White Paper

Student Learning in Simulation Learning System with Virtual Reality:

A Quantitative Ethnographic Examination of a Fundamentals of Nursing Scenario

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The National Council Licensure Examination (NCLEX®) is used by the national board for certifying the knowledge nursing students need to become practice ready. This goal is particularly relevant for the Next Generation NCLEX (NGN)—students' success on NGN and in practice will depend on how nursing programs develop job-ready graduates. An essential aspect of meeting this goal is using comprehensive tools across the nursing curriculum that foster clinical judgment and critical thinking.

At Elsevier, we strive to empower nursing programs with curricular solutions that are beneficial for cultivating the requisite knowledge, skills, and attitudes students need to excel on the NCLEX and in practice. Through Elsevier digital solutions, we are committed to supporting faculty in meeting their teaching, learning, and assessment needs. Our educational solutions focus on three primary areas to support students' knowing, doing, and becoming competent nursing professionals: building knowledge, applying clinical judgment, and assessing & reviewing.

This white paper uses Quantitative Ethnographic (QE) approaches for examining how students' clinical competencies are nurtured through their participation in Simulation Learning System (SLS) with Virtual Reality (VR) for RN. SLS with VR, developed in partnership with SimX, is a curricular solution designed to help faculty cultivate students' ability to "think like a nurse" in authentic learning situations where knowledge acquisition and clinical judgment application are tightly integrated. The research team examined discourse data from two groups of sophomore students and their teacher who were located at a public college in the northeastern region of the United States. Specifically, data from two simulation sessions (October and November 2020) were examined, where a Fundamentals of Nursing scenario was used during the SLS with VR Fall 2020 Study.

The research team used Epistemic Network Analysis (ENA) to illustrate how NCSBN Clinical Judgment Measurement Model (NCJMM) tasks and Quality and Safety in Education for Nurses (QSEN) competencies were practiced during the pre-briefing, simulation, and debriefing phases for each session. These visualizations are followed by an assessment of whether statistical differences existed between the phases for each session. Finally, qualitative examinations of individual student experiences are described to establish the connection between their practice of clinical competencies related to the scenario objectives in SLS with VR.

Findings from this QE examination allowed the research team to identify the unique contributions of each phase in helping students practice being a nurse and caring for patients. Through visual depiction, statistical analysis, and thick descriptions, the results demonstrate that teacher-student discourse during pre-briefing was characterized by recognizing and analyzing cues. During debriefing, the discourse was characterized by managing safe and coordinated care. Importantly, teacher-peer-student-virtual character discourse during the simulation worked to bridge the tasks of understanding the situation and providing safe and coordinated care. SLS with VR provides a relevant technological, pedagogical, and content ecosystem for nursing faculty keen to augment their clinical curricula and cultivate a range of cognitive, social and psychomotor skills for their students.

SIMULATION LEARNING SYSTEM WITH VIRTUAL REALITY (SLS WITH VR)

SLS with VR is created with a goal for faculty to facilitate immersive clinical experiences alongside current practices in nursing simulation labs (e.g., hands-on simulations). Faculty have a choice of 100 scenarios across multiple content areas in nursing, including Health Assessment, Fundamentals, Medical-Surgical, Maternity, Pediatric, Psychiatric, Community, and Leadership. Example scenarios include Postoperative Respiratory Distress, Fall and Pressure Ulcer Risk Assessment, Colostomy and Hyperkalemia Secondary to Medication Error, Scheduled Cesarean Delivery, Post-traumatic Stress Disorder, and Home Health.

From the faculty perspective, SLS with VR scenarios are selected, viewed, and moderated from an interactive interface (i.e., moderator tool). Meanwhile, students use compatible VR hardware (e.g., Oculus Quest headset and hand controllers) to participate in the scenarios. Moderating faculty have a full view of what students are experiencing in the VR space. Faculty also have access to orders and actions that help them facilitate a scenario, including opportunities to introduce multiple virtual characters (e.g., patient, nurse, doctor, dietitian, employer), and distractions (e.g. phone calls) that students must interact with and address respectively (see Figure 1). For more information on SLS with VR and how to integrate it in the nursing curricula, please see Nurse Educator's Guide: Using Virtual Reality to Boost Simulation Experiences by Barrie and colleagues (n.d.).

Figure 1. Simulation Learning System with Virtual Reality

SLS with VR Fall 2020 Study

This white paper reports findings from a larger study undertaken by Elsevier in Fall 2020 (October-November 2020). The objective of the study was to assess the efficacy and usability of SLS with VR and obtain actionable feedback prior to its release in early 2021. Two hundred and twenty-three students and 13 faculty from Associate Degree in Nursing (ADN) and Bachelor of Science in Nursing (BSN) programs participated in the study from six nursing institutions across the US.

