions, it is particularly necessary for novices (Getnet & Bifftu, 2017; Wickens & McCarley, 2008). To prepare for transition to the interruption-fraught practice environment, nursing students need to learn to both notice salient signs and symptoms of disease and acquire strategies for managing interruptions (Getnet & Bifftu, 2017; Jeffries, 2014).

Simulation-based education (SBE) promotes experiential learning and reflection to enhance the acquisition of knowledge and skills (Jeffries, 2014; Palaganas et al., 2015). Excellence in SBE requires that industry standards be implemented, simulations are designed...
appropriately, and that experiential learning is predicated on prior didactic exposure to content (Jeffries, 2014; Palaganas et al., 2015). Jeffries (2014) recommends that interruptions be embedded into simulations and that difficulty level be incrementally adjusted throughout the curriculum. During simulation scenarios, students must use what they have learned to solve problems, but the debrief session that follows focuses on uncovering assumptions and beliefs that impact decisions (Dreifuerst, 2015). These individual assumptions and beliefs also impact the ability to adapt to stressful situations, like those involving frequent interruptions (Roy, 2009).

The goal of this dissertation was to explore the current use of SBE to teach interruption management skills, and to identify how to best use SBE to facilitate adapting to interruptions. This project sought to determine whether combining purposeful interruption management training with SBE would enhance implementation of interruption management strategies and prevent increased cognitive load. An integrative literature review was performed to explore the use of SBE to teach interruption management to healthcare students. The findings from this review, including lack of purposeful training and weak simulation design, informed the subsequent research and analysis. (Chapter 2).

To determine the impact of purposeful interruption management training, a randomized between-subjects quantitative study was conducted. A researcher-designed educational intervention was provided and group differences for cognitive load, interruption strategy implementation, and simulation critical element criteria achievement were investigated. Findings from this study show that including purposeful interruption management training facilitates interruption management and positively impacts mental demand more than experiential learning alone (Chapter 3).
Desire to understand how coping with interruptions can be facilitated spurred investigation and application of the Roy Adaptation Theory. This theory describes the factors that facilitate coping and was applied to both interruptions and simulation-based education. Application of the theory demonstrates how role expectations and personal factors influence behavior and adaptation to frequent interruptions (Chapter 4).

The three manuscripts included in this dissertation present evidence about the use of SBE to teach interruption management to pre-licensure nursing students. The findings of the between-subjects research will enhance the body of evidence supporting the need for purposeful interruption management training combined with SBE. Application of the Roy Adaptation Theory further emphasizes the importance of combining purposeful training with SBE experiential learning and structured debrief to facilitate coping with interruptions. The evidence reported in this dissertation can influence nursing education practices by supporting the need for purposeful interruption management training throughout the curriculum.
References


Sitterding, M. C. (2014). *Situation awareness and the selection of interruption handling strategies during the medication administration process: A qualitative study* (Publication Number Ph.D.) Indiana University


CHAPTER 2:
USING SIMULATION-BASED EDUCATION TO TEACH
INTERRUPTION MANAGEMENT SKILLS: AN INTEGRATIVE REVIEW

Abstract

Background: Interruptions can lead to medical errors, which cost American lives every year. Novices are highly vulnerable to interruptions, which increase error risk, stress, and a propensity to quit.

Purpose: Simulation-based education (SBE) can be used to facilitate interruption management skill attainment. The purpose of this review was to identify the characteristics and quality of SBE that focuses on interruption management.

Methods: From 11 databases and 1,148 articles, ten studies met criteria, and were included in this integrative review.

Results: Research design lacked rigor, and simulations were not based on standards. Definitions varied, theoretical underpinnings were lacking, and there was no description of simulation facilitators’ expertise. Medical simulations were higher fidelity than nursing and included a variety of interrupted tasks, while nursing focused on medications.

Discussion: Future studies should be theoretically sound and designed using industry standards. Investigations comparing interruption training to SBE alone are also needed.

Key Words: Simulation-based education, interruptions, medical errors,

Remembering to Resume. Simulation research.
Introduction

Medical errors are the third leading cause of death in the United States (Makary & Daniel, 2016). Since nurses are the healthcare workers that spend the most time with patients, there are many opportunities for error (Butler, 2018). When a nurse’s concentration is interrupted, the risk for error increases (Campoe & Giuliano, 2017). Despite the increased error risk, nurses are frequently interrupted throughout all types of activity (Myers & Parikh, 2019). These continuous interruptions are particularly difficult for novice nurses, who require concentrated effort to solve problems (Getnet & Bifftu, 2017).

Background

Nurses are interrupted during all types of patient care (Getnet & Bifftu, 2017), with occurrence rates ranging from 0.3 to 13.9 times per hour (Prates & Silva, 2016). Frequent interruptions increase cognitive load (Campoe & Giuliano, 2017), which is associated with increased stress, time on task, and potential for errors (Wickens & McCarley, 2008). Cognitive load is the mental demand associated with the processing of new information and it is particularly high when dealing with complex or demanding tasks (Sewell et al., 2019).

Interrupted cognition is associated with medical errors, which may result in increased morbidity and mortality (Donaldson et al., 2000). Interruptions increase the time needed to complete a task and often result in repeated efforts and delayed care (McCurdie et al., 2018; Myers & Parikh, 2019), which can negatively impact efficiency and revenue (Makary & Daniel, 2016). During an interruption, attention is shifted away from the current task, increasing the risk that the initial task will be forgotten or incorrectly resumed (Foroughi et al., 2016). When frequent interruptions increase stress, job dissatisfaction can occur, which can increase nursing
turn-over (Snavely, 2016). Even small increases in turn-over are costly, because the price for replacing bedside nursing staff averages $44,000 (Nursing Solutions Inc., 2020).

**Vulnerability to Interruptions**

When nurses are not aware of the association between interruptions and errors, they are more likely to allow themselves to be frequently interrupted, which can result in procedural failures (Getnet & Bifftu, 2017). Novices in any profession are particularly vulnerable to the impact of interruptions on their concentration and experience a higher cognitive load when interrupted (Wickens & McCarley, 2008). High cognitive load has been associated with increased resumption lag (the time between stopping and resuming a task), time on task, and risk for errors (Forsyth et al., 2018; Thomas & Donohue-Porter, 2016). These risks can be reduced by learning to manage interruptions through purposeful education and deliberate practice (Wickens & McCarley, 2008).

**Simulation-Based Education**

To prepare nursing students for the reality of practice, they must be taught about the error risks, how to differentiate between salient and unnecessary interruptions, and how to use strategies to safely manage them (Getnet & Bifftu, 2017). When learners can draw on previously taught content and apply it in a realistic environment, the likelihood of learning increases (Kolb, 1984). Simulation-based education (SBE) can be used to create realistic settings, so students can learn techniques that pertain to clinical practice (Jeffries, 2014). To fully understand the available research using SBE to teach interruption management, a review of the literature was performed.
Methods

An integrative review was conducted to glean a comprehensive understanding of the available literature that uses SBE for interruption management training. This integrative review includes quantitative and qualitative studies, and project descriptions, and follows the Whittemore and Knafl (2005) method including, problem identification, literature search, data evaluation and analysis, and presentation. To synthesize the quantitative studies, effect sizes were reported. When effect size was not provided within the original study, it was calculated from the reported findings. The specific aims were to: 1. identify the number and types of studies using SBE for interruption management training; 2. critique the quality of the research evidence and simulation designs; and 3. identify limitations and gaps within the literature to inform research and nursing education.

Databases and Search Terms

To gain a thorough understanding, a variety of professions were included, and studies were sought across 11 databases: APA PsycInfo, Applied Science & Technology Source Management, Business Source Premiere, CINAHL, Cochrane Database of Systematic Reviews, ERIC, Health & Psychosocial Instruments, Health Source: Nursing/Academic Edition, Medline, Military & Government Collection, and Open Dissertations. The search terms Interrupt* (manag* OR mitigate* OR handl*) AND Simulat* OR (based education training learning) were used. No date limiters were applied to allow for investigation of the evolution and maturation of the concept.

Inclusion/Exclusion Criteria

Studies were included if they used SBE to teach interruption management. Simulations used solely to identify characteristics of interruptions were excluded. Studies designed to create
or test computer simulations that did not involve human participants, were excluded. While systematic reviews were included due to their rigor, literature reviews were excluded, but their references were explored for additional sources.

**Evaluation of Study Strength**

Since the included studies involved a variety of methods and designs, multiple tools were used for quality evaluation. Two separate instruments and a criteria checklist were used with author permission: The Simulation-Based Research Rating Rubric (Fey et al., 2015), The Johns Hopkins Nursing Evidence-Based Practice Research Evidence Appraisal Tool© (Dang & Dearholt, 2017), and Whittemore, Chase, and Mandle’s validity criteria (Whittemore et al., 2001).

The Simulation-Based Research Rating Rubric (Fey et al., 2015) is a valid and reliable instrument (overall CVI = 0.96; overall IRR = 0.92) that is used to evaluate all types of simulation research (Mariani et al., 2020). The instrument contains 16 elements that are rated 0-4 (4= Excellent). The overall possible score can vary as it is based on the type of research design and not all elements will apply (See Appendix A).

The Johns Hopkins Nursing Evidence-Based Practice Research Evidence Appraisal Tool© (Dang & Dearholt, 2017) was used to determine an overall quality rating for each study (See Appendix B). With this tool, random controlled studies are rated the highest (level I) followed by quasi-experimental (II) and non-experimental (III). Quality ratings, which are based on sample size, design, and consistency of results, are graded with ‘A’ representing high quality, and ‘C’ representing low (Dang & Dearholt, 2017).

Whittemore, Chase, and Mandle’s validity criteria was used to evaluate the rigor and validity of qualitative designs (Whittemore et al., 2001). These criteria were designed as author
guidelines and emphasize the importance of demonstrating authenticity and criticality (See Appendix C). Authenticity is demonstrated with participant quotes that highlight individual perception of the experience. Criticality is evident when authors describe their biases and emphasize the method that was used to overcome them. The criteria also emphasize the need for investigation of the use of repetitive validity assessments like triangulation and member checking, method decisions, and demonstrating congruence of themes (Whittemore et al., 2001).

Specific study elements were also examined. To determine the commonality of key concepts among the literature, the definition of interruptions used by each study was investigated. The degree of simulation fidelity, or realism, and specific features associated with interruption management were also appraised. Specific interruption features included: the characteristics of the interruption, the event being interrupted, and whether SBE was used alone or combined with targeted training.

**Results**

The initial search resulted in 1,148 studies. After removal of duplicates, 870 titles and abstracts were investigated, and 29 retained. Investigation of the 29 manuscripts and references resulted in the addition of seven more studies. Application of inclusion and exclusion criteria resulted in 10 included studies (See Figure 1).
Research Quality

Due to a lack of randomized controlled trials, the highest quality rating for the quantitative studies was II (Dang & Dearholt, 2017). Despite small sample sizes and varying methods, the effect sizes for measurement of interruption management ranged from medium to large across the three quantitative studies (see Table 1). Critical appraisal was lacking among the qualitative studies as no evidence was provided regarding methods used to limit bias (Whittemore et al., 2001). While theoretical underpinnings were described by two studies (Hayes, et al., 2015; Henneman, et al., 2018), specific use of attention or interruption theory occurred once (Henneman, et al., 2018). Definition for the term interruptions was provided by four studies but descriptions varied (Ford et al., 2017; Henneman et al., 2018; Thomas, 2015; Thomas et al., 2015). Measurement instruments were described in three of the studies but lacked information about psychometrics (Ford et al., 2017; Rochman et al., 2012; Thomas et al., 2015). While one study provided information about the standardized process used for developing the
simulation (Rochman, et al., 2012), none specifically mentioned International Nursing Association for Clinical Simulation and Learning (INACSL, 2016) or other professional simulation standards (see Table 2).

