ORIGINAL RESEARCH

Acquiring clinical reasoning skills via virtual simulation in nursing education: A qualitative study

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ABSTRACT

Objective: To explore students' perspectives on clinical reasoning development and their experiences of learning through virtual simulation.

Methods: An exploratory, descriptive qualitative study design was used. Twenty-eight nursing students studying in a bachelor's program received a 2-hour virtual simulation training with a debriefing session. Six semi-structured focus group interviews were conducted after the training. Thematic analysis was used to explore and analyze the students' perspectives on clinical reasoning development and their experiences of learning through simulation training.

Results: Three main themes emerged: engagement in and satisfaction with learning, enhancement of clinical reasoning skills, and preparedness for clinical practice.

Conclusions: Virtual simulation training with debriefing sessions increased students' engagement in and satisfaction with learning, developed their clinical reasoning skills, and enabled them to reflect on their own preparation for clinical practice. Our findings suggest that virtual simulation could be adopted in current nursing curricula to enhance the competencies of future nurses.

Key Words: Virtual patients, Clinical virtual simulation, Clinical reasoning, Nursing education, Qualitative study

1. INTRODUCTION

Nurses are the key personnel responsible for caring in the healthcare system.[1] However, nurses with poor clinical judgment fail to detect impending changes in patients' conditions.[2] Efforts to train nurses, especially nursing students, in safe practices may help uphold patient safety.[3] The traditional teaching method of nursing training focuses on imparting knowledge and skills in schools, with their practical application learned mostly in clinical practicums. Students need to utilize every learning opportunity to apply theoretical knowledge, develop clinical reasoning, and grasp the ethical nature of nursing practice.[3] Clinical reasoning is the process by which nurses collect cues, process information, come to an understanding of patients' problems or situations, plan and implement interventions, evaluate outcomes, and reflect on and learn from the process.[4] Effective clinical reasoning depends on the nurse's ability to collect the correct cues and take appropriate actions for the right patient at the right time and for the right reason. Nurses with effective clinical reasoning skills have a positive impact on patient outcomes.

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Virtual simulation and clinical reasoning

Virtual simulation with a digital simulator is a pedagogical strategy that adopts an interactive approach to provide students with interactive and immersive learning experiences in a controlled environment.[5] Through virtual simulation, students can practice their skills on virtual patients in simulated nursing scenarios without risking actual patient harm.[6,7] Although virtual simulation engages nursing students in assessing and analyzing virtual patients' problems and altered mental status in simulated clinical scenarios, it also encourages them to engage in active and critical action-based learning. Virtual simulation can increase student–patient interaction in the virtual environment, thereby enhancing their perceived self-confidence and satisfaction with learning. In addition, virtual simulation in realistic clinical scenarios may accelerate breakthroughs in improving clinical reasoning education through gaming and problem-based learning.[8,9] Such a simulation-based interactive learning strategy, which integrates briefing, debriefing, and students' cognitive, affective, and psychomotor skills development, could allow for competency-based education. Using virtual simulation to develop nurses' clinical reasoning skills could improve their performance and competencies related to psychomotor skills, critical thinking, clinical skills, and decision-making.[8,10] In addition, virtual simulation can provide training for nursing students anytime and anywhere. Thus, this could be an optimal teaching method during the COVID-19 pandemic.

Literature reviews have provided evidence that virtual simulation can improve knowledge and clinical competence among nursing students.[11,13] However, limited research has investigated nursing students' perspectives on engaging in virtual simulation training and how it impacts their clinical reasoning development. Therefore, this study explored nursing students' perspectives on clinical reasoning development and their experiences of learning through virtual simulation training with debriefing sessions.