STUDY PROCEDURE AND PARTICIPANTS

Over seven weeks, participating faculty received support asynchronously through onboarding materials, VR student and instructor guides, safety tips, and instructions to set up the play space for students. Faculty also had access to preparatory and follow-up activities for their students (e.g., readings, pre- and post-sim quizzes, and pre- and post-sim exercises) tailored to the scenarios offered within the SLS with VR ecosystem. Additionally, faculty had access to materials for each scenario, including case descriptions, pre-briefing, and debriefing guides. Lastly, a sandbox scenario was made available to all participants. Faculty were encouraged to orient their students to the VR environment and controls before the latter participated in scenarios directly or as observers. Faculty were supported synchronously through a remote but hands-on 90-minute SLS with VR training session before the start of the study. The research team provided additional synchronous remote support by observing and recording faculty-led SLS with VR sessions (pre-briefing, simulation, and debriefing phases) with their students at their respective institutions.

This white paper reports findings from SLS with VR sessions led by Tanya (pseudonym), a faculty in a traditional nursing program (i.e., Bachelor of Science in Nursing, BSN) at a public college in the northeastern region of the US. At the time of the study, she was the lead instructor for the Fundamentals of Nursing course with six to ten years of experience facilitating or assisting with simulations, typically engaging BSN students in their first semester of sophomore year. Additional details about Tanya's expertise with facilitating simulations of varying modalities, her pedagogical goals for enhancing students' clinical experiences, and her motivations for adopting virtual reality simulations are described in another report (Shah, Siebert-Evenstone, Moots & Eagan, 2021). To identify one student from each session, the research team examined the responses of students who participated in Tanya's session from October and November 2020. Responses were examined on a survey administered at the start of the study and after completing a Fundamentals of Nursing Scenario on Basic Assessment and Care Management in SLS with VR. The research team decided to examine Jessica and Cesar's (pseudonyms) experiences because they were similar and different in unique ways based on their responses on the pre-post surveys.

At the time of the study, Jessica (a participant in the October session) and Cesar (a participant in the November session) were sophomores in a RN to BSN program. Jessica enjoyed learning with simulations because they allowed her to gain hands-on experience and "make mistakes before working with real patients." However, Jessica believed she struggled to ask questions that would enable her to learn more about patient culture. Cesar, on the other hand, enjoyed practicing patient interactions while participating in simulations. Like Jessica, Cesar appreciated the safe boundaries of learning provided, especially through faculty guidance, while engaging in simulation experiences.

Both Jessica and Cesar did not play video games and had no experience with virtual reality (VR). Nonetheless, they were excited to try the modality and perceived it as a "great tool to use on top of labs and clinicals." Jessica hoped that simulations in VR would be more realistic than working manikins, and as a result, she would develop a better sense of patient care. Similarly, Cesar was hopeful to develop a heightened sense of interacting with patients and clinical situations through his participation in VR simulations. Both students strongly agreed that their ability to make sound clinical judgment decisions would deepen due to engaging in VR simulation scenarios facilitate by their instructor. Lastly, the two students perceived they would be able to promote safety for the patient, themselves, and others in a VR simulation environment.

Some differences were noted in Jessica and Cesar's initial perceptions of learning with VR. While Jessica strongly agreed she will (a) function effectively as a member of the health care team in a VR simulation environment, (b) identify factors that influence the quality of care in a VR simulation environment, and (c) utilize information technology to support patient care in a VR environment, Cesar seemed ambivalent about his abilities in the same. However, after

completing the Fundamentals scenario (Kyle Miller - Basic Assessment and Care Management) using SLS with VR, Jessica's perceptions remained positive, and Cesar's self-perception shifted. Both Jessica and Cesar enjoyed the patient interaction experiences afforded in VR. Jessica described, "I enjoyed the experience of having another person in the room asking questions and the phone ringing. This was a new experience, and it was very insightful." Cesar reported, "[I enjoyed] [i]nteracting with the patients and being able to speak to others through the phone." Both students strongly believed that including VR simulations would be extremely valuable in enhancing clinical educational experiences.

FUNDAMENTALS OF NURSING SCENARIO

Jessica and Cesar were assigned to participate in a Fundamentals scenario from SLS with VR. The purpose of this scenario was to provide students with the opportunity to conduct a basic nursing assessment while managing and prioritizing multiple distractions. The overview of the scenario is as follows:

> Kyle Miller, a 41-year-old Caucasian male, was admitted Monday morning for a low-grade fever and cellulitis of the forearm secondary to a recent puncture wound. IV antibiotics were administered and the affected area was cleaned and covered with dry gauze. Kyle's temperature has since returned to baseline, and he is slated for a Tuesday morning discharge to home. The scenario takes place on Tuesday at 0800, at which time a basic assessment is due. The provider has requested an SBAR update to help plan for discharge, but the hospital unit has multiple distractions and Kyle's visitor asks many questions. During this scenario, students will have the opportunity to conduct a basic nursing assessment while managing and prioritizing multiple distractions.

