Quality and Safety Education for Nursing (QSEN) in Virtual Reality Simulations: A Quantitative Ethnographic Examination

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Abstract. In this paper, we argue that virtual reality (VR) simulations can be used to (a) scaffold nursing students' practice of cognitive-psychomotor-social skills, and (b) provide feedback on their decisions; thus, mimicking what prelicensure students can expect to encounter in the real workplace. To demonstrate this possibility, we undertake a quantitative ethnographic (QE) examination of modeling faculty and student discourse in VR simulations and associated debriefing sessions and interpreting how quality and safety education for nurses (QSEN) competencies of patient center-care, teamwork and collaboration, and safety are practiced in the context of a fundamentals of nursing scenario. Combining the affordances of VR and QE can help transform nursing education research and practice on supporting and measuring students' emerging clinical readiness.

Keywords: Nursing education · Virtual reality simulations · Fundamentals of Nursing · QSEN competencies · Epistemic Network Analysis · Quantitative Ethnography

1 Introduction

Developing students' clinical readiness is a high priority for prelicensure nursing programs. Naturally, exposure to clinical situations is recognized as a cornerstone approach to engage undergraduate nursing students in domain-related activities. However, there are practical barriers to how frequently and deeply students can immerse themselves in these authentic situations. High-fidelity simulation experiences are advantageous alternatives in helping students prepare for clinical experiences [1].

High-fidelity simulations such as virtual reality (VR) are frequently adopted for workforce education and training purposes across multiple fields [2]. However, recent advancements in VR technology are rapidly catalyzing changes in the healthcare

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education sector [3]. In the context of nursing education, VR simulations are promising because nursing students can (a) participate in a three-dimensional environment that generates images and sounds emulating a clinical scenario, (b) communicate with team members and virtual characters, (c) perform relevant actions and (d) receive haptic feedback from elements in the environment [4]. Empirical evidence is growing regarding the effectiveness of VR simulations in nursing education [5, 6]. However, investigations uncovering how nursing faculty scaffold and sequence instruction using VR simulations, and tracing how learners progress before-during-after participating in VR simulations are scarce.

In this paper, we argue that VR simulations can be used to (a) scaffold nursing students' practice of cognitive-psychomotor-social skills by situating their practice within specific content areas (e.g., fundamentals, medical-surgical, pediatrics), and (b) provide feedback on their decisions; thus, mimicking what learners will encounter in the real workplace. To demonstrate this possibility, we undertake a quantitative ethnographic (QE) examination of modeling faculty and student discourse in VR simulations and associated debriefing sessions and interpreting how quality and safety education for nurses (QSEN) competencies [7] are practiced in the context of a fundamentals of nursing scenario.

The organization of this paper is as follows: we begin by introducing fundamentals as a core course in undergraduate nursing. Research on the trends and gaps in ascertaining the effectiveness of simulations for developing students' clinical readiness is reviewed in the context of nursing fundamentals. Next, we review extant literature on VR simulations in nursing. We underscore the need for using Quantitative Ethnography (QE) to examine the effectiveness of VR simulations for supporting clinical readiness. To ground our examination, we introduce the Quality and Safety Education for Nurses (QSEN) competencies. We present a rationale for modeling discourse related to patient-centered care, teamwork and collaboration, and safety in a nursing fundamentals scenario involving SLS with Virtual Reality (SLS with VR). We then proceed to describe the study methods, including a description of participants and settings, followed by a report of findings. We conclude with directions for future research and implications for practice.

This work seeks inspiration from Shaffer and colleagues' [8] vision for 'digital medicine', which they defined as "the augmentation of human abilities through the external generation and application of medical knowledge that will make health care safer and more effective by enhancing our ability to diagnose and treat disease." We hope that our investigation provides a worked example of how the affordances of VR and QE can help transform nursing education by creating, processing, and interpreting information for researchers and educators to understand nursing students' emerging clinical readiness.

2 Theory

2.1 Fundamentals of Nursing

Fundamentals is a foundational course in undergraduate nursing education. The objective of a fundaments course may include an emphasis on developing students' competencies in "communication and collaboration; implementation of holistic, evidence-based, patient-centered care; providing safe patient care; and demonstration of professional values of caring: altruism, human dignity, and social justice [p, 23; 9]." Clinical experiences during the early stages of nursing education vary widely and are often inconsistent even within a single program [10]. Additionally, fundamentals clinical experiences often focus on routine task completion without the opportunity for higher-level thinking, problem-solving, or collaboration [11].