2. METHODS

2.1 Research design and participants

An exploratory, descriptive qualitative study design was adopted to gain an understanding of nursing students' experiences of learning through virtual simulation. Focus group interviews (FGIs) were used for data collection. The study was conducted between July and August 2022 in one of Hong Kong's tertiary institutions that mainly provides health-related programs, covering higher diploma and bachelor's degree programs. The researcher recruited participants through the internal email system. Purposive sampling was used to select participants who met the following inclusion criteria: 1) were currently studying on the baccalaureate pre-registration nursing program, 2) had never been trained in virtual simulation, and 3) had never been assigned to clinical placement. Students who showed an interest in this study were invited to attend an initial eligibility screening meeting. Eligible students were asked to sign an informed consent form and complete a form to gather information about their current year in the nursing program and previous experiences of simulation training with mannequins.

2.2 Flow of the study

The virtual simulation training included two scenarios of 1 hour each and was delivered using a software program (Body Interact, Coimbra, Portugal) (see Figure 1). The virtual simulation fosters a digital game-based environment suitable for learners in different needs. The students first received a brief introduction to virtual simulation from the tutor. Subsequently, they interacted with the virtual patient through dialogues to monitor physiological parameters, make observations, conduct physical examinations, analyze complementary examination findings, and finally, provide interventions. Two cases were selected, one medical and one surgical. The first case was an older man with chronic obstructive pulmonary disease, and the second case was a woman with acute cholecystitis. Two to four students were assigned to a group to perform appropriate assessments to analyze the virtual patient's condition and then provide appropriate nursing interventions to relieve the patient's discomfort. The closure of a clinical case was determined either by the successful resolution of the scenario or when 20 minutes had passed. After the simulation ended, the simulator generated a simulation report for the students, and a debriefing session was conducted by the tutor for each group. The simulation report summarized each of the students' choices in relation to the correct response, from the beginning to the end of the scenario. The tutor used the reports to review students' actions step by step and minute by minute, as well as to analyze their scores and provide feedback on and rationales for their performance. The entire virtual simulation training lasted 2 hours.

2.3 Theoretical framework

Kolb's experiential learning model was adopted to develop guiding questions for use in FGIs to explore students' experiences of acquiring clinical reasoning skills from the virtual simulation training.[14] Kolb's experiential learning model involves a clinical reasoning cycle of four stages—concrete experience, reflective observation, abstract conceptualization, and active experimentation[14] —that formed the framework for our semi-structured interviews. Within each construct, open-ended questions and probing questions were used to allow the students to share their virtual simulation experiences (see Table 1).

Figure 1. Virtual simulator using in the study

Table 1. Interview questions based on four components of Kolb's Experiential Learning Model

Concrete experience (feeling)
• Do you know of simulation training for nursing students?
• If yes, what is the difference between the simulation tried before and VPS?
• Have you used virtual simulation before?
• As a nursing student, what does clinical reasoning and critical thinking mean to you?
Reflective observation (watching)
• How was your experience with this VPS?
• How do you find the virtual simulation experience in several areas, i.e., the difficulty, ease of use, realism, learning environment, learning content etc.
• What do you think about the learning content of virtual simulation? (Rephrase to the above question)
• How is the debriefing session?
• How is the guidance or instruction?
Abstract conceptualization (thinking)
• What are the important elements of virtual simulation in gaining clinical reasoning for students?
• How is simulation useful in developing your critical thinking and clinical reasoning?
• Any new concepts created in your first attempt can apply to the second attempt.
Active experimentation (doing)
• What kind of skills have you applied in the VPS?
• How did you demonstrate your nursing assessment, planning, nursing intervention and evaluation in the VPS?
• How can the VPS link the theory to practice?
• What do you take away from this training activity?
• Which area of virtual simulation do you think can be improved further?
• Do you enjoy this learning experience?

2.4 Data collection

A semi-structured FGI was conducted for each group immediately following the virtual simulation training. Each interview lasted 50–60 minutes and was conducted in Cantonese face-to-face in a conference room that was quiet and free from disturbance. All interviews were audio recorded. Two trained researchers conducted all of the interviews using a semi-structured interview guide (Table 1). A note-taker was present during the interviews, who took field notes and summarized the key points at the end of the discussion to allow the participants to clarify any misinterpretation.