The identifiable actions that the students were expected to perform during this scenario are based on the nursing process. We believe these are comparable to the Tanner's Clinical Judgment Model and the NCSBN Clinical Judgment Measurement Model (NCJMM) as described by Ignatavicius and Silvestri (n.d.) in Getting Ready for the Next-Generation NCLEX® (NGN): How to Shift from the Nursing Process to Clinical Judgment in Nursing. Scenario goals are also organized according to the QSEN competencies. Thus, students' performance objectives included the following (see Table 1):

Table 1. SLS with VR Fundamentals Scenario Objectives and Actions

No.	Scenario Objectives	Identifiable Actions
1	Provide individualized patient-centered care	Conducting a focused assessment Utilizing therapeutic communication Maintaining patient's privacy
2	Function competently as a member of the health care team	Delegating tasks and patient care appropriately Providing an SBAR report to the provider
3	Implement best clinical practices	Recognizing that vital signs and physical assessment findings are within normal parameters Prioritizing and managing distractions
4	Promote safety for patient, self, and others	Adhering to standard precautions Assessing and maintaining a safe environment
5	Identify factors that influence quality of care	Evaluating patient's response to interventions Evaluating effectiveness of communication
6	Utilize information technology to support patient care	Accessing patient data including prior care and lab results Documenting care in the electronic health record

DATA ANALYSIS

We adopted a Quantitative Ethnographic (QE; Shaffer, 2017) approach to examine student learning in the Simulation Learning System (SLS) with Virtual Reality (VR). QE unites research methodologies by quantifying the qualitative while maintaining richness and complexity. This method is often used to examine large data (e.g., conversations, transcripts) from digital environments (e.g., simulations, intelligent tutoring systems) and discover meaningful patterns in human behavior and interaction.

Discourse during SLS with VR was audio-recorded and transcribed. Each line designated a new *turn of talk*, where a turn was defined as starting with a statement by one individual and ending when another individual spoke (Sacks, Schegloff, & Jefferson, 1978). Transcribed data were deductively coded for NCJMM competencies and QSEN competencies. See Table 2 for codes that correspond with the competencies.

Table 2: Competency Codes for Data Transcription

	COMPETENCIES	CODES
NCJMM Competencies	Recognizing Cues	RecCues
	Analyzing Cues	AnaCues
	Prioritizing Hypothesis	PriHyp
	Generating Solutions	GenSol
	Taking Actions	TakeAct
	Evaluating Outcomes	EvalOut
QSEN Competencies	Patient-Centered Care	PCC
	Teamwork and Collaboration	TCC
	Safety	Safety

To address the reliability and validity of qualitative coding, we used social moderation, where two raters coded all 621 lines of data and then agreed on each code. Each utterance was coded for the occurrence (1) or nonoccurrence (0) of the skills determined as essential through NCJMM or QSEN thus, quantifying qualitative data.

This study uses a moving stanza window (Siebert-Evenstone et al., 2017) of 7 utterances (each line plus the six previous lines) within a given conversation. This window size was chosen based on qualitative analysis of the discourse. A conversation, in this case, included all turns of talk associated with one phase (e.g., pre-briefing) within an SLS wtih VR session. Codes that occurred outside of this window were not considered connected. For the dimensional reduction, we chose a technique called a *means rotation* (Swiecki et al., 2020) that creates a high-dimensional space that maximizes the difference between the means of two units.

In this study, we rotated the space by the Pre-Briefing and Debriefing phases to highlight differences across the phases on the x-axis. This resulted in two coordinated representations for each unit (an instructor or participant in each phase of the SLS with VR session) including the weighted network graph, which visualized these connections as network graphs

where the nodes corresponded to the codes and edges reflected the relative frequency of the connection between two codes, and a plotted point. In this way, we quantified and visualized the structure of connections among elements of NCJMM and QSEN competencies and compared differences in talk across phases.

Mean networks for each phase were calculated by averaging the connection strengths across the phase and plotting the resulting network in the space. For example, the mean network for the simulation phase represented the average network for that time. Mean ENA scores were created by calculating the average ENA scores on each dimension for each phase and plotting the resulting value in the space. Statistical tests were performed on the mean ENA scores to test whether there were statistical differences between groups.

Throughout this process the research team worked to close the interpretive loop. In doing so, they checked the correspondence between and within analytic methods and maintained a grounded understanding of the context and participants. As such, closing the interpretive loop is an iterative process—in this case, the consistency of interpretations within each session were checked by evaluating how the discourse of the class related to the discourse of the phase and our understanding of the scenario objectives and activities of SLS with VR. The research team also checked the consistency of interpretation by comparing the thick descriptions and examples with their respective quantitative models to ensure that models visually represented our qualitative understandings.

RESULTS

Students practiced NCJMM and QSEN concepts in the context of the Fundamentals of Nursing scenario. They made connections across these clinical competencies because of their experiences with SLS with VR, facilitation from the teacher, and interactions with peers. Findings for each class (Session 1: October 2020, and Session 2: November 2020) are illustrated using Epistemic Network Analysis; they highlight the differences between pre-briefing, simulation, and debriefing phases. To further understand student learning in each class, we provide a qualitative explanation of their experiences. Jessica's experiences are explained in detail, and Cesar's experiences are explained in brief.