Typically, simulations are first implemented in a fundamentals course. They are then threaded throughout the nursing curriculum. In an integrated review, Stroup [12] concluded that fundamentals courses provide important opportunities to apply and evaluate simulation effectiveness. According to Dearmon and colleagues [13], early years in nursing students' programmatic journey are characterized by anxiety about patient interaction, budding practice with critical thinking, and psychomotor skills that need further mastery. The use of simulation at this level has proven to be beneficial in all of these areas [13]. However, much of the existing literature considers simulation as a means of assessing the competency of psychomotor clinical skills. For instance, Bornais and colleagues [14] assessed the skill competency of fundamentals students using standardized patients, while Yang and colleagues [15] provided students with single-skill-focused simulation opportunities to assess competency in skills such as vital signs, feeding, and aseptic technique. Beyond the assessment of psychomotor skills, there is a glaring need for furthering our understanding regarding how simulations help students achieve clinical objectives within a fundamentals course.

2.2 Virtual Reality Simulations in Nursing

A surge of recent papers has communicated the potentials of virtual reality (VR) simulations for nursing education. For instance, Dean and colleagues [16] argued that the value of immersive VR simulation experiences lies in their potential to nurture empathy in nursing students so that their ability to engage in patient-centered care is enhanced. They elaborated on this potential by proposing that VR simulations can be used to foster an understanding of what it feels like to communicate with and care for patients with specific characteristics. In another study, Ramakrishnan and colleagues [17] demonstrated the application of three VR simulations designed to support students' situational awareness, clinical judgment, clinical decision making, and understanding of patients' perspectives. Lastly, Bayram and Caliskan [5] reviewed research on VR simulations and their effectiveness in helping students engage in safe practices while providing quality caring for patients. Broadly, positive support was found for VR simulations and their effect on helping students identifying patients correctly, improving effective communication, improving the safety of the high-alert medication, and ensuring correct-site, correct-procedure, correct-patient surgery, reducing the risk of healthcare-associated infections, and reducing the risk of patient harm resulting from falls [5]. However, most studies included in the review focused on measuring change for an isolated nursing skill (e.g., effective drug administration) or outcome (e.g., preventing patient falls).

Studies measuring the effectiveness of VR simulations should consider accounting for the complex nature of clinical work. We believe that adopting a Quantitative Ethnographic (QE) approach can advance nursing education research and practice on VR simulations in this direction. QE unites research methodologies by quantifying the qualitative 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 [18]. QE techniques such as Epistemic Network Analysis (ENA) have been employed to assess and visualize communication patterns and teamwork dynamics in a high-performing primary care team [19]. Scholars have also analyzed multimodal data to visualize team movement in nursing simulations [20]. QE techniques such as ENA provide a valuable approach to create models of situated action [21]; that is, to generate representations of participation in simulated clinical settings. The Quality and Safety Education for Nurses (QSEN) framework provides useful indicators to model and interpret nursing students' emerging readiness for clinical work. We believe that doing so in a Fundamentals of Nursing course might be a good starting point.

2.3 Quality and Safety Education for Nurses

The Quality and Safety Education for Nurses (QSEN) framework was designed to prepare nurses with the competencies necessary to continuously improve the quality and safety of the health care systems in which they work. Cronenwett and colleagues [7] adapted the Institute of Medicine competencies for nursing; that is, patient-centered care, teamwork and collaboration, evidence-based practice, quality improvement, safety, and informatics. In doing so, they operationalized the QSEN competencies and proposed statements of the knowledge, skills, and attitudes (KSAs) for each competency that should be developed during prelicensure nursing education.

According to Preheim, Armstrong and Barton [22], nurses with a strong foundation in patient safety and quality improvement are better able to assimilate into the current complex health care environment. These researchers also emphasized specific QSEN competencies and related KSAs that are important for students to be introduced to early on, specifically in a fundamentals of nursing course. As such, we use patient-centered care (PCC), teamwork and collaboration (TCC), and safety as our primary codes in tracing how SLS with VR simulation and associated debriefing afforded faculty and students those experiences (see Table 1).