**Table 1: Effect Sizes for Included Studies**

<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects (n=)</th>
<th>Statistical Test</th>
<th>Significant Results</th>
<th>Effect Size (ES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford, Cleland &amp; Thomas, 2017</td>
<td>n=23</td>
<td>Mann-Whitney U test</td>
<td>OSCE global mark: Z= -2.20 (p=.03)</td>
<td>n²=Z²/N-1 4.84/22 = ES=.22 Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Good interruption management: Z= -3.197 (p≤.00)</td>
<td>n²=Z²/N-1 -3.197 x -3.197 = 10.22 10.22/22 = ES =.46 Large</td>
</tr>
<tr>
<td>Henneman et al., 2018</td>
<td>n=20</td>
<td>Paired t-test Pre/Post-test (one group)</td>
<td>Time (seconds) distracted from primary task: Pretest = 134.47, SD =6.87, Posttest = 6.08, SD =1.27 (p≤.00)</td>
<td>ES = (Mean(post - Mean(pre))/SD_diff 6.08 -134.47/5.6 = ES=.22 Medium</td>
</tr>
<tr>
<td>Thomas et al., 2015</td>
<td>n=28</td>
<td>Spearman’s rank coefficient &amp; Mann-Whitney U tests</td>
<td>Correlation between error and mismanagement of interruptions: Spearman’s Rank =.66 (p=.01).</td>
<td>Correlation between error and interruption mismanagement: r=0.663, p=0.01, r²=ES=.44 Medium</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Error rate reduction difference: intervention reduced errors by 34.3% more than control (p≤.00, U=34)</td>
<td>Error rate reduction for final study=34.3% ES=.34 Medium</td>
</tr>
</tbody>
</table>
Table 2: Appraisal of Literature Evidence by Study

<table>
<thead>
<tr>
<th>Study &amp; Population</th>
<th>Design &amp; Theory</th>
<th>Aim</th>
<th>Instrument</th>
<th>Findings</th>
<th>Limitations</th>
<th>Quality</th>
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<tr>
<td>Thomas et al., 2015 Scotland Med Students (N=28).</td>
<td>Prospective non-random. No theory stated.</td>
<td>Determine if targeted feedback reduces errors and improves interruption management on subsequent simulation, 4 weeks later.</td>
<td>Observation checklist.</td>
<td>Mismanagement of interruptions (r=0.66, p&lt;00) Errors decreased 76.4% (p&lt;.00, U=.50) Error rate reduction: 34.30% error rate vs. control p&lt;.00, U=34).</td>
<td>Small sample size of volunteers. Lacks blinding. Psychometrics not reported.</td>
<td>Hopkins: IIB Research Rigor Rubric Score: 37/56</td>
</tr>
<tr>
<td>Study &amp; Population</td>
<td>Design &amp; Theory</td>
<td>Aim</td>
<td>Instrument</td>
<td>Findings</td>
<td>Limitations</td>
<td>Quality</td>
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</tr>
<tr>
<td>Rochman, et al., 2012 United States IPE (N=10).</td>
<td>Student perception survey. No theory stated.</td>
<td>Determine perception of non-nurse health students to role of nurse during interruptions. Determine perception of learning material.</td>
<td>10-question survey with 5-point Likert scale</td>
<td>60% completed pre-learning activities. 66.70% agreed the pre-learning material was valuable. Gained awareness about error risk with interruptions</td>
<td>Lacks criticality, member checking, and triangulation. No psychometrics reported.</td>
<td>Hopkins: III Research Rigor Rubric Score: 32/56</td>
</tr>
<tr>
<td>Thomas, McIntosh &amp; Allen, 2014 United States Nursing students (N=none reported).</td>
<td>Simulation Design. No theory stated.</td>
<td>Explore impact of distractions on safety and determine participant view (during debrief) of distraction sources and how they can change future behavior.</td>
<td>None.</td>
<td>Conversations most distracting. Repetitive sounds become less distracting over time. Noisy environment is not realistic to nursing practice.</td>
<td>No sample size or data analysis provided. Lacks criticality, member checking, and triangulation.</td>
<td>Hopkins: III Research Rigor Rubric Score: 15/40</td>
</tr>
</tbody>
</table>

*OSCE= Objective Structured Clinical Examination; NASA-TLX*=NASA-Task Load Index; IPE=Interprofessional Education. Med = Medical, RN = Registered Nurse; SD = Standard Deviation.
Simulation Quality

One study (Rochman et al., 2012) included enough detail about the simulation development to earn an ‘excellent’ rating on the simulation rating rubric (Fey et al., 2015). While some studies indicated that the simulations were facilitated by faculty or content experts, none described the simulation expertise or training of the facilitators. Reporting of the simulation debrief session did not rise to the excellent level on the simulation rating rubric for any of the studies. While two of the studies included some information about the debrief method, neither reported the facilitators’ debriefing qualifications (Thomas, 2015; Thomas et al., 2015). Despite all the studies including some description of the simulation fidelity, explanations about the scenario validity and information about the accuracy of the ‘patient’ records were lacking (see Table 3).

<table>
<thead>
<tr>
<th>Study</th>
<th>Physical fidelity</th>
<th>Conceptual fidelity</th>
<th>Psychological fidelity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford, Cleland, &amp; Thomas (2017)</td>
<td>Volunteers as patient actors. Multi-patient unit setting with working head walls, furniture and equipment. Moulage to simulate clinical features (sweating, sputum).</td>
<td>Medical notes and laboratory results for each patient – no information regarding expert verification.</td>
<td>No information about standardization of patient actors. No information regarding script, training, or expertise.</td>
</tr>
<tr>
<td>Hayes et al., (2015)</td>
<td>Set up class like hospital unit, props (wigs/scarf) for role play. Medication cart, fluids, appropriate charts.</td>
<td>Students played all roles, including interrupting family, without scripts or training.</td>
<td>Management of interruptions (patient requests) used to mimic real-world practice.</td>
</tr>
<tr>
<td>Henneman et al., (2018)</td>
<td>No information provided.</td>
<td>No information provided.</td>
<td>No information provided.</td>
</tr>
<tr>
<td>Thomas (2014)</td>
<td>Recorded healthcare environment sounds played over headphones worn during medication preparation in laboratory.</td>
<td>No simulation scenario. Faculty reviewed MARs* for accuracy.</td>
<td>Use of recorded sounds and headphone to engage students with emotions felt while being distracted.</td>
</tr>
</tbody>
</table>
Several themes were consistent among the studies. Interruption management SBE was shown to increase recognition of the impact of interruptions on safety and error risk (Hayes et al., 2017, 2018; Hayes et al., 2019; Rochman et al., 2012; Thomas, 2015). Frequent interruptions were also associated with increased frustration and decreased concentration (Hayes et al., 2018; Thomas et al., 2014). Appreciation for how interruptions impact nurses was also discovered (Rochman et al., 2012). Conversations were found to be the most distracting of all the environmental sounds, with students reporting difficulty with concentration while discussions occurred around them (Thomas et al., 2014).

**Interruptions and Interruption Management Training**

Interruptions to the medication preparation or administration process was the most used scenario. The characteristics of the interruption or distraction ranged from environmental sounds to colleague or patient/family requests. Only one study included any purposeful interruption management training (Henneman et al., 2018), while the remainder relied on the use of experiential learning alone.

**Discussion**

The studies in this review consistently found that participating in SBE improves participants’ ability to manage interruptions (Ford et al., 2017; Henneman et al., 2018; Thomas et al., 2015). The qualitative studies reported participant themes demonstrating that SBE
participation increased awareness of the error risk associated with interruptions (Hayes et al., 2017; Rochman et al., 2012; Thomas, 2015). Reliability of the results was negatively impacted by study and simulation design. Although effect sizes were moderate to large, the sample sizes for the quantitative studies were small. Randomization was not achieved, blinding did not occur, and the risk of Hawthorne effect was high as the simulations were facilitated by the researchers. Qualitative studies lacked rigor as they did not demonstrate critical appraisal, member-checking, triangulation of findings or participant confirmation of themes. To provide reliable results that can inform education and practice, high quality studies are needed.

**Research Design**

The quantitative studies in this review were rated ‘good quality’ (IIB) or higher (Dang & Dearholt, 2017). Since randomization was not achieved and self-selection or participant volunteers were used, internal validity was threatened. To advance the science concerned with SBE for teaching interruption management, rigorous research design and reporting is needed (Fey et al., 2015; Mariani et al., 2020). To allow for replication, the resultant literature should provide a complete description of both the research and simulation methodology and designs, and identify limitations (Fey et al., 2015; Mariani et al., 2020).

**Theories, Conceptual Models**

Studies involving SBE for interruption management should be grounded in both attention and simulation theories. Attention and memory theories could include Attention Regulation (Posner & Petersen, 1990), Memory for Goals (Altmann & Trafton, 2002), Prospective Memory (Brandimonte et al., 1996), or Applied Attention Theory (Wickens & McCarley, 2008). Each of these theories addresses the cognitive processes associated with how the brain focuses and how interruptions affect these processes. In this integrative review, one study specifically reported
grounding the research in an attention or interruption theory (Henneman et al., 2018). Despite all the included studies using simulation as an education modality, education or simulation theoretical underpinnings were reported once (Hayes et al., 2015).

Definitions

To prevent potential confusion, key terms and concepts should be well defined. Among the studies in this review providing a formal definition, descriptions varied. For those studies defining interruptions, all indicated that some type of stimuli would cause a break or cessation of activity (Ford et al., 2017; Henneman et al., 2018; Thomas, 2015; Thomas et al., 2015). One study limited the definition of interruptions to those caused by external factors (Ford et al., 2017). Three studies specifically differentiated between interruptions and distractions, but the definitions varied and were not consistently shared. One study differentiated between interruptions and distractions by emphasizing that while interruptions result in stopping a current task, distractions require acknowledgement but do not cause task cessation (Ford et al., 2017). Other studies described distractions as stimuli that produce observable changes in task execution behaviors (Thomas, 2015; Thomas et al., 2015). The SBE interruptions literature should strive for a standard set of definitions that can be used to frame consistent objectives.

Instruments

When using an existing instrument, researchers should either replicate the validation process or report on existing reliability and validity data (Polit & Beck, 2017). One study in this review reported psychometrics for the data collection instrument (Henneman et al., 2018). Three studies used researcher-designed instruments but did not provide any psychometric analysis (Ford et al., 2017; Rochman et al., 2012; Thomas et al., 2015). Inclusion of psychometrics is important to demonstrate the validity and reliability of the results (Polit & Beck, 2017). For
qualitative studies that may not use instruments, a thorough description of the data collection process enhances replication of the study. This includes details about the thematic analysis, triangulation of the themes against available evidence like records, and checking the results with the participants (Whittemore, Chase & Mandle, 2001). Aside from the coding of themes, minimal descriptions were provided by the qualitative studies in this review.

**Use of Professional Simulation Standards**

The use of simulation best practice standards facilitates consistency of outcomes and quality across simulations (Rutherford-Hemming et al., 2015). A reference to the guiding standards of the SBE provides evidence of standardization that facilitates replication of the simulation and research (Fey et al., 2015). Among the ten included studies, one highlighted the standards used in their simulation development (Rochman et al., 2012). A five-step simulation development process was described, including mapping of competencies and standards, but no professional standards were included. Inclusion of INACSL (2016), or other professional simulation standards facilitates replication of design and standardization of participant experiences, to advance the science.

**Fidelity**

Simulation fidelity can be enhanced through the physical, conceptual, and psychological domains, but when attention to realism is high in all areas, it is easier for participants to suspend disbelief and engage with learning (Lavoie, 2020). While most of the studies described the physical fidelity of the simulation, realism ranged in complexity from a simple skills laboratory setting (Thomas et al., 2014) to detailed simulated hospital units (Ford et al., 2017; Henneman et al., 2018; Thomas et al., 2015). Even among the most complex scenario settings, no information was provided for the validity of the simulation scenario or the accuracy of the ‘patient’ records.
that were used (Ford et al., 2017; Thomas et al., 2015). When embedded participants were used, level of standardization or training for the actors was not provided. Descriptions of the fidelity of the simulations designed for medical trainees surpassed those designed for nursing students (see Table 3).

**Interruptions**

The characteristics of both the interruption and the interrupted activity varied by study. Despite literature evidence showing that interruptions occur throughout all aspects of patient care (Cole et al., 2016; Myers & Parikh, 2019; Prates & Silva, 2016), the studies in this review focused on medication administration. While medical and interprofessional graduate students received the most robust interruption experience, the simulations for nursing education were limited. The nursing interruption SBEs did not reflect current research evidence regarding the common characteristics of interruptions to nursing practice, which are needed for adequate experiential learning. Since nurses are interrupted during all types of activities (Cole et al., 2016; Myers & Parikh, 2019; Prates & Silva, 2016), simulations designed to teach nursing students how to manage interruptions should involve a variety of tasks.

**Interruption Management Training**

Experiential learning theory emphasizes that requiring learners to actively apply content facilitates optimal learning (Kolb, 1984). Success with experiential learning is dependent on the level of prior knowledge, so didactic education is also an important consideration (Merriam & Bierema, 2014). Experiential learning that is predicated on purposeful training facilitates the creation of mental models (schema). Cognitive schema are individual pieces of information that have been combined into related groupings and stored in long-term memory (Anderson, 2000). Schema are continuously refined based on the internal and external feedback received during
experiences, and they become more complex as novices move toward proficiency (Anderson, 2000; Benner, 1984). While predicking SBE on purposeful didactic content facilitates creation of schema, most of the studies in this review relied on experiential learning alone to teach interruption management. One study assigned the reading of interruption articles as a pre-simulation activity, but only 60% of the participants completed the assignment (Rochman et al., 2012). Teaching participants about interruption management strategies prior to engaging in the SBE occurred in one of the ten included studies in this review (Henneman et al., 2018). To enhance learning, SBE should be predicated on purposeful interruption management training.

Gaps in the Literature

The studies in this review found that the use of SBE to teach interruption management skills is effective. While SBE was found to improve participants’ awareness of the risk for interruption related error, reliability of these findings is challenged by the limitations of the study and simulation designs. The fidelity of simulations for medical trainees was much more complex than those for nursing students. Simulations designed to teach pre-licensure nursing students to manage interruptions were based on experiential learning alone and were not predicated on purposeful interruption management training.

Despite research evidence demonstrating that nurses are interrupted throughout all duties and tasks (Forsyth et al., 2018; Johnson et al., 2017; McCurdie et al., 2018), nursing student SBE did not reflect current literature evidence regarding the types of interruptions that are experienced by practicing nurses. The interrupted tasks for medical students were complex and included dynamic activities requiring significant concentration, like assessment and diagnosis, while nursing simulations focused on medication preparation or administration. Uniformity in definitions for interruptions was also lacking, and foundational theories for both simulation and
interruption science were not consistently reported. While most simulations were reported as facilitated by faculty, no evidence of simulation expertise or specific training was provided. Reporting of instrument psychometrics rarely occurred, and the use of any specific simulation best practice standards was lacking.