Session 1: October 2020

The research team performed a means rotation between pre-briefing and debriefing, which created an ENA metric space where the first dimension explained the most difference between these two phases (see Figure 2). This rotation also provided a temporal trajectory across the x-axis from pre-briefing to debriefing phases. In the ENA metric space, the plotted points correspond to the underlying structure of connections between nodes. Therefore, we can use the node positions to understand different unit locations across the space. In this model (see Figure 2), the first dimension (i.e., x-axis) uses a means rotation to maximize the difference between the discourse of pre-briefing and debriefing.

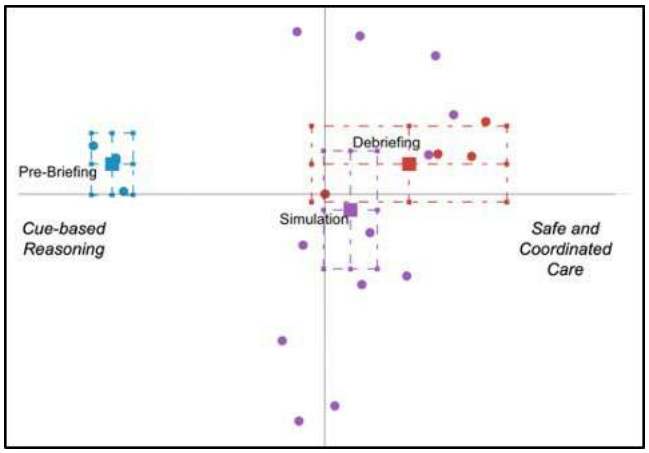


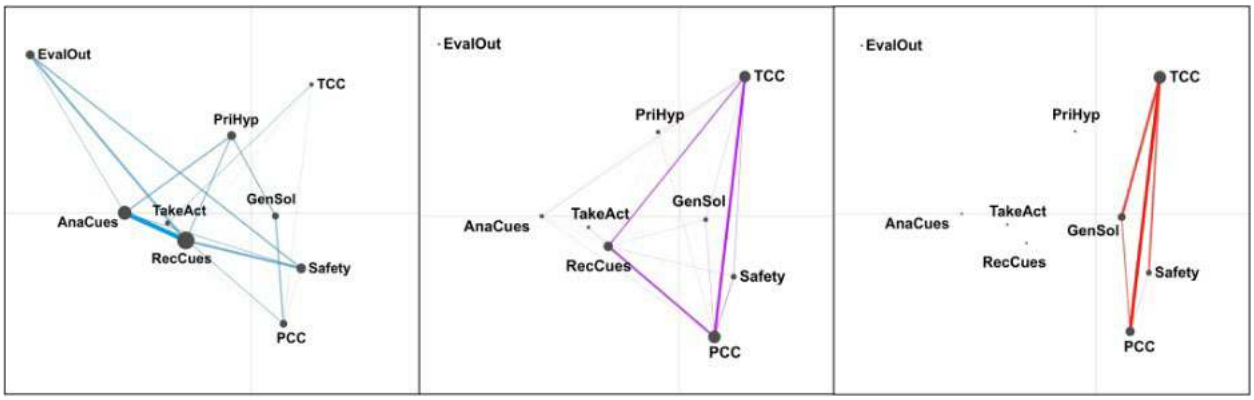
Figure 2. Plotted points (dots), means (squares), and confidence intervals (dashed lines) for Pre-Briefing (blue), Simulation (purple), and Debriefing (red) phases.

The node positions show that most of the NCJMM concepts are to the left of the space, and the QSEN concepts are to the right of the space. Specifically, recognizing cues (RecCues), analyzing cues (AnaCues), and evaluating outcomes (EvalOut) have the lowest x-values or farthest to the left of the space, indicating that discourse in the pre-briefing phase involved making connections to noticing and interpreting cues. Therefore, we characterized the left side of the dimension as cue-based reasoning about patient outcomes.

On the other hand, the highest x-values or farthest to the right of the space included all the QSEN concepts. Specifically, there were strong connections to teamwork and collaboration (TCC) and between TCC and Safety, patient-centered Care (PCC), and generating solutions (GenSol), indicating that discussions during debriefing involved making connections to these care competencies. Therefore, we characterized the first dimension of the space with cue-based reasoning on the left versus safe and coordinated care on the right (See Figure 2).

Along the x-axis (cue-based reasoning/safe and coordinated care), we conducted a two-sample t-test assuming unequal variance which showed that discourse during the pre-briefing phase (M = -2.16, SD = 0.13, N=4) was statistically significantly different at the alpha = 0.05 level from discourse during the simulation phase (M=0.26, SD = 0.53, N = 17; $t(18.61) = 16.71$, $p < 0.001$, Cohen's d = 4.94) and discourse from the debriefing phase (M=0.85, SD = 0.80, N = 5; $t(4.27) = 8.30$, $p < 0.001$, Cohen's d = 1.00). There was no significant difference between simulation and debriefing discourse on the x-axis and there were no statistical differences between phases on the y-axis.