2.4 Current Study

In this study, we examine the following research question, *'What similarities and differences can be found in the connections students and faculty make between Quality and Safety Education for Nurses (QSEN) competencies through participation in virtual reality simulations and debriefing as it relates to Fundamentals of Nursing?'* We collected discourse data from a nursing fundamentals scenario in SLS with Virtual Reality and debriefing. We then conducted a qualitative analysis of the interactions to identify and understand the key elements of QSEN competencies: patient-centered care, safety, teamwork and collaboration and associated KSAs, and importantly, how these elements are connected to one another. Once key elements were identified, the structure of connections between these elements was represented as a network of relationships using epistemic network analysis (ENA). This resulted in a visual representation of the structure, a mathematical model of the structure, and a way to compare the quantified data with its underlying qualitative data. After assessing important elements of nursing using ENA, we compared these results to the qualitative findings. Finally, we describe the implications of this study. Below, we elaborate on the study methods, report findings, and discuss key takeaways.

3 Methods

This investigation is situated in a larger pilot study undertaken at Elsevier, a global health and analytics company in Fall 2020 (October-November 2020). The objective of the pilot was to identify actionable insights and feedback on the efficacy, usability, and viability of SLS with Virtual Reality, a VR simulation system for undergraduate nursing education prior to its release in early 2021. Given the uncertainty of college reopenings due to the COVID-19 pandemic, the pilot study was designed flexibly; that is, researchers could support participants and collect data synchronously and asynchronously in an online-only, hybrid, or in person. This was possible because SLS with Virtual Reality is designed for participants to collaborate in a virtual space while being present in physically remote locations.

3.1 SLS with Virtual Reality

SLS with Virtual Reality (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 (e.g., fundamentals, medical-surgical, pediatrics). From the faculty side, SLS with VR scenarios are selected, viewed, and moderated from an interactive interface (i.e., moderator tool). Meanwhile, students participate in the VR scenarios using Oculus Quest headset equipment and hand controllers. 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 Fig. 1).

3.2 Participants

Tanya (pseudonym) is a faculty in a traditional nursing program (i.e., Bachelors of Science in Nursing, BSN) at a public college in the northeastern region of the United

States. She is the lead instructor for the Fundamentals of Nursing course and has 6–10 years of experience facilitating or assisting with simulations, typically engaging BSN students in their 1st semester of sophomore year.

Broadly, Tanya was motivated to engage her students in simulated clinical experiences for helping them develop communication, professionalism, and clinical judgment skills through exposure to diverse patients. Supporting students to practice patient safety, focused assessment and medical administration were additional skills Tanya focused on. Typically, Tanya's goal for pre-briefing was to ensure that students are as prepared as they can be to engage in a simulation so that they can have an opportunity to apply what they are learning in class. As such, Tanya provided her students with written objectives for the simulation at least four days in advance of a simulation. On the day of the simulation, she reminded students of the objectives by writing them on the whiteboard in the classroom and discussing them in a large group. For debriefing, Tanya deemed important the need to help students be cognizant of how they met the scenario objectives and the gaps that persisted in their knowledge, and identify take-aways from the simulation session. In terms of assessment, Tanya evaluated students' performance as satisfactory, unsatisfactory, or incomplete. Anecdotal verbal feedback and written feedback were also provided. Actual participation in the simulation was non-punitive.

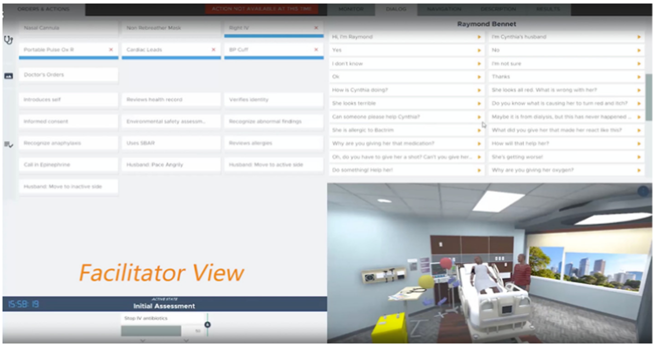

Fig. 1. Moderator tool and faculty view within SLS with virtual reality.