**Recommendations for Research and Nursing Education**

To advance the science and inform education, quantitative evidence gained through quality research with large sample sizes and randomization is needed. To improve the quality of the available research, future studies should be grounded in theory, use industry standards of best practice, and investigate interruptions within a variety of complex and dynamic situations. Specifics about the simulation method and design and the use of trained facilitators is also needed to inform future research. Qualitative approaches should demonstrate efforts to increase authenticity by referencing critical appraisal throughout the process and enhance integrity by emphasizing the repeated use of validity checks. Triangulation of themes to available data, and the use of member checking to validate findings would also facilitate quality. While experiential learning is beneficial, future research demonstrating the impact of targeted training on interruption management is necessary. Studies investigating the differences between groups receiving both training and SBE versus experiential learning alone, could prove beneficial.

**Conclusion**

Nurses are interrupted more than any other health professional, with interruptions occurring during all types of tasks. These continuous interruptions increase cognitive load, which overwhelms thought processes and increases the risk of errors. Novice nurses are most vulnerable to interruptions and can be easily overwhelmed. To safely transition from academia to practice, nursing students need to gain the skills necessary to prevent errors and manage
interruptions. While simulation is an excellent method for providing experiential learning, the current evidence does not provide the rigor, theoretical basis, or the use of simulation standards necessary for replication of findings or furthering of the research evidence. Future studies using randomization, large sample sizes, and adherence to best practice standards are needed to further the science of the use of simulation-based education for interruption management. Future studies are needed to determine if predicing SBE on purposeful interruption management content is beneficial.
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CHAPTER 3: REMEMBERING TO RESUME: A RANDOMIZED TRIAL COMPARING COMBINED INTERRUPTION MANAGEMENT TRAINING AND SIMULATION-BASED EDUCATION TO SIMULATION-BASED EDUCATION ALONE.

Abstract

Introduction: Interruptions can increase cognitive load and errors, and novices are particularly vulnerable to their impact. To prepare nursing students to transition to an interruption fraught practice environment, they must be taught to manage interruptions. Simulation-based education (SBE) is an optimal modality because it combines experiential learning with guided reflection. The goal of this study was to determine if purposeful, pre-simulation training for pre-licensure nursing students enhances interruption management and prevents increased cognitive load more than experiential SBE alone.

Methods: Between-subjects design with block randomization was used with prelicensure Baccalaureate nursing students (N=146). The intervention group (n=78) received purposeful interruption management training prior to engaging in a high-fidelity simulation scenario, while the control group (n=68) received training afterward. The NASA-Task Load Index (TLX) facilitated determining group differences for post-simulation cognitive load. Checklist guided observations enabled identification of interruption management strategy use and simulation critical element completion. Open-ended questions were posed to determine participant awareness of interruption risk following training and SBE.

Results: ANCOVA analysis demonstrated a significantly lower perceived mental demand for the intervention group. The intervention group implemented interruption strategies and notified the provider significantly more than the control group. Age was moderately associated with strategy
use, with older participants implementing more than those aged 18-25. Awareness of the error risk associated with interruptions was evident in 45.07% of answers.

**Conclusion:** Combining SBE with purposeful training enhances interruption management more than SBE alone. Frequent interruption training and SBE are recommended to enhance risk awareness. Future studies are needed to further explore types of training and necessary frequency.

*Key words: Interruption Management, Cognitive Load, NASA-TLX, Simulation-Based Education, Simulation, Pre-licensure nursing students.*
Introduction

Tragedies and accidents often prompt the identification of training methods to improve safety. Aviation, automobile, and healthcare industries have all implemented safety protocol due to evidence linking errors with poor outcomes (Girbes et al., 2016; Institute of Medicine, 2001; Salvetti et al., 2020). For example, the airline industry incorporated new training protocols after discovering that cockpit conversations were linked to accidents (Salvetti et al., 2020). Now, to enhance the ability to manage real crises in the air, pilots are first taught principles, and then given an opportunity to practice them in simulation (Malakis & Kontogiannis, 2012).

Nursing students are also prepared for practice by first learning concepts and then practicing them, but the concept of interruption management is rarely taught (Stephenson, 2017). Learning interruption management is necessary because interruptions are associated with errors (Campoe & Giuliano, 2017; Drews et al., 2019) and occur during all aspects of nursing work (Cole et al., 2016). Simulation-based education (SBE) is an excellent method for teaching interruption management because it provides an opportunity to experience the impact interruptions have on concentration (Jeffries, 2014). SBE is most effective when students are first introduced to concepts and then given a chance to practice (Jeffries, 2016; Merriam & Bierema, 2014). In the current SBE literature, nursing students engage with interruptions during simulation without prior introduction to the concept (Hayes et al., 2017, 2018; Hayes et al., 2015, 2019; Thomas et al., 2014).

Background

An interruption is anything that causes a pause or cessation of concentration or attention to a task (Banich & Compton, 2018; Wickens & McCarley, 2008). Nursing interruptions have been observed an average of 85 times per shift, during all types of tasks (Forsyth et al., 2018).
Frequent interruptions are associated with an increased time on task, (Cooper et al., 2016), greater risk of errors (Johnson et al., 2017), intensified stress and high cognitive load (Thomas et al., 2017). Interruptions are most frequently caused by colleagues for information sharing or socialization (Johnson et al., 2017). While nurses perceive interruptions as a job expectation, they also indicate that dealing with them increases stress and cognitive load (Laustsen & Brahe, 2018; Sitterding, 2014).

Cognitive load is the mental demand felt by an individual during task performance or concentration (Banich & Compton, 2018; Plass et al., 2010; Sewell et al., 2017). Several tools, including the NASA-TLX (Task Load Index), are used to gather data about perceived cognitive load, and have been used to demonstrate the negative impact of interruptions on cognition (Forsyth et al., 2018; Hart & Staveland, 1988; Young et al., 2021). Difficult tasks, serially occurring high cognitive load events, or situations requiring sustained mental effort are all associated with increased fatigue and decreased alertness (Borragán et al., 2017). While previous professional experience and advanced educational level have been shown to have a protective effect on cognitive load, exhaustion exacerbates and increases it (Sewell et al., 2017). Sustained high mental demand can result in cognitive fatigue, which negatively impacts performance (Borragán et al., 2017). Even when mental load is high, the most common response to an interruption is to stop the current task and deal with the new issue (Johnson et al., 2017). Task switching increases the time spent on each task (Campoe & Giuliano, 2017; Cole et al., 2016), enhances the probability of procedural failures (Thomas et al., 2017), decreases efficiency (Cooper et al., 2016; Johnson et al., 2017; Sasangohar et al., 2017), and increases perceived time pressure (Leroy & Glomb, 2018).
Nurses who recognize the impact interruptions can have on cognition often create strategies to manage them (Cole et al., 2016; Getnet & Bifftu, 2017). Learning these strategies typically occurs by trial and error, often after years of experience (Laustsen & Brahe, 2018). The deleterious effects of interruptions are minimized by using checklists, waiting for an appropriate stopping point and creating explicit cues to facilitate remembering where to resume the interrupted task (Cole et al., 2016; Henneman et al., 2018; Wickens & McCarley, 2008). Novice nurses, with less than two years in practice, are more negatively impacted by interruptions and require training to learn to manage them safely (Getnet & Bifftu, 2017).

Novices solve problems based on rules because they have not yet created complex mental schema (Benner, 1984). Mental schema are groups of individual elements of learned content that have been stored in long-term memory as knowledge packages (Banich & Compton, 2018; Merriam & Bierema, 2014). Problem solving is facilitated when complex schema, with many layers of content, are created (Merriam & Bierema, 2014). Complex schema creation is like creating detailed computer file folders. Instead of searching for each piece of information, one ‘folder’ can be accessed that holds all the necessary material. For novices, the lack of mental schema makes problem solving more involved, and interruptions to the process can enhance the risk for error and lead to stress and high cognitive load (Thomas et al., 2017; Wickens & McCarley, 2008). Stress and high cognitive load are associated with job dissatisfaction (Forsyth et al., 2018; Thomas et al., 2017) and can impact retention and result in costly turnover (Nursing Solutions Inc., 2020). Pre-licensure students need to learn interruption management skills to facilitate transition to the role of novice nurse (Thomas et al., 2017).

In healthcare, minimizing the negative effects of interruptions has involved strategies ranging from mindfulness training to the wearing of ‘do not disturb’ vests, signs, and tabards.
While mindfulness can be beneficial to mood (Kelly, 2017; Noble et al., 2019), and can moderately boost executive attention (Burger & Lockhart, 2017) it is unclear whether these effects insulate against the impact of interruptions. Mandating wearable signs, vests, and tabards to prevent interruptions has met with resistance (Palese et al., 2019; Williams et al., 2014). While studies showed that wearing these items decreased interruption frequency, nurses found them wieldy, unsanitary, and disruptive to their patient relationships (Palese et al., 2019; Williams et al., 2014). Nurses also indicate that some interruptions can be beneficial or imperative to patient safety (Myers et al., 2016). Learning interruption management strategies can facilitate prioritization of necessary interruptions while preventing deleterious effects (Wickens & McCarley, 2008).

Management of interruptions is dependent on the work environment, role expectations, and competence level (Laustsen & Brahe, 2018). Providing safe care while being interrupted requires creation of mental schema about interruptions that includes error risk and the need to advocate for the ability to concentrate (Laustsen & Brahe, 2018; Wickens & McCarley, 2008). When didactic and SBE are combined, schema creation is facilitated and learning outcomes improve (Jeffries, 2016). Current nursing SBE studies use experiential learning alone without first providing interruption management training (Hayes et al., 2015; Thomas et al., 2014). Among the SBE studies specifically designed to teach nursing students to manage interruptions, experiential learning involved immersion in an interrupted simulation scenario. Students were not provided any purposeful didactic information about interruptions or how to manage them but were expected to learn through experience alone. While all the themes and findings based on these simulations demonstrated that participants gained an awareness about interruptions, the

**Purpose**

The goal of this study was to determine if predicating simulation on purposeful training enhances interruption management more than traditional SBE. Since interruptions have been associated with increased cognitive load (Campoe & Giuliano, 2017; Thomas et al., 2017), this study sought to determine if prior interruption management training would insulate against post-simulation cognitive load gains. The literature also indicates that awareness of the risks associated with interruptions spurs the use of strategies to mitigate them (Getnet & Bifftu, 2017; Laustsen & Brahe, 2018). This study pursued determining whether teaching nursing students about interruption risks and specific methods of managing them would translate to greater strategy implementation during the simulation scenario. Due to the evidence regarding the impact of interruptions on task time and the duration of nursing interventions (Campoe & Giuliano, 2017; Cole et al., 2016), this study sought to determine if training would impact the completion of the simulation critical elements. The specific aims were to: 1. explore group differences in cognitive load for those receiving pre-simulation interruption management training versus SBE alone; 2. compare observed group differences in interruption management strategy implementation and 3. identify group differences in completion of simulation critical element outcome objective criteria.

**Theoretical Framework**

The theoretical frameworks for this research included four theories: Cognitive Load (Plass et al., 2010), Applied Attention (Wickens & McCarley, 2008), the NLN/Jeffries Simulation (Jeffries, 2016), and Novice to Expert theories (Benner, 1984). Cognitive Load
Theory is concerned with the mental effort exerted during the process of schema creation (Banich & Compton, 2018; Merriam & Bierema, 2014; Plass et al., 2010). The degree of cognitive load depends on the number of elements that need to be simultaneously processed, and the extent of prior knowledge (Plass et al., 2010). Learners with prior knowledge require less cognitive strain to create schema, so their load is lower (Merriam & Bierema, 2014; Plass et al., 2010).

Applied Attention Theory (Wickens & McCarley, 2008) was the framework for the creation of the interruption management training presentation. This theory suggests that learning and practicing specific techniques can increase attention and situational awareness, while minimizing cognitive load. Applied Attention Theory (AAT) emphasizes that remembering to resume an interrupted task is enhanced when the risks are known and specific attention capturing strategies are used (Wickens & McCarley, 2008). The training used in this study emphasized prioritization of both the current and interrupting task, waiting for a natural stopping point, pausing and rehearsing the current task, creating visual and verbal reminders, delegating, and using teamwork (see Figure 2).
Benner’s (1984) Novice to Expert Theory emphasizes that there are stages inherent to clinical reasoning that occur as nurses grow in expertise. Students, who are in the beginning stages of this process, have not yet created mental schema and are instead reliant on guidelines. Novices and students work by completing tasks, and when derailed from the process must start again from the beginning (Benner, 1984). The ‘Remembering to Resume’ training was designed to teach memory cues that might prevent the need to completely restart tasks and facilitate safe resumption of interrupted cognition.