These results suggest that **conversations during pre-briefing involved making connections to cue-based reasoning**, including strong connections to and between RecCues and AnaCues (see Figure 3a). This is an important finding, suggesting that the class was getting oriented to providing individualized patient care and implementing best clinical practices (objectives 1 and 3 in Table 1). On the other hand, **conversations during debriefing involved making connections between safe and coordinated care**, including strong connections to TCC from Safety, PCC, and GenSol (see Figure 3c). Once again, this finding is important because it demonstrates the class' focus on functioning as a member of a healthcare team, promoting safety for all, and identifying factors that influence the quality of care patients receive (objectives 2, 4, and 5 in Table 1). What is noteworthy is the simulation phase which involved the participation of students in SLS with VR and Tanya's moderation of the Fundamentals scenario. During this phase, most connections were made to RecCues, TCC, and PCC, suggesting that **the simulation served as an experiential bridge for connecting cue-based reasoning with safe and coordinated care** (see Figure 3b). To further showcase what these illustrations and interpretations mean, we describe one student's discourse with the teacher, peers, and characters in SLS with VR.



(a) (b) (c)

Figure 3. Network representations of pre-briefing (a, blue), simulation (b, purple), and debriefing (c, red). Thicker lines represent more frequent connections.

STUDENT 1: JESSICA

Pre-briefing

During pre-briefing, Tanya prepared the students for the Fundamentals scenario by opening a discussion about a relevant ailment. First, the instructor asked the students what they knew about cellulitis. When it was Jessica's turn, the instructor redirected the question to specifically ask about mental images of cellulitis and asked if "in your mind, did you see any pictures of an extremity of cellulitis?" Here, Jessica responded, "yeah, it was like red." The instructor then built on the information provided by Jessica and another student to describe how cellulitis could look "hot," "shiny", and "bumpy." After describing how it would look, she asked the students where cellulitis would likely occur. Both students answered "legs," and then the instructor asked a follow-up question about why it might occur in this region. Jessica answered that legs have "poor circulation, comparatively", which provided a local assessment of anatomy and considered the body as a system.

In this short vignette that demonstrates the conversations between Tanya, Jessica and another student, there is a focus on recognizing cues and analyzing cues of cellulitis. These cue-based reasonings are important primers for conducting focused assessments and identifying what findings are within normal parameters. Later in the pre-briefing, Jessica considered how treatments for cellulitis may have "adverse outcomes" such as "anaphylaxis." In this way, Jessica also experienced using cue-based reasoning to think about safety while evaluating outcomes. Such discourse can also be represented by a network that show the connections Jessica made during this phase (see Figure 4a).

Simulation

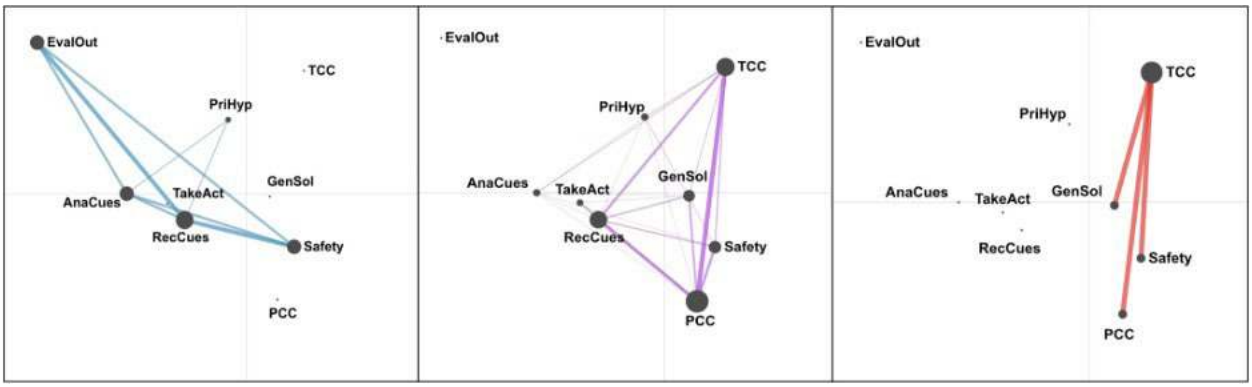
After discussing various aspects of assessing and providing cellulitis care, Jessica participated in SLS with VR simulation. She participated in a scenario that mimicked a virtual patient presenting with similar issues discussed during pre-briefing (i.e., Kyle Miller experiencing cellulitis in Fundamental of Nursing Scenario). It provided her a low-risk environment to practice identifying a patient's background, assessing the situation, and giving recommendations to the provider. For example, towards the end of the simulation, Jessica provided the following SBAR report to the virtual doctor, "Ok, Kyle Miller was admitted for a wound in his right arm with cellulitis. We recommend antibiotic for his wound and medication for his pain. Vitals are stable. Wound is healing but the area is still red. There are no abnormalities in the assessment. I would say he is good to go home for this part."

In this longer passage, Jessica described why the patient was admitted and his current symptoms. She provided assessments about the patient's vitals, reported on the wound status and recommended a medication and discharge plan. As such, Jessica was able to synthesize her understanding from patient assessment and maintain open communication with the team while foregrounding patient-centered care and safety. In other words, an important benefit of the SLS with VR simulation experience was that **Jessica was able to engage in cue-based reasoning while learning to provide safe and coordinated care** (see Figure 4b).