Tanya participated in the pilot along with 29 students who were in their second year of RN-BSN program. These students expressed several hopes from VR simulations developed for nursing education. Obtaining a deeper understanding of the patient-nurse relationship in the care process was a recurrent theme. For instance, one student expressed "[I look forward to obtaining] a better grasp on patient interaction while performing my procedures." Another reported "I hope we can learn how to manage feedback from our patients. I hope to gain a more interactive perspective and be able to accommodate my patient better than a lab simulation." Students also hoped VR simulations would more closely emulate working in a clinical environment. For instance, one student said, "[VR] will help us be able to do tasks and be able to participate more and maybe get more of a real feeling since we have not been able to go to a real clinical site." Another student looked forward to opportunities for "dealing with patient family members and speaking with other members of the healthcare team."

3.3 Procedure

Over seven weeks (October to November 2020), researchers supported Tanya asynchronously by sharing onboarding materials, VR student and instructor guides and safety tips, and instructions to set up the play space for students. She also had access to preparatory and follow-up activities for her students- readings, pre/post-sim quizzes, and pre/post exercises which were tailored to the scenarios being offered within the SLS with VR ecosystem. In addition, Tanya had access to materials for each scenario including case descriptions, pre-briefing and debriefing guides, and dialog transcripts for characters in respective scenarios within the SLS with VR ecosystem. Lastly, a sandbox scenario was made available to all participants, and Tanya was encouraged to orient her students to the VR environment and controls before they participated in scenarios directly or as observers. Researchers also supported Tanya synchronously by facilitating a remote, but hands-on 90-min SLS with VR training session prior to the start of the study. Synchronous remote support was also provided when researchers observed Tanya facilitate scheduled sessions using SLS with VR starting from pre-briefing, running the simulation, and debriefing with her students.

For the purpose of this study, we chose to examine Tanya's simulation practices using SLS with VR over two weeks (once in October and once in November 2020). Each session followed the same procedure (pre-briefing, running a scenario using a scenario in SLS with VR, and de-briefing). Each session typically had 1–2 students who role-played as nurses in the virtual reality scenario and 1–2 students that observed. For all these sessions, Tanya chose a fundamentals scenario from the SLS with VR catalogue of scenarios.

3.4 Fundamentals of Nursing Scenario in SLS with Virtual Reality

The purpose of the fundamentals scenario Tanya chose 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.

3.5 Data Coding and Analysis

Discourse during SLS with VR was audio-recorded and transcribed so that each line designated a new *turn of talk*, where a turn is defined as starting with a statement by one individual and ending when another individual spoke [23]. Transcribed data were inductively coded for relevant nursing KSAs as well as deductively coded for QSEN competencies- patient-centered care (PCC), teamwork and collaboration (TCC), and safety. To address the reliability and validity of qualitative coding, we used social moderation, where two raters coded all 770 lines of data and then achieved agreement on each code [24]. Each utterance was coded for the occurrence (1) or nonoccurrence (0) of the skills that are essential to QSEN (see Table 1) thus, quantifying qualitative data.

3.6 Epistemic Network Analysis

To measure QSEN competencies and associated knowledge, skill, and attitudes during SLS with VR simulation and debriefing phases, we used Epistemic Network Analysis [ENA; 25] to model the connections between the three primary codes: patient centered care, teamwork and collaboration, and safety. ENA measured these connections by quantifying the co-occurrence of QSEN codes within a defined segment of data.

Table 1. Codebook of QSEN competencies and associated knowledge, skills, and attitudes.

Code and definition	Examples of Relevant Knowledge (K), Skills (S), Attitudes (A)
Patient-Centered Care (PCC): Recognize the patient or designee as the source of control and full partner in providing compassionate and coordinated care based on respect for the patient's preferences, values, and needs	K-Demonstrate a comprehensive understanding of the concepts of pain and suffering S-Assess presence and extent of pain and suffering A-Appreciate the role of the nurse in relief of pain
Teamwork and Collaboration (TCC): Function effectively within nursing and inter-professional teams, fostering open communication, mutual respect, and shared decision-making to achieve quality patient care	K-Discuss effective strategies for communicating S-Follow communication practices that minimize risks associated with handoffs among providers and across transitions in care A-Respect the centrality of the patient/family as core members of any health care team
Safety: Minimize risk of harm to patients and providers through both system effectiveness and individual performance	K-Delineate general categories of errors and hazards in care S-Demonstrate effective use of technology and standardized practices that support safety and quality A-Protect patient confidentiality

In this study, we used a moving stanza window [26] of four utterances (each line plus the three previous lines) within a given conversation. We chose this window size based on our qualitative analysis of the discourse. We also ran the model at a range of different window sizes (i.e. 3–7) and the interpretation of the result remained consistent. A conversation, in this case, included all turns of talk associated within one phase within the implementation. Codes that occurred outside of this window were not considered connected. For the dimensional reduction, we chose a technique called a *means rotation* [27] that combines (1) a hyperplane projection of the high-dimensional points to a line that maximizes the difference between the means of two units and (2) a singular value decomposition. The resulting metric space highlighted any differences between the units by constructing the dimensional reduction that placed the means of the two units as close as possible to the X-axis of the space. In this study, we rotated the space by the Simulation and Debriefing phases to highlight differences across the phases on the x-axis. Subsequently, ENA created two coordinated representations for each unit 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 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 then 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.