The simulation learning experience was based on the NLN/Jeffries Simulation Theory (Jeffries, 2016), which emphasizes how the dynamic interaction between educational strategies, facilitators and participants impacts outcomes. Facilitators and participants possess unique characteristics that can influence learning outcomes, including experience, knowledge, and personal style (Benner et al., 2010; Jeffries, 2016). Learners’ age, motivation, and learning styles can also impact knowledge acquisition (Jeffries, 2016). The NLN/Jeffries theory stresses the
need for an environment of trust that is collaborative, interactive, experiential, and learner centered. To facilitate learning and problem solving, simulation design must be based on specific behavioral objectives, be realistic (fidelity), provide student support (cues), and include debriefing to promote reflection (Jeffries, 2016). Predicating simulation on prior didactic and integrating SBE throughout the curriculum also facilitate optimal learning (Jeffries, 2016).

**Methods**

This study was determined ‘exempt’ by the Institutional Review Board (see Appendix D). Participants were informed about the study prior to their simulation day and consented by a research team member upon arrival to the center. Participation was voluntary, and no compensation or coercion was offered. Care was taken to ascertain that the simulation facilitator, researchers, and person providing consent information were not affiliated with the participants’ grades or program progress. While all participants were required to attend the simulation and training, the completion of instruments was voluntary. The intervention group attended the ‘Remembering to Resume’ training prior to engaging with any simulations for the day, while the control group attended the training at the end, after completing all simulations and the NASA-TLX (Hart & Staveland, 1988) but prior to completing the open-ended questions.

**Simulation**

The simulation scenario was based on International Nursing Association for Clinical Simulation and Learning (INACSL) standards of best practice: Simulation℠ (INACSL Standards Committee, 2016). Scenario content was validated by advanced certified healthcare simulation educators (CHSE-A™) (SSH, 2021) affiliated with the simulation center (Chu et al., 2017; Díaz et al., 2020). Staging involved a high-fidelity simulation suite equipped with a pediatric five-year-old Gaumard® manikin that included working heart and lung sounds. The
room was furnished with realistic oxygen and suction equipment, an operational nebulizer, and a touchscreen patient monitor. Remote voice over was provided by a CHSE™ (Certified Healthcare Simulation Educator) facilitator to promote realistic interaction and communication with the ‘patient’ (SSH, 2021). The room was fitted with a baby-monitor that simulated a hands-free communication device, which allowed participants to simultaneously interact with the patient and take ‘phone’ calls.

The scenario involved a male pediatric patient with a history of premature birth and asthma, who presented with symptoms of pneumonia, quickly transitioning to sepsis (Díaz et al., 2020). Participants were provided a pre-brief to facilitate psychological safety and room orientation followed by 15-20 minutes engaged in the scenario (Dileone et al., 2020). A CHSE (SSH, 2021) certified faculty member, who was not affiliated with the study, facilitated both the scenario, and debrief session. Forty minutes were allowed for instrument completion, ‘Rapid Fire’ huddle (Díaz et al., 2017), and debriefing, using the Debriefing for Meaningful Learning method (Dreifuerst, 2015). The debrief was standardized based on the simulation objectives and the sepsis protocol associated with the scenario (Chu et al., 2017; Díaz et al., 2020).

**Design**

A between-subjects design using block randomization of a convenience sample of pre-licensure Bachelor of Science in Nursing students (N=146) was used to determine group differences in cognitive load, simulation criteria completion, and implementation of interruption management strategies. Participants attended one of four simulation events, with a randomizer calculator used to determine each cohorts’ research role. The intervention group (n=78) received an interruption management training prior to simulation engagement, while the control group (n=68) received the education afterward. Participants were assigned simulation teams (n=5-9),
with Covid-19 guidelines restricting active participants to two for each team while the remaining team members engaged in active observation. This resulted in a smaller sample (n=42) for measurement of interruption management strategy use and simulation critical element completion. Teams rotated through several scenarios throughout the day, but only the pediatric sepsis event was included in the data for this study.

Sample

G*Power analysis (ES=0.35, α=0.05, power = 0.80) for One-Way ANCOVA of two groups indicated that N=142 participants were needed to determine differences between groups. All assigned students agreed to participate (N=146) but some instruments were not fully completed, which decreased group numbers for some elements. However, the N=142 threshold was maintained throughout.

Procedures

Following consent, participants were provided with a research packet including a demographic questionnaire, pre- and post-simulation NASA-TLX surveys (Hart & Staveland, 1988), and open-ended questions about their learning. After initial instrument completion, the intervention group (n=78) was presented the 30-minute researcher-designed ‘Remembering to Resume’ training (see Figure 2). This purposeful training was based on Applied Attention theory (Wickens & McCarley, 2008), and began by interrupting participants during a simple task to demonstrate the impact of interruptions on their cognition. Next, participants were taught to use strategies to minimize the risk of errors associated with interruptions, including prioritization, teamwork, waiting for a natural stopping point, and creations of visual and auditory reminders. Waiting for a natural stopping point and pausing to rehearse is believed to create a mental snapshot of the current task, increasing the likelihood that it will be resumed (Wickens &
McCarley, 2008). Likewise, creating a verbal reminder (speaking aloud) triggers the auditory centers of the brain, which enhances the number of mental cues (Banich & Compton, 2018). The use of visual reminders, like sticky notes, placing a finger on a screen, holding, or strategically locating an item, are believed to facilitate the re-capture of attention once the interruption is managed (Wickens & McCarley, 2008).

Mimicking the hands-free communication devices common in nursing, participants were notified that ‘mom’ was on the phone via a baby monitor hidden in the room. The ‘phone call’ was timed according to when the participants were the most engaged with patient care, which varied slightly between the teams. Determination of engagement was based on physical and facial cues demonstrating concentration, like becoming quiet and fixating vision on the task (Banich & Compton, 2018). During the phone call, ‘mom’ frantically provided several cues about the ‘patient’s’ premature birth and asthma history, and shared concern about his care during the pandemic. While all simulation teams received the phone call at slightly different times, the interruption occurred between minute five and nine within the scenario. Except for the first day, each simulation scenario was facilitated by the same faculty member.

**Data Collection**

**Cognitive Load.** Originally developed in the aviation industry, the NASA-TLX elicits information about the participant’s perceived cognitive load (Hart & Staveland, 1988). Participants completed a pen and paper version at baseline, prior to engaging in any simulation day activities, and immediately after the interrupted scenario (see Appendix E). The instrument was used to rate perceived cognitive load across six domains: mental demand, physical intensity, time pressure, effort, perceived task performance, and frustration level (Hart & Staveland, 1988). The NASA-TLX is rated from 0 (low) to 100 (high) for each of the six domains for an overall
raw score of 600, with reversed scoring used for the ‘perceived performance’ domain. Since its creation, it has been cited in over 4,400 studies, translated across more than 12 languages, and consistently resulted in a Cronbach alpha of .80 (Weigl et al., 2016). The psychometrics for this instrument were validated across 16 studies and included more than 3,400 data points (Hart, 2006).

Observations. Cameras within the simulation suite facilitated remote observation of the scenario from a variety of angles and allowed the facilitator to zoom in as needed. All simulations at this center include a checklist of behavioral objective criteria that are based on the content and educational level of participants. Simulation educators complete a computerized version of the checklist while remotely facilitating the scenario during live participant engagement. The checklist used in this study included sixteen critical elements involving safety, communication, and items specific to the care of a pediatric sepsis patient (Chu et al., 2017; Díaz et al., 2020). As students met objectives, the facilitator marked the checklist for that item with a ‘yes’ (see Appendix F). The sum of achieved critical elements was determined by adding the number of ‘yes’ designations. Task time was not investigated in this study because each simulation scenario was restricted to 15 to 20 minutes. Instead, investigation of the number of completed simulation critical elements was performed to facilitate identifying differences in task completion. Based on the evidence regarding the impact of interruptions on task time and the duration of nursing interventions (Campoe & Giuliano, 2017; Cole et al., 2016), this study sought to determine if training would impact the completion of the simulation critical elements. While errors were not specifically measured, completion of a greater number of critical elements was investigated to determine if training enhances the ability to complete more tasks.
**Intervention Checklist.** A researcher-developed checklist, based on the ‘Remembering to Resume’ training, was also used to determine the implementation of specific interruption management strategies (see Appendix G). During synchronous remote observation, the researcher placed a hash mark next to each individual strategy as it was implemented. Implementation of at least one strategy, along with the number and type of strategies used, were compiled to facilitate determination of group differences. Participants were scored based on whether they implemented one or more interruption management strategies during the simulation scenario.

**Demographic Data.** To facilitate determination of group composition similarities, participants were asked to provide their age, racial or ethnic background, gender, and previous degrees (see Appendix H). They were also asked about current or previous healthcare experience and any regular mindfulness practice (2 or more days per week). This information was used to facilitate determination of any potential relationships that could explain results.

**Open-Ended Questions.** Following completion of all simulations and study instruments, participants answered open-ended questions about their learning (see Figure 3). The purpose of the questions was to determine awareness of the risks associated with interruptions by identifying the frequency certain words were used including, error or mistake, and danger, dangerous, or deleterious.
**Question 1:**
Please describe what you learned most from the simulation and training today:

**Question 1:**
How will you apply what you have learned in your clinical practice?

**Question 1:**
Please explain the impact you believe interruptions have on patient care.

*Figure 3: Open-Ended Questions*

**Data Analysis**

**Cognitive Load.** Using Statistical Package for the Social Sciences (SPSS) version 27, estimates for normality, homogeneity of variance, and outliers were investigated. While controlling for baseline scores, an ANCOVA with Bonferroni was used to determine the effect of the ‘Remembering to Resume’ training on post-simulation NASA-TLX cognitive load scores. Assumptions for normality were not met as significant outliers (≥ 3 SD) were found. The outliers were retained for data analysis because the ANCOVA is robust against violations of normality (Laerd Statistics, 2020). Adjusted means are presented for ANCOVA findings, unless otherwise stated.

**Observations.** For observation data, whenever assumptions were not met the non-parametric statistical equivalent was used for analysis. The Fisher exact test was done to determine if an association existed between active participant group designation (intervention or control) and completion of each of the individual critical simulation scenario elements. Chi-
Square analysis was performed to determine if a relationship existed between group designation and the implementation of interruption management strategies (yes/no) for active participants.

**Associations.** Spearman rho was used to determine if relationships exist between age, healthcare experience, or regular mindfulness practice (two or more days per week) and the overall NASA-TLX scores (Hart & Staveland, 1988) both at baseline and post-simulation, as well as with the number of critical simulation elements achieved by active participants. To determine the association of mindfulness practice or healthcare experience with interruption management strategy (yes/no) Chi-square analyses were performed. For all Chi-square analyses, all expected cell frequencies were greater than five. Association of age range to the use of an interruption management strategy was analyzed using Spearman’s rho.

**Open-Ended Questions.** Since answers to the open-ended questions were solicited after all participants had attended the interruption management training, descriptive statistics were used to determine the number of interruption key words that were included. Answers were reviewed for inclusion of key words associated with the risk for errors, including *error, mistake, danger, dangerous, or deleterious*. The percentage of the overall population mentioning these risks was identified.

**Results**

**Demographics**

The convenience sample was primarily female (88.36%). Reported race and ethnicities included White (52.75%), Black or African American (8.22%), Hispanic/Latino (20.55%), Asian (12.33%), Multi-racial (4.79%), and Native American/ Alaska Native (0.07%). Participants were predominantly 18 to 25 years old (65.75%), with 28.77% between the ages of 26 and 35, and 5.48% indicating an age of between 36 and 60 years. Both traditional and accelerated program
students were included, and 55.48% indicated that they hold a bachelor’s degree from another discipline. Current or previous healthcare experience was reported by 40.41% of participants, and of those, 36.30% reported having six-months to two years of experience (see Table 4).

Regular mindfulness practice was reported by 25.34% of participants (see Table 5).