2.5 Ethics

This study was conducted with the approval of the Research Ethics Committee of the institute (REC2022132). Information sheet about the study purpose and related information were provided, all of the participants were informed that they could withdraw at any time without consequences for their academic performance. All students were informed about the format of the interview and they would be audio-recorded in the focus group. Consent for participation was obtained prior to the simulation training. Confidentiality of identities was maintained according to the institute's research guidelines.

2.6 Data analysis

Steps were taken to enhance the trustworthiness of the data, analysis, and reporting. The audio recordings were transcribed verbatim by two researchers who were familiar with both Cantonese and English. Thematic analysis by Braun and Clarke[15] was adopted. Researchers transcribed the students' natural speech and group dynamic discussion without bias. This analysis is useful for summarizing the key features of nursing students' experiences of developing clinical reasoning through virtual simulation, as it forces the researchers to adopt a well-structured approach to handling data, which in turn helps to produce a clear and organized final report.[16] Transcripts were read by two researchers independently to identify the main themes. The transcripts were read repeatedly until no new themes were identified. The raw data and summaries of the themes and sub-themes were then reviewed and discussed with a third researcher to ensure the credibility, transferability, dependability, and confirmability of the study findings.[17]

3. RESULTS

The study included 28 nursing students (average age: 21.1 years), who were studying in the second (n = 15) or third year (n = 13) of a 5-year baccalaureate nursing program. Of these, 15 (53.6%) were female and 13 (46.4%) were male. Half of the participants had previously received high-fidelity simulation training with mannequins (see Table 2).

Table 2. Characteristics of study participants (n = 28)

	n	% or mean
Sex		
Male	12	42.9
Female	16	57.1
Age		21.1
Year of study		
2nd year	15	53.6
3rd year	13	46.4
GPA	2.1-3.6	2.88
High Fidelity Simulation with mannequins		
Yes	14	50
No	14	50

Three themes (see Table 3) emerged from the students' virtual simulation experiences: 1) engagement in and satisfaction with learning, 2) enhancement of clinical reasoning skills, and 3) preparedness for clinical practice. The narratives used in the findings are anonymized by codes, for example, P1 for focus group participant one.

Table 3. Main themes and sub-themes extracted from data

Main themes	Sub-themes
Engagement and satisfaction with learning	Motivated by game-like format
	Flexibility and safety
Enhancement of clinical reasoning skills	Provision of logical guidance
	Motivation
	Habitual application of clinical reasoning
Preparedness for clinical practice	Feedback and evaluation
	Preparedness to practice in a clinical setting

3.1 Engagement in and satisfaction with learning

The students enjoyed the relaxing, game-based learning in virtual simulation. They found virtual simulation to be more flexible and accessible than high-fidelity simulation, especially during the COVID-19 pandemic, allowing them to learn at their own pace.

3.1.1 *Motivated by the game-like format*

The students said that they liked the non-stressful game-like format of the learning environment. A student (P1) pointed out that s/he could perform patient care more systematically in the relaxing virtual gamified environment than during face-to-face high-fidelity simulation training with mannequins: *"If you are not that scared, you can think clearly. I can clear my mind first… and analyze the clinical situation step by step systematically."* Another student (P10) shared, *"The virtual simulation is like playing a game: it offers many cases for me to do, and even if I did something wrong, I can correct it immediately, and I can deal with one thing very calmly, which can help me train myself in knowing the different options available in different cases, which decisions I can choose to make, and enhance my critical thinking."* Some students said that they enjoyed the virtual simulation training because of its game-like format. A student (P19) expressed, *"I think this virtual simulation is like playing a game, and then I have to play it in the right way to get through it… I like the game format; it helps to keep me relaxed and calm while I analyze what to do."* Another student (P28) pointed out, *"I will choose virtual simulation over just sitting in front of the [computer] passively and having the online lecture for two hours. I can learn a lot in the game-format virtual simulation."*