4 Results

Our analysis of discourse revealed rich insights into how Tanya facilitated QSEN related discussions with her students while moderating the fundamentals scenario using SLS with VR and debriefing. After reviewing the qualitative data, we found that there were important differences in how the instructor discussed safety during the simulation and debriefing phases of the implementation.

4.1 Quantitative Findings

To investigate and compare how Tanya engaged with her learners, we created mean networks of the connections between codes for the Simulation phase and the Debriefing phase. Within the ENA space, we performed a means rotation between Simulation and Debriefing, which creates a metric space where the first dimension explains the most difference between those two phases (See Fig. 2). Each of these means represents the average discourse network for that respective phase. Figure 3 shows the individual mean network plots for the simulation phase, on the left in blue, and the Debriefing phase, on the right in red.

First, both phases make strong connections between PCC and TCC. However, in the simulation phase, the instructor and students made more connections between PCC and safety. On the other hand, in the Debriefing phase, the instructor and participants made more connections between TCC and safety. To more clearly compare the similarities and differences between phases, we created a difference network (see Fig. 4).

Figure 4 shows two representations of the phases. First, it shows the mean and confidence interval for each phase which represents the average discourse network across that phase. Second, this figure shows the difference network comparing the Simulation and Debriefing mean networks. Connections represented in red lines were stronger among Debriefing discourse, while connections in blue occurred proportionally more often in Simulation discourse. Thicker lines indicate larger differences in connection strength, while thinner lines indicate smaller differences in the strength of connections.

Based on these representations, the average discourse pattern of students and the instructor in the Simulation phase focused more on connecting PCC and Safety compared to the Debriefing phase where the discourse focused more on connections between Safety and TCC. The faint and thin line connecting PCC and TCC indicates that on average both the Simulation and Debriefing phases made roughly the same number of connections between these two topics. Referring to Fig. 4, we see that both phases make many connections between these topics so that a comparison between the phases shows little difference.

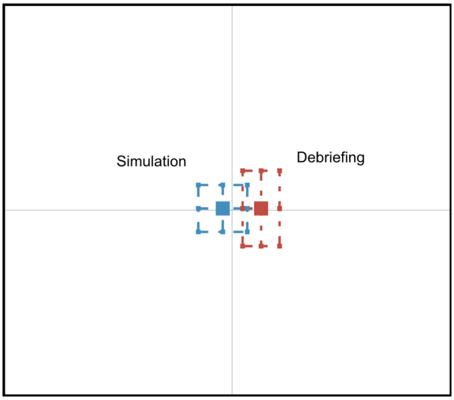

Fig. 2. Means (squares) and 95% confidence intervals (dashed lines) for Simulation (blue) and Debriefing (red) phases. (Color figure online)

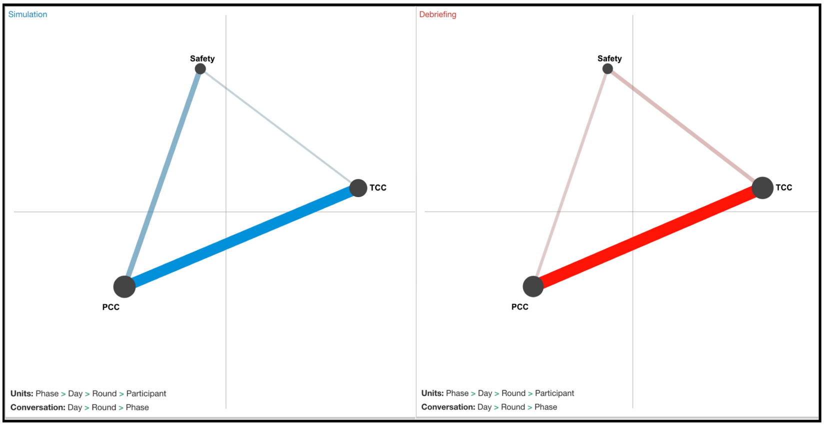

Fig. 3. Network representation of the simulation (blue) and debriefing (red) phases. Thicker lines represent more frequent connections. (Color figure online)