Table 4: Participant Demographic Data by Population and Group

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Category</th>
<th>Total Participant Population (n=146)</th>
<th>Control Group (n=68)</th>
<th>Intervention Group (n=78)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male:</td>
<td>n=17 (11.64%)</td>
<td>n=6 (8.82%)</td>
<td>n=11 (14.10%)</td>
</tr>
<tr>
<td></td>
<td>Female:</td>
<td>n=129 (88.36%)</td>
<td>n=62 (91.18%)</td>
<td>n=67 (85.90%)</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td>White:</td>
<td>n=77 (52.75%)</td>
<td>n=33 (48.53%)</td>
<td>n=44 (56.41%)</td>
</tr>
<tr>
<td></td>
<td>Black or African American</td>
<td>n=12 (8.22%)</td>
<td>n=4 (5.88%)</td>
<td>n=8 (10.26%)</td>
</tr>
<tr>
<td></td>
<td>Hispanic or Latino or Spanish Origin of any Race</td>
<td>n=30 (20.55%)</td>
<td>n=20 (29.41%)</td>
<td>n=10 (12.82%)</td>
</tr>
<tr>
<td></td>
<td>Asian:</td>
<td>n=18 (12.33%)</td>
<td>n=7 (10.29%)</td>
<td>n=11 (14.10%)</td>
</tr>
<tr>
<td></td>
<td>Multi-racial:</td>
<td>n=7 (4.79%)</td>
<td>n=4 (5.88%)</td>
<td>n=3 (3.85%)</td>
</tr>
<tr>
<td></td>
<td>Native American, Alaska Native:</td>
<td>n=1 (.07%)</td>
<td>n=0 (.00%)</td>
<td>n=1 (1.28%)</td>
</tr>
<tr>
<td></td>
<td>Unknown:</td>
<td>n=1 (.07%)</td>
<td>n=0 (.00%)</td>
<td>n=1 (1.28%)</td>
</tr>
<tr>
<td>Program</td>
<td>Prelicensure:</td>
<td>n=76 (52.05%)</td>
<td>n=33 (48.53%)</td>
<td>n=43 (55.13%)</td>
</tr>
<tr>
<td></td>
<td>Accelerated:</td>
<td>n=70 (47.95%)</td>
<td>n=35 (51.47%)</td>
<td>n=35 (44.87%)</td>
</tr>
<tr>
<td>Previous Degree</td>
<td>None:</td>
<td>n=28 (19.18%)</td>
<td>n=15 (22.06%)</td>
<td>n=13 (16.67%)</td>
</tr>
<tr>
<td></td>
<td>Associate:</td>
<td>n=35 (23.97%)</td>
<td>n=15 (22.06%)</td>
<td>n=20 (25.64%)</td>
</tr>
<tr>
<td></td>
<td>Bachelor:</td>
<td>n=81 (55.48%)</td>
<td>n=38 (55.88%)</td>
<td>n=43 (55.13%)</td>
</tr>
<tr>
<td></td>
<td>Master:</td>
<td>n=2 (1.37%)</td>
<td>n=0 (.00%)</td>
<td>n=2 (2.56%)</td>
</tr>
<tr>
<td>Age Range</td>
<td>18-25:</td>
<td>n=96 (65.75%)</td>
<td>n=46 (67.65%)</td>
<td>n=50 (64.10%)</td>
</tr>
<tr>
<td></td>
<td>26-35:</td>
<td>n=42 (28.77%)</td>
<td>n=17 (25.00%)</td>
<td>n=25 (32.05%)</td>
</tr>
<tr>
<td></td>
<td>36-46:</td>
<td>n=4 (2.74%)</td>
<td>n=3 (4.41%)</td>
<td>n=1 (1.28%)</td>
</tr>
<tr>
<td></td>
<td>47-60:</td>
<td>n=3 (2.05%)</td>
<td>n=2 (2.94%)</td>
<td>n=1 (1.28%)</td>
</tr>
<tr>
<td></td>
<td>No answer:</td>
<td>n=1 (.07%)</td>
<td>n=0 (.00%)</td>
<td>n=1 (1.28%)</td>
</tr>
<tr>
<td>Healthcare Experience</td>
<td>Yes:</td>
<td>n=59 (40.41%)</td>
<td>n=31 (45.59%)</td>
<td>n=28 (35.90%)</td>
</tr>
<tr>
<td>Experience Type</td>
<td>Aid/Tech:</td>
<td>n=45 (30.82%)</td>
<td>n=25 (36.76%)</td>
<td>n=20 (25.64%)</td>
</tr>
<tr>
<td></td>
<td>Administration:</td>
<td>n=2 (1.37%)</td>
<td>n=0 (.00%)</td>
<td>n=2 (2.56%)</td>
</tr>
<tr>
<td></td>
<td>Other:</td>
<td>n=12 (8.22%)</td>
<td>n=6 (8.82%)</td>
<td>n=6 (7.69%)</td>
</tr>
<tr>
<td>Years of Healthcare Experience</td>
<td>None:</td>
<td>n=87 (59.59%)</td>
<td>n=37 (54.41%)</td>
<td>n=50 (64.10%)</td>
</tr>
<tr>
<td></td>
<td>6 m – 1 year:</td>
<td>n=24 (16.44%)</td>
<td>n=16 (23.53%)</td>
<td>n=8 (10.26%)</td>
</tr>
<tr>
<td></td>
<td>1-2 years:</td>
<td>n=29 (19.86%)</td>
<td>n=18 (26.47%)</td>
<td>n=11 (14.10%)</td>
</tr>
<tr>
<td></td>
<td>3-10 years:</td>
<td>n=21 (14.38%)</td>
<td>n=8 (11.76%)</td>
<td>n=13 (16.67%)</td>
</tr>
<tr>
<td></td>
<td>10 + years:</td>
<td>n=2 (1.37%)</td>
<td>n=2 (2.94%)</td>
<td>n=0 (.00%)</td>
</tr>
</tbody>
</table>

Note: Percentages are rounded to nearest hundredth.
Table 5: Comparison of Mindfulness Practice for Total Population and Groups

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Population n=146</th>
<th>Control n=68</th>
<th>Intervention n=78</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mindfulness Practice at least 2 days per week</td>
<td>n=37 (25.34%)</td>
<td>n=16 (23.53%)</td>
<td>n=21 (26.92%)</td>
</tr>
<tr>
<td>No regular mindfulness practice</td>
<td>n=109 (74.66%)</td>
<td>n=52 (76.47%)</td>
<td>n=57 (73.08%)</td>
</tr>
<tr>
<td>Days in Practice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2:</td>
<td>n=7 (4.79%)</td>
<td>n=1 (1.47%)</td>
<td>n=6 (7.69%)</td>
</tr>
<tr>
<td>3:</td>
<td>n=9 (6.16%)</td>
<td>n=4 (58.82%)</td>
<td>n=5 (6.41%)</td>
</tr>
<tr>
<td>4:</td>
<td>n=7 (4.79%)</td>
<td>n=2 (2.94%)</td>
<td>n=5 (6.41%)</td>
</tr>
<tr>
<td>5:</td>
<td>n=9 (6.16%)</td>
<td>n=6 (8.82%)</td>
<td>n=3 (3.85%)</td>
</tr>
<tr>
<td>6-7:</td>
<td>n=5 (3.42%)</td>
<td>n=3 (4.41%)</td>
<td>n=2 (2.56%)</td>
</tr>
</tbody>
</table>

Note: Percentages have been rounded to the nearest 100\(^{th}\).

Cognitive Load Domain Findings

While the overall NASA-TLX (Hart & Staveland, 1988) and all domains except ‘perceived frustration’ were rated lower by the intervention group than the control group (see Table 4), only the mental demand domain reached significance. After adjustment for pre-simulation mental demand scores, One-Way ANCOVA showed significant difference in post-simulation mental demand perception (p = 0.01). The intervention group perceived a lower mental demand than the control group, with a mean difference of 9.15 between group scores (see Table 6).
Table 6: ANCOVA Results for NASA-TLX Scores with PRE-Simulation Scores as Covariate

<table>
<thead>
<tr>
<th>NASA-TLX Domain</th>
<th>Group</th>
<th>Unadjusted</th>
<th>Adjusted</th>
<th>ANCOVA: Differences Between Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>Control n = 68</td>
<td>µ = 312.18</td>
<td>SD = 83.60</td>
<td>µ = 321.88</td>
</tr>
<tr>
<td></td>
<td>Intervention n = 77</td>
<td>µ = 316.49</td>
<td>SD = 95.81</td>
<td>µ = 307.93</td>
</tr>
<tr>
<td>Mental Demand</td>
<td>Control n = 68</td>
<td>µ = 73.46</td>
<td>SD = 16.76</td>
<td>µ = 76.99</td>
</tr>
<tr>
<td></td>
<td>Intervention n = 77</td>
<td>µ = 70.97</td>
<td>SD = 24.87</td>
<td>µ = 67.85</td>
</tr>
<tr>
<td>Physical Demand</td>
<td>Control n = 68</td>
<td>µ = 19.41</td>
<td>SD = 16.69</td>
<td>µ = 18.64</td>
</tr>
<tr>
<td></td>
<td>Intervention n = 76</td>
<td>µ = 23.16</td>
<td>SD = 22.90</td>
<td>µ = 23.85</td>
</tr>
<tr>
<td>Temporal Demand</td>
<td>Control n = 67</td>
<td>µ = 59.18</td>
<td>SD = 22.05</td>
<td>µ = 60.09</td>
</tr>
<tr>
<td></td>
<td>Intervention n = 75</td>
<td>µ = 56.00</td>
<td>SD = 27.32</td>
<td>µ = 55.19</td>
</tr>
<tr>
<td>Performance *</td>
<td>Control n = 68</td>
<td>µ = 44.95</td>
<td>SD = 22.71</td>
<td>µ = 45.17</td>
</tr>
<tr>
<td></td>
<td>Intervention n = 75</td>
<td>µ = 49.20</td>
<td>SD = 22.21</td>
<td>µ = 48.91</td>
</tr>
<tr>
<td>Effort</td>
<td>Control n = 67</td>
<td>µ = 64.25</td>
<td>SD = 21.90</td>
<td>µ = 66.01</td>
</tr>
<tr>
<td></td>
<td>Intervention n = 76</td>
<td>µ = 66.58</td>
<td>SD = 21.25</td>
<td>µ = 65.03</td>
</tr>
<tr>
<td>Frustration</td>
<td>Control n = 68</td>
<td>µ = 53.68</td>
<td>SD = 26.66</td>
<td>µ = 55.37</td>
</tr>
<tr>
<td></td>
<td>Intervention n = 74</td>
<td>µ = 57.16</td>
<td>SD = 27.06</td>
<td>µ = 55.61</td>
</tr>
</tbody>
</table>

*NOTE: n = number of participants, M = Mean, SD = Standard Deviation, SE = Standard Error. Intervention group received ‘Remembering to Resume’ purposeful interruption management training prior to engaging with simulations. *Performance domain is reversed scored (0 = excellent perceived performance), as poor perception is associated with higher cognitive load.
Critical Element Completion

Despite the active participants in the intervention group (n=20) outperforming the control group (n=21) on 11 of the 16 individual critical elements, only one element demonstrated a significant relationship. The Fisher exact test found a significant association between group designation and the element concerned with notifying the physician (p = .03). The intervention group notified the physician 15 times compared to seven for the control group.

Implementation of Interruption Management Strategies

Chi-Square analysis demonstrated a significant association between group designation and implementation of at least one interruption management strategy \(X^2(1) = 13.244, p = .00\). Active participants in the intervention group implemented interruption management strategies at a higher rate (71.43%) than those in the control group (15.00%).

Correlation of Age, Mindfulness Practice and Healthcare Experience

Cognitive Load. Spearman rho analysis was used to determine if NASA-TLX (Hart & Staveland, 1988) overall pre- or post-simulation scores were associated with participant’s age range, mindfulness practice or healthcare experience. No significant association was found between the baseline NASA-TLX overall scores and age range (rs(143) = 0.01, p = .93), regular mindfulness practice (rs(143) = 0.03, p = .70), nor healthcare experience (rs(143) = -.05, p = .55). Likewise, the post-simulation overall NASA-TLX scores were not significantly associated with age (rs (144) = -.11, p = .20), experience (rs (144) = -.10, p = .24), nor mindfulness practice (rs(144) = .08, p = .33).

Critical Element Completion. To determine if age, experience, or mindfulness practice were associated with the number of simulation critical elements that were successfully completed, a Spearman’s rho analysis was performed using the active participant population
(n=41). No significant association was found between the number of completed simulation elements and age range (rs(39) = .21, p = .19), days per week spent in mindfulness (rs(39) = -.01, p = .97), nor for years of current or previous healthcare experience (rs(39) = p = .78).

**Use of Interruption Management Strategies.** Chi-square analysis found no significant association between implementation of interruption management strategies and regular mindfulness practice (X²(1) = .034, p = .85), nor for possession of current or previous healthcare experience, X²(1) = 3.39, p = .07. Spearman rho analysis demonstrated a moderate but significant association between age and the implementation of interruption management strategies, with 31% of the variance explained by age, rs(39) = .31, p = .045. Despite a greater number of participants between the ages of 18 and 25, older active participants (26 to 60) implemented strategies more (see Table 7).

**Table 7: Active Participant Implementation of Interruption Management Strategies by Age Range**

<table>
<thead>
<tr>
<th>Age range:</th>
<th>Implemented Interruption Management Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-25 years: (n=27)</td>
<td>μ = .33, SD = .48</td>
</tr>
<tr>
<td>26-35 years: (n=13)</td>
<td>μ = .62, SD = .51</td>
</tr>
<tr>
<td>47 to 60 years: (n=1)</td>
<td>μ = 1.00, SD = 0</td>
</tr>
</tbody>
</table>

Note: SD = Standard Deviation

**Open-Ended Questions**

Answers to the open-ended questions were provided by 97.26% of participants (142/146). The words *error* or *mistake* were mentioned by 45.07% of participants (64/142). Interruptions were described as *dangerous* or *deleterious* by 32.40% (46/142).

**Discussion**

Combining purposeful didactic training with experiential learning facilitates the creation of complex mental schema. While previous SBE studies used experiential learning alone to teach students about the impact of interruptions (Hayes et al., 2015; Thomas et al., 2014), this study set out to determine the influence of purposeful, pre-simulation training on interruption
management, completion of simulation critical elements, and cognitive load. After one thirty-minute interruption management training session, the participants in this study were able to implement strategies at a higher rate than the control group (p < .001), while rating their mental demand lower.

**Strategy Implementation**

The lack of relationship between healthcare experience, or mindfulness practice and the implementation of management strategies demonstrates that these factors did not significantly impact the outcome. While older participants implemented strategies more, on average, than younger participants, healthcare experience was not related to strategy use. Life experience may have been a factor that influenced this finding (Merriam, 2014).