Debriefing

Discourse during the debriefing section was much more rapid with shorter sentences, which were most commonly affirmations of what a previous speaker said (e.g., "Right", "yeah", "hmm hmm", "correct", "very good"). Therefore, there were fewer connections overall for the class. However, the ones that Jessica made centered her approaches to function as a healthcare team member.

For example, the class discussed their interactions with the virtual doctor in SLS with VR. During this interaction, the students reflected on what they did well, and Jessica described that a part she was proud of was her teamwork. Jessica echoed a peer's recollection of a time in the scenario where they worked together on vital signs assessment. In this example, Jessica built on the discussion, highlighting her conversation with the virtual doctor and the significance of providing take-home instructions for the patient. In this way, Jessica used ideas of safe and coordinated care while reflecting on her experiences in the scenario (see Figure 4c).



(a) (b) (c)

Figure 4. Network representations of Jessica's connection making during pre-briefing (a, blue), simulation (b, purple), and debriefing (c, red). Thicker lines represent more frequent connections.

Session 2: November 2020

The research team repeated the ENA for another class led by Tanya using SLS with VR. Similar to the model for Session 1, a means rotation was performed between pre-briefing and debriefing, which created an ENA metric space where the first dimension explained the most difference between these two phases (see Figure 5). This rotation also formed a temporal trajectory across the x-axis from pre-briefing to debriefing phases. In this second ENA metric space, node positions and structure of connections were used to understand different participants and phases across the space.

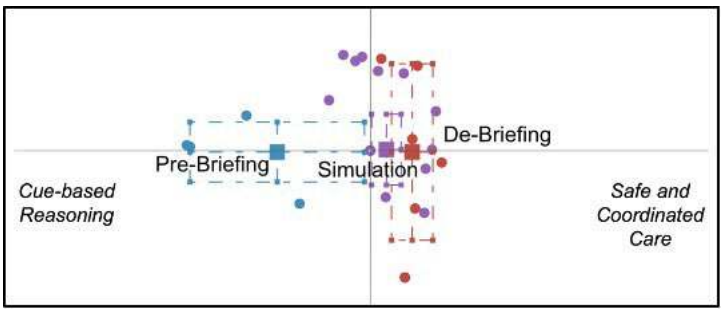


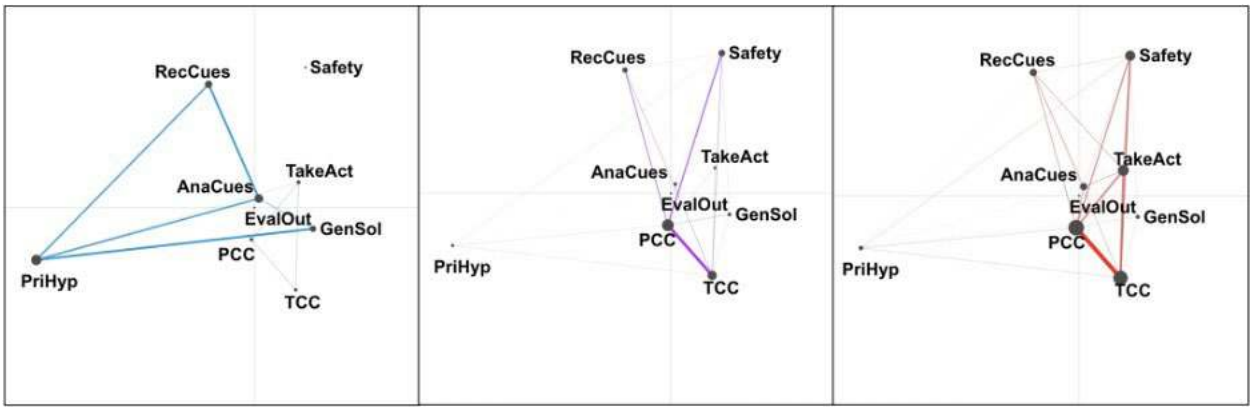
Figure 5. Plotted points (dots), means (squares), and confidence intervals (dashed lines) for Pre-Briefing (blue), Simulation (purple), and Debriefing (red) phases.

During pre-briefing in Session 2, frequent connections were made to and between recognizing and analyzing cues, but there were also more connections to prioritizing hypotheses (PriHyp) than in Session 1. Once again, the class focused on noticing and interpreting cues. But on this day, they spent more time hypothesizing what to do with the cues they would notice. On the other side of the dimension, that is during debriefing, TCC and safety continued to play an important role in Session 2 as well. Furthermore, there continued to be a strong connection between TCC and PCC. Therefore, this dimension was similarly characterized as cue-based reasoning versus safe and coordinated care.