Despite these commonalities in connection patterns between PCC and TCC, there were systematic differences between the two phases. A two-sample t-test assuming unequal variance showed the discourse pattern in the Simulation phase (mean = −0.13, SD = 1.20, N = 51 was statistically significantly different at the alpha = 0.05 level from the Debriefing phase along the X-axis (mean = 0.40, SD = 0.48, N = 16; t (61.18) = −2.56, p = 0.01, Cohen's d = 0.49). This statistical difference in discourse patterns is mainly driven by the instructor and students making more connections between PCC and Safety in the Simulation phase and more on connections between Safety and TCC in the debriefing phase. In other words, the big difference between the two phases is how the discourse makes connections to safety.

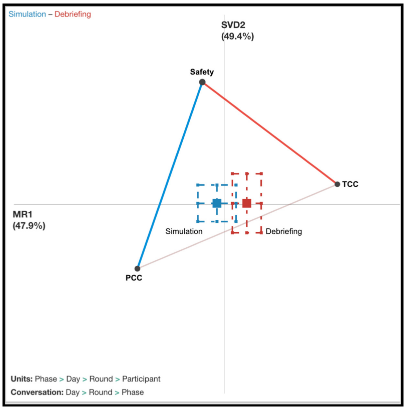

Fig. 4. Means (squares) and confidence intervals (dashed lines) for Simulation (blue) and Debriefing (red) phases. Difference network comparison between simulation phases, where thicker lines represent greater differences. (Color figure online)

4.2 Qualitative Findings

To better understand the different ways the instructor and students discussed safety, we analyzed how the discourse unfolded in the two phases.

4.2.1 Simulation Phase

As part of this fundamentals scenario, students practiced meeting and assessing a patient for care. During this practice, students assessed the patient's pain, determined if pain medication was indicated, and discussed pertinent pain-related data with the provider, including how it would be managed upon the patient's discharge. Here, the simulation provided an opportunity for students to demonstrate KSAs of Patient-Centered Care, Safety, as well as Teamwork and Collaboration.

This scenario provided students an opportunity to demonstrate key indicators of knowledge, skills, and attitudes for patient-centered care. For example, a student asked the patient, "Could you rate your pain on a scale of 0-10, 0 being no pain and 10 being the worst pain?" (PCC-K, S). After discussing pain and other symptoms with the patient, the student then summarized the assessment for the doctor (TCC). Each time the teacher facilitated this scenario, students got experience communicating patient preferences (PCC – S) to another member of the healthcare team (TCC – S).

Also, during the simulation phase, Tanya challenged students to address patient privacy concerns. In this case, the instructor posed as the patient's employer and requested medical information and updates. With this experience, students explored the ethical and legal implications of patient-centered care while providing the necessary sensitivity and respect for the patient's privacy (PCC-S). Students dealt with a belligerent employer and had to navigate communicating with the employer without releasing private health information as a potential error (Safety-K). One student responded to the employer and said, "Per the hospital policies, I am not allowed to disclose any information." In this example, the student demonstrated a strategy to prevent an error in disclosing protected information (Safety-S), value their role in preventing that error (Safety-A), and provide patient-centered care (PCC). The students needed to identify and utilize an effective communication strategy to minimize patient risk while presenting pertinent information about the patient's condition.

4.2.2 Debriefing Phase

After the simulation, Tanya facilitated debriefing sessions which provided the opportunity to draw attention to specific topics and push students to consider alternative decisions and actions. Similar to the simulation phase, Tanya made frequent connections between the importance of both centering patient needs (PCC) and communicating those needs to members of the care team (TCC).

For example, Tanya led the class in a reflection about assessing pain by discussing how it is common to assess pain and recommend medicine but "not follow through getting the rest of the assessment" (PCC). She followed up by focusing on the role of communication, asking, "Okay, so you said communication. You think your communication was good. So what was good? Give me some specifics. What did you do well with the communication?" (TCC). One student responded, "We both helped each other. And also in talking to each other. We had to discuss what was going on" (TCC).