The significant findings for mental demand and strategy implementation demonstrate that the difference between groups did not occur by chance nor due to experiential learning alone. While fifteen percent of the active participants in the control group implemented interruption management strategies, the proportion was 71.43% for the intervention group. This finding aligns with the literature evidence that shows that experience alone is not guaranteed to facilitate the use of strategies to manage interruptions (Getnet & Bifftu, 2017).

**Cognitive Load**

The NASA-TLX mental demand domain measures perceived cognitive load involved with thinking and concentration (Hart & Staveland, 1988). While no differences were found between groups for the overall cognitive load scores (p = 0.32), perceived mental demand was significantly different (p = .01). Both groups rated this domain higher than all other domains. Controlling for baseline perceptions, the adjusted mean score was higher for the control group by 9.14 points (see Table 6). Out of 100 points, the control group’s mean was 76.99, while the
intervention group mean was 67.85. This indicates that while both groups found the simulation mentally demanding, the group receiving the ‘Remembering to Resume’ training perceived significantly less demand. While increased cognitive load is common during complex problem-solving (Plass et al., 2010), minimizing mental demand is important because high strain can result in cognitive fatigue, which can negatively impact performance (Borragán et al., 2017).

Cognitive Load theory (Plass et al., 2010) emphasizes that life experience can impact learning, so the impact of age and healthcare experience on the dependent variables were investigated. Mindfulness practice has also been shown to impact executive function and attention (Burger & Lockhart, 2017). In this study, healthcare experience and regular mindfulness practice were not found to be related to cognitive load scores, completion of simulation critical elements, nor implementation of interruption management strategies. The significant group differences for implementation of interruption management strategies also suggests that dealing with an interruption during the simulation did not impact this outcome. While both groups experienced the interruption, the group with purposeful training perceived significantly different mental demand and interruption management outcomes than the control group. While experience can lead some people to create strategies to manage interruptions on their own, the process often takes years (Cole et al., 2016; Getnet & Bifftu, 2017). Until these mitigating strategies are learned, there is a risk for increased mental strain that can result in cognitive fatigue (Borragán et al., 2017). While the results of this study show that one training session combined with SBE impacted strategy implementation and mental demand, repeated exposure is needed to facilitate engraining interruption management skills and to positively impact the transition to practice (Getnet & Bifftu, 2017).
Participant Perception of Error Risk

Despite purposeful training and experience managing interruptions, less than half of the participants mentioned errors or mistakes while describing the impact of interruptions on patient care. This aligns with the evidence indicating that awareness of interruption related risks and use of mitigating strategies often only occurs after years of experience (Cole et al., 2016; Getnet & Bifftu, 2017; Laustsen & Brahe, 2018). While this study demonstrated that combining SBE with purposeful training increases use of strategies and minimizes cognitive load gains, the findings from answers to the open-ended questions indicate that more training is needed.

To create complex mental schema that can inform problem-solving, multiple layers of learning are required. While didactic and experiential learning each contribute units of learning to the schema creation, repeated exposure is needed to facilitate refinement (Merriam & Bierema, 2014; Phye, 1990; Plass et al., 2010). Interruptions should be specifically addressed throughout the curriculum and multiple opportunities for practice provided with SBE (Jeffries, 2014). SBE is uniquely suited to facilitating learning about interruptions because it provides both deliberate practice opportunities and guidance for uncovering the assumptions and beliefs that impact problem-solving (Dreifuerst, 2015; Jeffries, 2014). Interruption management simulations should be scheduled throughout the nursing education curriculum and should increase in difficulty and complexity as students advance (Jeffries, 2014). The findings of this study indicate that combining purposeful interruption management training with SBE are effective, but that more exposure is needed to facilitate a full awareness of the risks associated with interruptions. To prepare nursing students to transition to the interruption fraught practice environment, multiple exposures to both didactic and experiential learning through SBE are recommended.
Limitations

While the pre- to post-test design of this study facilitated data analysis, it also increased the potential for regression effect bias. While providing a different type of training for the control group might have decreased this bias, the current design facilitated determining whether adding purposeful training was more beneficial than SBE alone. Covid-19 pandemic restrictions also created several limitations. Room capacities severely limited the ability to include multiple researchers and observers, which prevented interrater reliability. However, the use of specific checklists reduced the potential for subjective judgment biases. The number of active participants was also reduced to maintain social distancing, which decreased the population size for the simulation critical elements and interruption management strategy variables. While the simulation used for this study typically includes the use of a bedside embedded participant (Chu et al., 2017; Díaz et al., 2020), Covid-19 restrictions thwarted the ability to do so. Instead, the use of a ‘phone call’ was implemented. While this alteration was effective, the addition of a trained embedded participant would have facilitated greater observation of interruption management during the scenario. Since all participants answered the open-ended questions after receiving purposeful training, comparison between groups was not feasible.

Recommendations for Future Research

To prevent potential regression effect bias of pre- to post-test design, future studies are needed to compare different types of pre-simulation training. To determine group differences regarding awareness of interruption-related risks, future studies eliciting this information both pre- and post-intervention are needed. While the results of this study indicate that training was effective at minimizing post-simulation mental demand, further research is needed to replicate these findings. Research is also needed to further explore the relationship of age to the
implementation of interruption management strategies. Post-pandemic research should strive to facilitate interrater reliability and involve a larger active participant population. Future studies are also needed to determine if specific interruption management strategies are more effective than others in facilitating quick resumption of the original task. While the participants in this study received only one training session, future investigation is needed to determine if repeated educational efforts increase beneficial outcomes. Future research should also investigate other measures, like time on task, to determine the impact of interruption training on performance. While this study investigated combining purposeful training with SBE, studies comparing different types of training could also be beneficial. Clinical observation studies are also needed to determine the impact of interruption management training on patient care.

**Conclusion**

Frequent interruptions are common in nursing practice, occurring 85 times per shift on average (Forsyth et al., 2018). While these frequent interruptions are perceived as an expected part of the job, they also increase cognitive load and stress (Laustsen & Brahe, 2018; Sitterding, 2014). Nurses can decrease the harmful effects of interruptions by implementing strategies that facilitate remembering to resume the original task (Cole et al., 2016; Wickens & McCarley, 2008). Proficient nurses tend to create mitigating strategies based on their experience with interruptions. This study found that student nurse ability to manage interruptions was not impacted by previous healthcare experience, nor regular mindfulness practice.

While the study was limited due to pandemic restrictions, combining interruption management training with SBE was found to be more effective than simulation alone. Trained participants implemented more interruption management strategies, while those without training demonstrated higher mental demand. While these findings indicate that combining purposeful
training with SBE is effective, results of the open-ended questions indicate that more frequent exposure is needed to increase awareness of interruption-related risks. Future studies are needed to determine the impact of training on clinical practice and to identify which interruption management strategies are the most beneficial. Including interruption management strategies in the curriculum is recommended, and students should practice them during SBE. Learning to effectively manage interruptions should help student nurses adapt to the demands of practice as they transition to the role of novice nurse following graduation.
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CHAPTER 4:
USING SIMULATION-BASED EDUCATION TO HELP NURSING
STUDENTS ADAPT TO INTERRUPTIONS: APPLICATION OF THE ROY
ADAPTATION THEORY

Abstract

Introduction: Responding to interruptions is associated with errors, decreased efficiency, and increased stress. To safely transition to practice, nursing students need to learn methods of coping with interruptions. Educators who understand the factors associated with effective coping can facilitate this process.

Methods: This paper applies the Roy Adaptation theory to the concept of interruptions and demonstrates how simulation-based education (SBE) is an appropriate method of facilitating student adaptation.

Results: Coping with stressors is influenced by external stimuli, and inherent and acquired adaptation modes. SBE can be designed to facilitate coping by including purposeful interruption management content with opportunities for practice and reflection. Debrief sessions can help students identify how their assumptions and beliefs impact their behavior and facilitate the learning of new coping methods.

Discussion: Including interruption management content in SBE will ensure that students are afforded repetitive and purposeful practice opportunities. By facilitating adaptation to the stressor of interruptions, SBE can help prepare students to successfully transition to practice.

Keywords: Simulation-Based Education, SBE, Interruptions, Roy’s Adaptation theory, Pre-licensure Nursing Students.
Introduction

The goal of undergraduate nursing education is to prepare students to safely transition to practice (Benner et al., 2010). Nursing programs are designed to facilitate the learning of skills and concepts while simultaneously socializing students to the profession (Bastable, 2020; Benner et al., 2010). During the learning process, students notice cues in their surrounding environment and react based on internalized assumptions, attitudes, and beliefs (Bastable, 2020; Merriam & Bierema, 2014). These dynamic interactions facilitate the creation of complex mental models which are drawn upon to manage patient care or solve problems (Benner, 1984).

While professionalism is taught in undergraduate nursing curriculum, students often mimic the conduct they witness (Benner et al., 2010). As students interact with practicing nurses, they begin to create foundational attitudes and beliefs about role expectations that shape their future practice (Bandura, 1997; Roy, 2009). Since the ever-changing healthcare environment precludes any guarantee of comparable clinical experiences, students are likely to observe nurses with a variety of expertise and coping skills (Hayden et al., 2014). There are also some aspects of the nursing role that are not explicitly taught in nursing curricula and instead, are learned through experience and socialization to the profession (Bastable, 2020). For example, while interruptions are common in nursing practice, methods of coping with them vary, so students may witness and adopt less than optimal behaviors (Laustsen & Brahe, 2018).

Background

Interruptions are defined as anything that necessitates pausing or stopping a current task or shifting of focus to attend to a secondary issue (Wickens & McCarley, 2008). Practicing nurses are frequently interrupted to manage patient care problems or provide information to colleagues (Huckels-Baumgart et al., 2017; Myers & Parikh, 2019; Prates & Silva, 2016). As
nurses stop one task or thought process to attend to another, the risk for error increases (Campoe & Giuliano, 2017; Johnson et al., 2017). Starting and stopping tasks can result in omitted steps or a complete failure to remember to resume the original activity (Brumby et al., 2013; Foroughi et al., 2016). Relationships have also been found between the number of interruptions and task time, demonstrating that the more frequently a task is interrupted the longer it takes to complete (Cole et al., 2016; Cooper et al., 2016). Frequent interruptions can also enhance stress because the brain is taxed with managing multiple stimuli and competing demands (Forsyth et al., 2018; Thomas et al., 2017). Without positive coping mechanisms, interruption-related stress can result in mental fatigue (Borragán et al., 2017). To prevent interruptions from negatively impacting mental load, workflow and patient outcomes, positive coping methods must be adopted (Huckels-Baumgart et al., 2017; Prates & Silva, 2016).

There is a commonly held belief among healthcare professionals that interruptions are a job expectation and that nurses should always be available and attentive (Laustsen & Brahe, 2018; Sitterding, 2014; Sørensen & Brahe, 2014). This underlying role expectation makes it difficult for nurses to advocate for the time they need to think (Laustsen & Brahe, 2018). As students socialize to the profession of nursing, this shared belief is acquired and the practice of attending to every interruption begins (Benner et al., 2010). Nurse educators need to purposefully introduce the concept of interruptions and help students learn to positively adapt to this stressor (Getnet & Bifftu, 2017).

Students are usually taught concepts in class and given the opportunity to gain psychomotor skills in the lab prior to engaging with patients in the clinical setting (Bastable, 2020). While students initially indicate feeling confident about their knowledge and skills, they often report difficulty implementing them when facing the realities of clinical practice.
Managing technology, dealing with interruptions and perceived time pressure overwhelm thought processes and limit the ability to translate knowledge and skills to the clinical environment (Krautscheid et al., 2011). While students may be challenged to manage these difficulties during clinical rotations, the nature of the healthcare setting makes it difficult to guarantee comparable experiences for all students (Hayden, 2014). To facilitate acquisition of positive coping skills, interruption management opportunities should be purposefully included in the nursing curriculum (Jeffries, 2014). Simulation-based education (SBE) can be used to combine prior didactic and lab practice with realistic experiences that enhance learning.

**Simulation-Based Education to Teach Interruption Management Skills**

SBE is an educational modality that can be used to integrate intentional experiential learning opportunities with specific program outcomes (Jeffries, 2021). SBE is a particularly appropriate modality for teaching interruption management because it addresses multiple domains of learning and provides opportunities for peer support (Jeffries, 2014; Palaganas et al., 2015). During SBE, participants work both independently and collaboratively to solve problems. As they observe their peers gather information, address patient needs, and make decisions, they develop a more complex grasp of the content than they might when learning alone (Bandura & Jeffrey, 1973). Participants also learn how to purposefully gather patient data to meet goals, which facilitates deeper understanding (Endsley et al., 2003). Post-simulation group debriefing further enhances peer learning and provides an opportunity to address the underlying assumptions that influenced decision-making (Dreifuerst, 2015). As participants interact during the debrief, they are encouraged to uncover the beneficial and detrimental assumptions that impacted their course of action during the scenario (Dreifuerst, 2015; Palaganas et al., 2015). The advantage of SBE over clinical education is the ability to control the scenario and the
environment (Jeffries, 2014). While comparable patient assignments cannot be guaranteed in the clinical setting, SBE allows students to care for the exact same patient in a controlled environment (Palaganas, et al., 2015. The complexity of learning facilitated by using SBE makes it an appropriate educational modality to help nursing students adapt to the stressor of interruptions. Application of the Roy Adaptation Theory (Roy, 2009) demonstrates why SBE is an excellent modality for helping student nurses learn to cope with the stressor of frequent interruptions.