Along the x-axis (cue-based reasoning/safe and coordinated care), a two-sample t-test assuming unequal variance showed that discourse during the pre-briefing phase (M = -0.87, SD = 0.77, N = 6) was statistically significantly different at the alpha = 0.05 level from discourse during the simulation phase (M = 0.15, SD = 0.29, N = 19; t(5.44) = 3.15, p <0.05, Cohen's d = 2.31) and discourse from the debriefing phase (M = 0.39, SD = 0.18, N = 6; t(13.49) = 2.42, p <0.05, Cohen's d = 0.90). There was also a significant difference between simulation and debriefing phases (t(5.55) = 3.87, p < 0.05, Cohen's d = 2.23).

These results suggest that during this second implementation of SLS with VR by Tanya, there were three distinct phases: **discourse in the pre-briefing included more cue-based reasoning (see Figure 6a) and discourse in the debriefing included more safe and coordinated care (see Figure 6c)**. Importantly, in this second session, the discourse during the simulation (see Figure 6b) differed from both the pre- and debriefing. This finding suggests that **as Tanya's experience with SLS with VR deepened, she could take advantage of the system to facilitate richer clinical experiences for her students.**

During Session 1 and 2, the discourse in the simulation connected ideas across the space, including cue based-reasoning and safe and coordinated care. However, one major difference was found in the session in November 2020. The instructor used the simulation differently, spending more time discussing and centralizing PCC while engaging with the simulated patient. One important facet of quality care is knowing how to be a good team member and communicator (TCC) and provide competent and safe care (PCC). However, it may not always be apparent who should know what information. Therefore, **the instructor used the simulation to make a pedagogical adjustment (i.e., introduce the virtual employer character) so that students in the scenario gained practice in applying good judgment about how to manage both the care and privacy of their patients.**

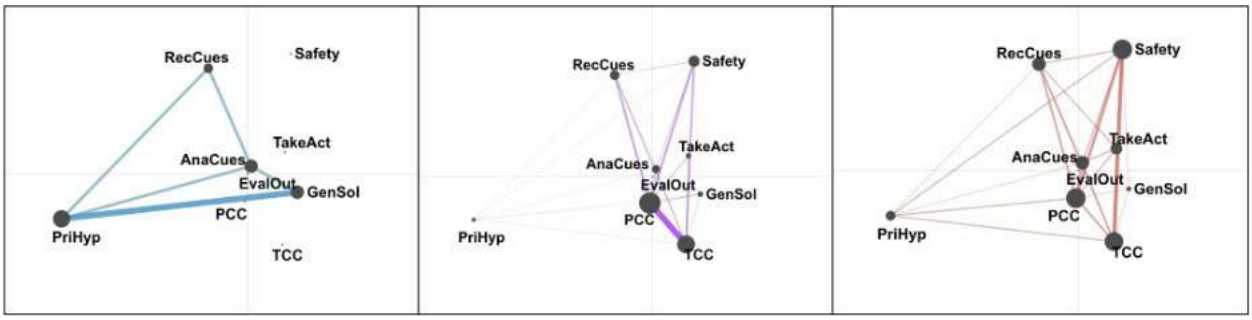


(a) (b) (c)

Figure 6. Network representations of pre-briefing (a, blue), simulation (b, purple), and debriefing (c, red). Thicker lines represent more frequent connections.

STUDENT 2: CESAR

Based on the interpretation of the metric space from Session 2 and what was learned from Session 1, one would predict that throughout the implementation, Cesar would make more connections to cue-based reasoning, then connections between cue-based reasoning and safe and coordinated care, and finally more connections to safe and coordinated care.



(a) (b) (c)

Figure 7. Network representations of pre-briefing (a, blue), simulation (b, purple), and debriefing (c, red). Thicker lines represent more frequent connections.

Notably, Cesar's networks (Figures 7a, 7b, 7c) are very similar to the overall networks for each phase for the class in Session 2 (Figures 6a, 6b, 6c). Therefore, the research team wanted to highlight a few instances from Cesar's experiences that were unique to Session 2. As indicated earlier, the class in Session 2 made more connections to prioritizing hypotheses during pre-briefing while engaging in cue-based reasoning. An illustration of this is manifested through an excerpt of a conversation on cellulitis Cesar engaged in with Tanya, the instructor, and a peer:

> **Peer:** A couple of different areas but the main ones might be legs.
>
> **Tanya/Instructor:** Yes. Why do you think that is? Why would it happen? So, you can get it on your arms or other places, but why do you think it's more common to get it on the legs?
>
> **Cesar:** I would assume it probably has something to do with circulation because…

Compared to the simulation phases in Session 1, connections to safety, and safety with TCC and PCC were prominent when Cesar and his peers engaged in the scenario in SLS with VR. This heightened connection was prompted due to the introduction of the virtual employer who tried to obtain information about the patient. Through their encounters with this character, Cesar and his peers were able to practice prioritizing and managing distractions and, by extension, not violate HIPPA. Additionally, students had to address a situation by adhering to standard precautions of maintaining a safe environment. Debriefing in Sessions 1 and 2 were similar. However, it is important to document Cesar's description of how he described his performance,

> *"I felt like I did good. At first, like the first situation, what's going on with the wound. But then when I started thinking like that endpiece like what to tell them to do. the part about the medication."*

It is also important to recall that Cesar reported being ambivalent about his performance before he participated in SLS with VR.