In this instance, and across the debriefing Tanya made sure that students reflected on how they understood the situation and how they communicated these assessments to others.

Safety was also a consistent topic during debriefing. Tanya helped students identify errors as well as safety-related issues that arose during simulation. In one example, Tanya made sure students understood the appropriate identification of the patient, allergies, and prioritization of assessment & interventions (PCC, Safety – K, A). While discussing how students assessed their patients, Tanya focused on how students used standardized practices and tools to ensure patient safety (Safety-S). For example, Tanya asked students, "when you took the dressing off, did you wear gloves?" This question about basic safety practice was used to further discuss connecting what they did in the simulation with real-world practices and past experiences.

To emphasize the importance of TCC and Safety, Tanya told students, "you were using our closed loop communication with each other and open teamwork communication during the VR, which we encourage you to use." Tanya and the students discussed the importance of maintaining a closed-loop communication to protect patient rights but remaining in open communication with the providers. Navigating who needs to know what led to further discussion about the importance of effective communication between the student nurses, the patient, and other members of the healthcare team (PCC – K, S; TCC – K, S, A; Safety).

Within the scenario and emphasized in the debrief, Tanya made sure to dive into these nuances of communication. She encouraged students in the observer roles to comment on the overall communication, asking "how was their communication with the patient and the family". The student observers identified the importance of communication stating, "I'll be prepared to talk with the family members and other members of the healthcare team" and "be prepared a little better with SBAR" when asked how they would use their role as observer to guide them when they participate as students. In each of these instances, not all students had the same role in the simulation, however, Tanya used debrief to ensure all students received a similar experience. Though the simulation had objectives and expected student actions, each scenario took a slightly different course based on the students' actions. In one instance, students never contacted the provider. In another, the employer didn't call. But the educator was able to bring these issues up during debrief and facilitate meaningful discussion and learning.

In each instance, she spent time discussing closed-loop communication as an important tool for communicating information with other members of the healthcare team (TCC- S; Safety – S). Importantly, though, when Tanya taught students about safety during the debriefing, she focused her discussion on how the students communicated risk with others.

4.2.3 Comparing Simulation and Debriefing Discourse

Throughout the fundamentals scenario in SLS with VR—simulation and debriefing—the instructor and students interacted with the patient, gathered the patient's background, assessed patient needs, recommended next steps, and communicated with the patient, family, and other providers. This scenario was therefore rich in examples of and connections between all three QSEN competencies as students practiced patient-centered care (PCC), maintained patient safety (Safety), and worked in teams to address patient needs (TCC). However, there were important differences in how participants made connections between these three topics.

Both the simulation and debriefing included many and about the same relative number of instances where participants made connections between providing patient-centered care (PCC) and working and communicating in teams (TCC). At the same time, there were important differences in how Tanya and her students discussed safety in relation to these two codes. Across the phases, the simulation included more opportunities to connect PCC with Safety, while the debriefing included more instances of TCC and Safety. In the simulation, Tanya directed student practice to communicating with patients and protecting patient privacy. While in the debriefing, Tanya facilitated reflections on how students communicated risk with others.

5 Discussion

This paper demonstrates that we can meaningfully model nursing education discourse during a VR simulation and associated debriefing. It shows that, by using QE, we can find statistically significant differences between phases that also reflect the underlying qualitative stories. As such, advances in digital technologies and research methods can usher new directions in nursing education especially as it relates to shaping students' clinical readiness [8, 21].

Using the QSEN competency framework [7] to study SLS with VR simulation and debriefing activity, this paper demonstrated how undergraduate students can be supported to identify with professional nursing roles that reach far beyond tasks, skills, and procedures. They can be supported to develop a beginning awareness of safety and quality in the context of a health care system, nurse-sensitive quality indicators, and local and national safety initiatives impacting health care delivery. Nurturing a well-rounded clinical competency is important; a fundamentals course is a relevant starting point for introducing and examining the efficacy of pedagogical approaches that support this goal [9–13]. In the future, this research will be expanded to additional content areas in nursing education (e.g., medical-surgical).

Examining discourse and moment-to-moment interactions using ENA can expand nursing educators' ability to assess participation in simulation-based experiences. They can also broaden the data sources nursing education researchers rely on for measuring the effectiveness of novel simulation modalities such as VR [5, 6]. Making tools accessible and usable for nursing educators would be a relevant direction for the QE community to strive towards [28].

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