**The Roy Adaptation Theory**

Adaptation to the stressor of interruptions can be positive and result in creation of strategies that mitigate potentially negative outcomes (Laustsen & Brahe, 2018). Dealing with frequent interruptions can also result in maladaptation, and lead to job dissatisfaction and a desire to leave the profession (Dotson et al., 2014; Holden et al., 2011). The Roy Adaptation Theory highlights the interactive individual and environmental factors that influence adaptation, behavior, and coping (Roy, 2009).

**Defining Characteristics of the Theory**

The Roy Adaptation Theory is based on Systems and Adaptation-Level theories and describes people and groups as holistic beings that are continuously adapting (Roy, 2009). This theory emphasizes that an individual’s thoughts and emotions are the foundation for their awareness and interaction with the people and structures of their environment. Roy stipulates that there are levels of adaptation that can either facilitate coping or can be compromised and lead to maladaptation. As people respond to changes, new behaviors are created, which in turn become feedback for the adaptation system. When appropriate adaptation has occurred, the feedback positively informs future actions (Roy, 2009).
**Stimuli.** Roy (2009) emphasizes that within each personal environment there are three classes of stimuli that are believed to influence behavior: focal, contextual, and residual. Focal stimuli, like a blaring alarm, are obvious and demand that the individual pay attention and expend energy to manage the incoming stimulus. Contextual stimuli are less obvious but are aspects of the environment that influence attention to focal stimuli or exacerbate reactions to them. Contextual stimuli can also be subtle aspects of the environment that impact whether focal stimuli are noticed (Roy, 2009). For example, factors like patient load and shift variations serve as contextual stimuli that impact adaptation to interruptions. The frequency of interruptions increases for nurses assigned extra patients (Duruk et al., 2016), and for those working weekend and day shifts (Cooper et al., 2016; Getnet & Bifftu, 2017). Since contextual stimuli are less obvious than the focal type, reactions to them often do not occur until they provoke an emotional response (Roy, 2009).

Residual stimuli are subtle factors that influence adaptation, and are often related to emotions (Roy, 2009). For example, perceived time pressure can plague a nurse with concerns about completing tasks, which increases mental load and can result in stress (Leroy & Glomb, 2018). While trying to remember to complete all tasks, the nurse spends mental energy ruminating on the original task until it is completed (Leroy, 2009). Both the time pressure and the rumination are forms of residual stimuli that will influence behavior. Residual stimuli can also be related to prior experiences or long-held beliefs that surreptitiously impact behaviors. In the practice setting, the belief that interruptions are an expected part of the nurse’s job often triggers attempts at multi-tasking, which enhances the risk for errors (Getnet & Bifftu, 2017; Laustsen & Brahe, 2018). The three types of stimuli, and the personal coping skills of the individual, impact resultant behaviors and overall adaptation (Roy, 2009).
Adaptation

The Roy Adaptation Theory describes three different levels of adaptation: integrated, compensatory, and compromised (Roy, 2009). Integrated adaptation involves all aspects of the individual’s attitudes, experiences, and senses working together to facilitate successful coping and management of challenges. Compensatory adaptation involves different attempts at managing a problem after the initial response fails to produce the desired result. If compensation is not effective, the resultant maladaptation can result in compromised coping and produce behaviors that derail success. Within these levels of adaptation, there are four specific modes that influence responses to and with the environment: physiologic-physical, self-identity, interdependence, and role function (Roy, 2009). The physiologic-physical mode involves bodily reactions to the adaptation process (Roy, 2009). The self-identity mode is based on both internal perceptions and judgments of others. The role function mode is concerned with the way perceptions of status influence the treatment of others (Roy, 2009). The interdependence mode encompasses social relationships and the way in which they impact group operation.

Attempts to juggle the conflicting demands associated with interruptions triggers the physiologic-physical mode of adaptation (Roy, 2009). The physical response to stress can include an increased heart rate that subsides once the stressor is dealt with (Organ et al., 1978) but chronic situations can result in systemic inflammation and long-term damage (Banich & Compton, 2018). If stress is sustained and coping does not occur, the resultant maladaptation can include serious physical issues (Lever-van Milligen et al., 2020; Roy, 2009).

The self-identity mode applies equally to individuals and groups and involves the beliefs and attitudes that influence perceived identity (Roy, 2009). The self-identity mode is evident when nurses describe interruptions and constant availability as an unwritten expectation of the
role (Laustsen & Brahe, 2018; Sitterding, 2014; Sørensen & Brahe, 2014). The role mode of adaptation is evident when the perception of other healthcare professionals influences their willingness to use the bedside nurse as a source of information even when other methods are available (Mamykina et al., 2017).

The interdependence mode involves the interaction between the many members of the healthcare team. Interdependence can produce maladaptation as scheduling difficulties and role demands force the burden of interruptions toward the bedside nurse (McCurdie et al., 2018). Interdependence can also facilitate group identity and positive socialization. For example, some nurses allow ‘small talk’ interruptions as a means of developing relationships with their co-workers (Hopkinson, 2011). Creating work relationships can result in a support network that facilitates positive coping responses (Roy, 2009), so allowing these interruptions can be beneficial. The figure below shows the application of the four modes to the concept of nursing workflow interruptions (see Figure 4).

![Diagram of the four modes applied to nursing interruptions]

**Figure 4:** Application of the Four Modes to Nursing Interruptions (As interpreted by author in Powerpoint)
**Behavior**

Roy (2009) emphasizes that individuals are active participants who purposefully interact with the focal and contextual cues in their surroundings to adjust levels of adaptation as needed. There are also inherent features within everyone that influence the coping behaviors they use when adapting to challenges (Roy, 2009). Knowledge, capability, skill level, developmental stage, life commitments and underlying attitudes and beliefs influence adaptation, with some taking longer to adapt than others (Benner, 1984; Roy, 2009). While an innate coping response is genetically predisposed, acquired processes are related to previous experiences and learning (Roy, 2009). Roy emphasizes that acquired coping mechanisms involve specific pathways including judgment, emotion, and learning. Just as an iceberg continues deep below the visible surface, there are many unseen factors that influence behavior (see Figure 5). To meaningfully impact the adaptation process, the underlying attitudes and beliefs that surreptitiously impact behavior must be addressed (Roy, 2009).

*Figure 5: Coping Factors: Above and Below the Surface (As interpreted by author in Powerpoint)*
The use of SBE can help students acquire coping skills because it builds on prior didactic content and provides experiences that allow participants to apply what they have learned (Jeffries, 2016). The American Association of Colleges of Nursing (2013) emphasizes that safety skills should be taught to nursing students, including managing stressful situations like frequent interruptions. SBE can be used to facilitate the learning of these skills by providing opportunities to practice managing interruptions and following up with debriefing that uncovers emotions and assumptions that impacted behaviors (Jeffries, 2014). SBE can also be used to increase awareness about the impact of interruptions on concentration, routines, and safety, and help students learn how to communicate with their teammates to prevent deleterious outcomes (Jeffries, 2014).

Each aspect of the Roy Adaptation Theory is applicable to the use of SBE to teach interruption management to nursing students (see Figure 6). In SBE, focal stimuli include the items that are strategically placed in the simulation suite to facilitate noticing important assessment elements. In the simulated patient room, a red-tinged tissue on the bedside table, or a urinary collection bag with a small amount of dark liquid, can serve as focal stimuli intended to provoke specific assessment behaviors. When simulation fidelity (realism) is high, the focal stimuli will mimic real-world situations and serve to facilitate learning (Lavoie, 2020). While students should act on the stimuli they notice, in dynamic environments some focal stimuli never fully capture attention (Banich & Compton, 2018; Roy, 2009).
When many stimuli occur simultaneously, the brain must quickly determine which require focus and which should be ignored (Banich & Compton, 2018). This process can be difficult for students who are still learning to prioritize and determine salience and is particularly demanding when interruptions occur and create conflicting cognitive demands (Wickens & McCarley, 2008). To encourage noticing of these clues, simulation scripts often include contextual stimuli designed to trigger responses (Jeffries, 2014). For example, if an increasing body temperature is not initially noticed, the facilitator may cue the participants by making the simulated patient complain about feeling cold or ill. If this cue is noticed, participants should be prompted to adapt their behavior and attempt to manage the problem, but if it is not noticed more contextual stimuli are added until attention is captured or the simulation ends.

In SBE, residual stimuli are specifically addressed through structured, guided debriefing (see Figure 6). During debrief, facilitators can help student nurses process the emotions they felt during the simulation scenario and uncover the underlying assumptions and beliefs that impacted
their decision-making (Dreifuerst, 2015). Once these assumptions are uncovered, the debrief facilitator can guide students toward understanding how attitudes and beliefs impacted the care they provided. This process can help students identify whether their assumptions facilitated or derailed performance, so changes can be made for future situations (Dreifuerst, 2015).

SBE provides students with opportunities to gain personal experience with interruptions. Practicing interruption management facilitates learning in the affective domain as students recognize what it feels like to try to concentrate on providing patient care while dealing with conflicting demands (Bastable, 2020). The use of SBE to facilitate learning about interruptions and uncovering assumptions should also result in observable behaviors changes (Roy, 2009). The physiologic-physical stress response should decrease as students learn to cope with the challenge. Peer learning through scenario and debrief engagement should also facilitate adjustment of the attitudes and beliefs that influence behavior. To facilitate optimal adaptation, repetitive practice managing interruptions is needed (Jeffries, 2014). The more frequently students engage in practice with interruptions, the more engrained their responses will become. As students advance through nursing programs, the complexity of the interruptions should begin to align more with the realities of nursing practice (Jeffries, 2014).

Specific interruption management objectives should be included in every simulation and scaffolded throughout the curriculum. In the early semesters, patient questions during the simulation can serve as an effective means of practicing interruption management (Jeffries, 2014). As communication skills advance, students should be challenged to manage interruptions from embedded participants at the bedside or via phone calls. In the final semesters, students should be tasked with managing multiple patients, and their simulations should include interruptions that require emergency interventions prior to resuming the initial task. Providing
opportunities for practicing reintegration of safety protocols following an interruption can also facilitate development of knowledge that will impact future decision making (Jeffries, 2014). The more frequently these skills are practiced in the simulated patient care environment, the more likely they are to become engrained (Jeffries, 2014). By addressing the underlying beliefs and attitudes that influence behavior, structured SBE can help nursing students learn to adapt to interruptions (Dreifuerst, 2015). Learning to adapt to the stressor of interruptions should facilitate a safe transition from pre-licensure academia to nursing practice.

**Conclusion**

During undergraduate education, students learn concepts, acquire skills, and are socialized to the profession of nursing. Learning to cope with the stressor of interruptions is imperative for a safe transition to practice, as frequent interruptions are associated with increased task time, job dissatisfaction, stress, and medical errors. While interacting with nurses in the clinical setting, students begin to mimic what they perceive as professional behavior. Depending on the proficiency of the exemplar, students may either learn beneficial behaviors or adopt ineffective coping responses.

Application of the Roy Adaptation Theory demonstrates that SBE is an excellent educational modality for teaching nursing students how to cope with frequent interruptions. The theory emphasizes the interactive factors that influence adaptation and how maladaptation can manifest in physical damage, poor self-identity, and impaired socialization. SBE is unlike other educational modalities because it provides consistent experiences for students that cannot be guaranteed in the clinical setting. The use of SBE can facilitate coping by combining purposeful interruption management training with opportunities for practice and reflection. Inclusion of specific focal and contextual cues in the simulation scenario can help nursing students learn to
recognize when interruptions threaten their concentration. Through engagement with a structured debrief, students can learn how their previously held beliefs impacted their decision-making and learn how to change negative assumptions.

By building the objective of interruption management into SBE, students will have the opportunity to continuously refine their assumptions and improve their skills. As skills advance, the challenge should be increased until students are prepared to safely transition to practice. Including interruption management as an objective for scaffolded SBE events would provide the multiple exposures needed to build and refine coping processes and interruption management skills. As students move from academia to practice, their experiences with managing interruptions in SBE can facilitate optimal adaptation to a demanding and frequently interrupted role.
References


APPENDIX A:
SIMULATION-BASED RESEARCH RATING RUBRIC WITH PERMISSION LETTER
Figure 7: Author Permission for Simulation Research Rating Rubric
Dear Peggy,

Thank you for reaching out. If you have permission from the authors, then I have no issue with you using this rubric as part of your coursework and/or a publication. If you include this, please indicate that it is used with permission. If you are going to alter it in any way, please contact the author. If you are just using part of it, no additional permission is required.

Best wishes with your work.

Cheers,

Nicole

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Editor-in-Chief Clinical Simulation in Nursing

Figure 8: Publisher Permission for Simulation Research Rating Rubric
Simulation Research Evaluation Rubric

Rate each element of the published study to reflect the content of the manuscript by using the rater instructions that follow on pages 3-7. For “description of study design” and “study instruments” select the appropriate element for quantitative or qualitative studies. For mixed methods studies, rate both quantitative and qualitative elements. Record the score for each element in the Score Column at the far right of the grid, and total the score for all elements in the last row.