CONCLUSION, DISCUSSION, AND IMPLICATIONS

In this white paper, the research team was interested in understanding the efficacy of Simulation Learning System with Virtual Reality (SLS with VR) for student learning related to practicing skills valued in nursing. Specifically, the examination focused on modeling, measuring, and interpreting patterns of connections for and between NCSBN Clinical Judgment Measurement Model (NCJMM) and Quality and Safety Education for Nurses (QSEN) competencies during pre-briefing, simulation, and debriefing phases. A quantitative ethnographic examination was undertaken towards these study goals using discourse data from the Fall 2020 study on SLS with VR. Data was examined from two sessions (October and November 2020) led by a Fundamentals of Nursing instructor. The study provided visual, mathematical, and qualitative evidence of whether and how sophomore students' performance was consistent with the scenario objectives in SLS with VR.

Overall, learning experiences across the two sessions and the three phases were enriched through teacher facilitation, collaboration with peers, and roleplaying in the scenario with virtual characters. In the first session, discourse during the pre-briefing was statistically significantly different from the simulation and debriefing discourse. The pre-briefing included more connections to cue-based reasoning, and the simulation and debriefing included connections to safe and coordinated care. In the second session, each of the three phases showed statistically different discourse patterns. Again, the pre-briefing included more connections to cue-based reasoning with a larger emphasis on prioritizing hypotheses. Importantly, and in contrast to the first case, the instructor moderated the SLS with VR scenario in new ways so that students spent more time navigating the issues of privacy regarding patient symptoms and care. This pedagogical adjustment was also identified in the statistical differences in the metric space and the different pattern of connections. Excerpts from Jessica and Cesar's experiences illustrated the range of actions students can practice, the nature of orientations faculty can scaffold, and the pedagogical characteristics of a VR simulation. These **findings exemplify the potentials of integrating SLS with VR within undergraduate nursing education to promote practice readiness.**

Of course, there are limitations to this study. First, this study presents two cases which by nature are only a small sample of the larger set of data we have on this project. Second, the research team provide an analysis of a single instructor using SLS with VR. Future analyses will explore how different instructors and more implementations of SLS with VR result in connections between the competencies nursing students need practice with to become job-ready. Despite these limitations, **this study offers a useful exploration of the statistical structure and thick qualitative nature of instructors and learners using SLS with VR.**

As implications for further research, we will investigate the affordances of different simulation modalities (e.g., SLS with VR and SLS hands-on/manikin-based simulation) for facilitating specific cognitive, social, and psychomotor skills. An investigation of how student learning (building knowledge, practicing clinical judgment, and assessing and reviewing for NCLEX) connects across curricular experiences (e.g., Elsevier's Adaptive Quizzing, SLS with VR, and HESI Exit Exam) is also a direction of interest to us. The Applied Learning Sciences team is committed to examining the effectiveness of Elsevier's digital solutions, including SLS with VR, through academic-industry partnerships to inform product design and advance nursing education research and practice (Shah, Gouveia & Barakat, 2022; Shah et al., 2020).

REFERENCES

Sacks, H., Schegloff, E. A., & Jefferson, G. (1978). A simplest systematics for the organization of turn taking for conversation. In *Studies in the organization of conversational interaction* (pp. 7-55). Academic Press.

Shaffer, D.W. (2017). *Quantitative ethnography*. Madison, Wisconsin: Cathcart Press.

Shah, M., Gouveia, C. & Barakat, S. (2022). Simulation Learning System with Virtual Reality for Supporting Practice Readiness in Undergraduate Nursing Education. To be published in proceedings of the Annual Meeting of the International Society of the Learning Sciences. June 6-10, 2022, Hiroshima, Japan/Online

Shah, M., Siebert-Evenstone, A., Moots, H., & Eagan, B. (2021). Quality and Safety Education for Nursing (QSEN) in Virtual Reality Simulations: A Quantitative Ethnographic Examination. In *International Conference on Quantitative Ethnography* (pp. 237-252). Springer, Cham.

Shah, M., Snow, E., Baker, R., & Gouveia, C. (2020). Learning Scientists in Academia and Industry: Building Bridges and Expanding the Potential of our Community. In Gresalfi, M. and Horn, I. S. (Eds.), The Interdisciplinarity of the Learning Sciences, 14th International Conference of the Learning Sciences (ICLS) 2020, Volume 2 (pp. 697-700). Nashville, Tennessee: International Society of the Learning Sciences.

Siebert-Evenstone, A. L., Irgens, G. A., Collier, W., Swiecki, Z., Ruis, A. R., & Shaffer, D. W. (2017). In search of conversational grain size: Modelling semantic structure using moving stanza windows. *Journal of Learning Analytics, 4*(3), 123-139.

Swiecki, Z., Ruis, A. R., Farrell, C., & Shaffer, D. W. (2020). Assessing individual contributions to collaborative problem solving: a network analysis approach. *Computers in Human Behavior, 104*, 105876.

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