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Instructions for “Description of Study Design” element: If the study uses mixed methods, please rate both aspects, otherwise choose either qualitative or quantitative (i.e., if quantitative only, then N/A should be entered for any qualitative item).

Figure 9: Simulation Research Rating Rubric
APPENDIX B:
JOHN HOPKINS NURSING EVIDENCE-BASED PRACTICE RESEARCH
EVIDENCE APPRAISAL TOOL WITH AUTHORIZATION LETTER
Figure 10: Permission email for Johns Hopkins Nursing Evidence Appraisal Tool
Johns Hopkins Nursing Evidence-Based Practice Research Evidence Appraisal Tool

Evidence Level and Quality: ____________________________

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Does this evidence address my EBP question? [ ] Yes [ ] No
Do not proceed with appraisal of this evidence

Level of Evidence (Study Design)

A. Is this a report of a single research study? [ ] Yes [ ] No
If No, go to B.

1. Was there manipulation of an independent variable?
2. Was there a control group?
3. Were study participants randomly assigned to the intervention and control groups?

If Yes to all three, this is a Randomized Controlled Trial (RCT) or Experimental Study

If Yes to #1 and #2 and No to #3, OR Yes to #1 and No to #2 and #3, this is Quasi Experimental (some degree of investigator control, some manipulation of an independent variable, lacks random assignment to groups, may have a control group)

If No to #1, #2, and #3, this is Non-Experimental (no manipulation of independent variable, can be descriptive, comparative, or correlational, often uses secondary data) or Qualitative (exploratory in nature such as interviews or focus groups, a starting point for studies for which little research currently exists, has small sample sizes, may use results to design empirical studies)

NEXT, COMPLETE THE BOTTOM SECTION ON THE FOLLOWING PAGE, “STUDY FINDINGS THAT HELP YOU ANSWER THE EBP QUESTION”

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### Johns Hopkins Nursing Evidence-Based Practice
#### Research Evidence Appraisal Tool

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2. For Systematic Reviews and Systematic Reviews with meta-analysis or meta-synthesis:
   a. Are all studies included RCTs? → LEVEL I
   b. Are the studies a combination of RCTs and quasi-experimental or quasi-experimental only? → LEVEL II
   c. Are the studies a combination of RCTs, quasi-experimental and non-experimental or non-experimental only? → LEVEL III
   d. Are any or all of the included studies qualitative? → LEVEL III

COMPLETE THE NEXT SECTION, “STUDY FINDINGS THAT HELP YOU ANSWER THE EBP QUESTION”

STUDY FINDINGS THAT HELP YOU ANSWER THE EBP QUESTION:

NOW COMPLETE THE FOLLOWING PAGE, “QUALITY APPRAISAL OF RESEARCH STUDIES”, AND ASSIGN A QUALITY SCORE TO YOUR ARTICLE
Johns Hopkins Nursing Evidence-Based Practice
Research Evidence Appraisal Tool

Quality Appraisal of Research Studies

- Does the researcher identify what is known and not known about the problem and how the study will address any gaps in knowledge? [Yes No]
- Was the purpose of the study clearly presented? [Yes No]
- Was the literature review current (most sources within last 5 years or classic)? [Yes No]
- Was sample size sufficient based on study design and rationale? [Yes No]
- If there is a control group:
  - Were the characteristics and/or demographics similar in both the control and intervention groups? [Yes No NA]
  - If multiple settings were used, were the settings similar? [Yes No NA]
  - Were all groups equally treated except for the intervention group(s)? [Yes No NA]
- Are data collection methods described clearly? [Yes No]
- Were the instruments reliable (Cronbach’s α [alpha] ≥ 0.70)? [Yes No NA]
- Was instrument validity discussed? [Yes No NA]
- If surveys/questionnaires were used, was the response rate ≥ 25%? [Yes No NA]
- Were the results presented clearly? [Yes No]
- If tables were presented, was the narrative consistent with the table content? [Yes No]
- Were study limitations identified and addressed? [Yes No]
- Were conclusions based on results? [Yes No]

Quality Appraisal of Systematic Review with or without Meta-Analysis or Meta-Synthesis

- Was the purpose of the systematic review clearly stated? [Yes No]
- Were reports comprehensive, with reproducible search strategy? [Yes No]
  - Key search terms stated [Yes No]
  - Multiple databases searched and identified [Yes No]
  - Inclusion and exclusion criteria stated [Yes No]
- Was there a flow diagram showing the number of studies eliminated at each level of review? [Yes No]
- Were details of included studies presented (design, sample, methods, results, outcomes, strengths and limitations)? [Yes No]
- Were methods for appraising the strength of evidence (level and quality) described? [Yes No]
- Were conclusions based on results? [Yes No]
  - Results were interpreted [Yes No]
  - Conclusions flowed logically from the interpretation and systematic review question [Yes No]
- Did the systematic review include both a section addressing limitations and how they were addressed? [Yes No]

QUALITY RATING BASED ON QUALITY APPRAISAL

A **High quality**: consistent, generalizable results; sufficient sample size for the study design; adequate control; definitive conclusions; consistent recommendations based on comprehensive literature review that includes thorough reference to scientific evidence

B **Good quality**: reasonably consistent results; sufficient sample size for the study design; some control, and fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence

C **Low quality or major flaws**: little evidence with inconsistent results; insufficient sample size for the study design; conclusions cannot be drawn
APPENDIX C:
EMAIL AUTHORIZATION TO USE THE WHITTEMORE, CHASE, AND MANDLE VALIDITY CRITERIA
Once ideas are published, all you really need to do is cite them. “We never developed a copyrighted instrument or anything like that.” I would be happy to see what you come up with. “Sadly, Dr. Mandle is deceased. “Dr. Whittemore is active at Yale. I see her at meetings occasionally.”

Susan

Figure 14: Email Permission for Use of Whittemore, Mandle, & Chase Qualitative Research Guidelines
APPENDIX D:
IRB LETTERS
EXEMPTION DETERMINATION

September 15, 2020
Dear Peggy Hill,

On 9/15/2020, the IRB determined the following submission to be human subjects research that is exempt from regulations:

<table>
<thead>
<tr>
<th>Type of Research</th>
<th>Title</th>
<th>Status Category 1-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peggy Hill</td>
<td>Remembering to Resume: A Randomized Controlled Trial</td>
<td>Category 1, 2</td>
</tr>
<tr>
<td></td>
<td>Comparing combined intervention management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Training and simulation-based education</td>
<td></td>
</tr>
</tbody>
</table>

Investigator: Peggy Hill
Funding: None
Grant ID: None

Documents Reviewed:
- 255 Remembering to resume UPDATE.docx
- Demographic Data form.docx
- Category: Survey
- Questionnaire
- Consent Form
- Institutional Flyer.docx
- Category: Recruitment
- Materials
- NASA-TLX survey form.pdf
- Category: Test
- Instruments
- Open ended questionnaire.docx
- Category: Survey
- Questionnaire
- Peter B. S. checklist.docx
- Category: Test
- Instruments
- Remembering to Resume presentation.pptx
- Category: Others

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, and there are questions about whether these changes affect the exempt status of the human research, please submit a modification request to the IRB. Guidance on submitting Modifications and Administrative Check-in are detailed in the

Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system. When you have completed your research, please submit a Study-Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Adrienne Showman
Designated Reviewer

Figure 15: IRB Exempt Status Letter
CLOSURE

March 23, 2021

Dear Peggy Hill:

On 3/23/2021, the IRB reviewed the following protocol:

<table>
<thead>
<tr>
<th>Type of Review:</th>
<th>Continuing Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title:</td>
<td>Remembering to Resume: A Randomized Control Trial Comparing combined interruption management Training and simulation-based education to Simulation-Based Education Alone</td>
</tr>
<tr>
<td>Investigator:</td>
<td>Peggy Hill</td>
</tr>
<tr>
<td>IRB ID:</td>
<td>CR00000998</td>
</tr>
<tr>
<td>Funding:</td>
<td>None</td>
</tr>
<tr>
<td>Grant ID:</td>
<td>None</td>
</tr>
<tr>
<td>IND, IDE, or HDE:</td>
<td>None</td>
</tr>
</tbody>
</table>

The IRB acknowledges your request for closure of the protocol effective as of 3/23/2021. As part of this action:

- The protocol is permanently closed to enrollment.
- All subjects have completed all protocol-related interventions.
- Collection of private identifiable information is completed.
- Analysis of private identifiable information is completed.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

[Signature]

Kamille C. Birkbeck
Designated Reviewer

Figure 16: IRB Study Closure Letter
NASA TLX

- NASA Task Load Index
  - (Hart & Staveland 1988)
  - Step 1: weights
    - Pair comparison of the scales gives them weights from 0 to 5
    - Allows adjusting to specific task demands
  - Step 2: assessment
    - Evaluate task load on 6 Likert scales
- www.nrl.navy.mil/aic/ide/NASATLX.php

- Generic scales
- Adjustable weights

**Figure 17**: NASA-TLX Score Card
Re: [EXTERNAL] authorization for use

To: Peggy Hill

Hello Peggy,

You are free to use the NASA TLX paper and pencil version. You can download the material from the NASA TLX website. https://humansystems.arc.nasa.gov/groups/TLX/tlxpapercpencil.php

Note also that we have released an official version of the TLX for iOS (Apple). https://humansystems.arc.nasa.gov/groups/TLX/tlxapp.php

Brian

--
NASA-Ames Research Center
Brian F. Gore, PhD
HFBP Ames Lead/HF-TEAM Project Scientist
HSIA Discipline Scientist
MS 262.4
Bldg 262, Office 226
PO Box 1
Moffett Field, CA 94035-0001
O: 650.604.2542
C: 650.224.1208

Figure 18: Permission Email for Use of NASA-TLX
APPENDIX F:
SIMULATION CRITICAL ELEMENT CHECKLIST
**Figure 19: Simulation Critical Element Checklist**

<table>
<thead>
<tr>
<th>Dimension 1: Assessment</th>
<th>Individual</th>
<th>Yes</th>
<th>No</th>
<th>Group</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assesses IV site AND tubing/label by looking OR commenting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Checks O2 saturation – asks for it OR visualizes Pulse O2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Checks pain assessment appropriate for developmental level (such as FACES)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Obtains temperature – looks OR asks for it</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Obtains BP AND HR (vital signs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Administers Medication (or states they were given in ER)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Verbalizes out of range, specifically WBC/bands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Performs focused lung assessment - listens to front AND back OR side of chest ON SKIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Checks Health Care Provider’s orders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Dimension 2: Deterioration | | |
|-----------------------------| | |
| 10. Washes hands for at least 30 seconds | | |
| 12. Notices/discusses downward trend of O2 sat | | |
| 13. Assesses LOC by name, DOB, OR checking pupils | | |
| 14. Checks lab work | | |
| 15. Calls Health Care Provider to report abnormalities related to assessment | | |
| 16. Lactic Acid (ask for lactic acid) | | |

Total

Reported in:

References:
**CHECKLIST OF INTERRUPTION-MANAGEMENT BEHAVIORS**

Please place a check mark for EACH INCIDENT throughout the simulation.

(Head Nurse = student taking lead role; Team-Mate = remaining student)

---

**Date:** ____________

**Simulation Session:** Am-Pm ____________

**Simulation Rotation:** 1-2-3...

**Active Participant IDs:** ____________________________

<table>
<thead>
<tr>
<th>Interruption-Management Behavior</th>
<th>Role</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Delegates Interruption-Management (asks team-mate to handle, assigns activity)</td>
<td>Head Nurse</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Team-Mate</td>
<td></td>
</tr>
<tr>
<td>Offers to manage interruption (mark whether offer accepted or not)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual reminder created: marks with sticky note or other alert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual reminder created: holds an item or other reminder in hand or in field of vision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual reminder created: places finger to hold spot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual reminder created: creates any type of visual reminder not already addressed (please specify what was done)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speaks reminder aloud (to self or to others)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Takes obvious pause to rehearse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No obvious interruption management behavior used throughout simulation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Figure 20:** Researcher-Developed Interruption Management Observation Checklist
APPENDIX H:
DEMOGRAPHIC DATA QUESTIONNAIRE
DEMOGRAPHIC DATA SHEET

Today’s Date: ____________________________ Study Number: ____________________________

Group (provided by study personnel): ______________________

1. Gender (Please circle): Male Female Transgender

2. Program (Please circle): Prolicensure Accelerated

3. Campus (Please circle): Orlando Daytona Cocoa

4. Age Range (Please circle): 18-25 26-35 36-46 47-60 60+

5. Ethnicity/Race (Please circle ONE. If multi-racial, choose ‘multi-racial’ option):
Caucasian Black/African American/Caribbean Hispanic/Latino
Asian Native Hawaiian/Pacific Islander Multi-racial
Native American/Alaska Native Unknown

6. Degree: Please list any previous degrees you have earned: ______________________

7. Healthcare Experience: Please list any current or previous healthcare work experience you have (including number of years): ____________________________

8. Mindfulness: Do you regularly (2 or more days a week) practice meditation, yoga or another mindfulness exercise? (Please circle): YES NO

   a. Amount of Mindfulness Practice: Please list the typical number of days per week spent in mindfulness practice: ____________________________

Figure 21: Demographic Data Collection Sheet Included in Student Study Packet