3.1.2 *Flexibility and safety*

Compared with face-to-face high-fidelity simulation with mannequins, virtual simulation offers greater flexibility regarding scheduling and location, allowing students to practice at their convenient time and from anywhere, provided an Internet connection is available. A student (P22) said, *"It is a novel experience as it is in online mode. That means I am not restricted geographically; I do not have to go to school to do [simulation laboratory training]. It means I can do this training even at home, even at night, so it fits my tight learning schedule."* Another student (P24) pointed out that high-fidelity simulation could not fulfill students' learning needs: *"We have to go back to the school sim lab that has limited quota and turns, and it is not convenient during the pandemic. Virtual simulation allows us to practice our nursing skills at home or anywhere else."* Virtual simulation also motivates students to engage in self-study or peer learning, irrespective of location and time. A student (P20) said, *"You can do it on your own or with other classmates. Moreover, you can set different durations for each case, giving you more time to think about what to do if you are a beginner on that course."*

The game-based virtual simulation training provides a safe environment for students to practice clinical skills and decision-making abilities without risking harm to patients. The students expressed that they could learn from the mistakes they made in virtual simulation. A student (P6) said, *"I can have a second or even a third attempt. That way I can learn from my mistakes without any adverse impact on the patients."*

3.2 Enhancement of clinical reasoning skills

The students expressed that virtual simulation helped them to enhance their clinical reasoning skills. It prompted them to think about and analyze the case step-by-step and follow the clinical reasoning cycle. As a result, they started applying clinical reasoning in nursing practice.

3.2.1 *Provision of logical guidance*

A student (P2) used hand hygiene as an example, indicating that the virtual simulation training provided hints and guidance while learning. She said, *"[virtual simulation] has clear and distinct guidelines; when we entered the system, we would know that the first thing to do was perform hand hygiene. Then upon arrival, we would press the hand hygiene button. At that moment, [I] would feel that it's like providing a well-structured direction for us, guiding us on what to think."* Another student (P3) shared her experience that the virtual simulation training guided her in nursing assessment, and she got a full picture of the problem at the end of the training. She recounted, *"… we are following the thinking mode of virtual simulation. What is to be done first, what is to be done later … so we will gradually unveil the problem of the case throughout the learning process."* The virtual simulation guidance encourages students to think and practice clinical reasoning skills based on accumulated knowledge.

3.2.2 *Motivation*

The students reviewed that when they joined the virtual simulation training, they were immersed in the clinical reasoning cycle, which motivated them to think critically. A student (P12) shared his experience of learning to administer medication to virtual patients: *"… I think that [virtual simulation] would let me take the initiative to seek information …, I must quickly find out about this medicine and its type, purpose, side effects, etc., enabling me to take the initiative to learn further."* Thus, this motivation enabled students to learn/review the names and groups of different medicines consciously.

3.2.3 *Habitual application of clinical reasoning*

According to the software developer, the virtual simulation training was developed based on the clinical reasoning cycle, so that the participants would develop the habit of applying clinical reasoning skills. A student (P6) said, *"[virtual simulation] was most helpful to us not in skills development or*

practice, but in learning how to process and evaluate the situation. . . ." The virtual simulation training guided students to think systematically. It would ask the participants questions such as *"What is the problem?"* The students would then need to reflect on the situation in a cyclical manner, for example, using reflective questions such as *"Right, what did I do?"* "What are the signs and symptoms of the problem?" *"What is the clinical manifestation?"* Subsequently, the students would integrate the answers to all of those questions and review the scenario, analyze the case, identify the problems, and provide interventions. A student (P1) appreciated how he developed a clinical reasoning mindset through virtual simulation. He said, *". . . The system helps me to set the priority.... to build a mindset. Also, I can gain experience, e.g., when I come across this sign and symptom, I would analyze what potential problems might appear. This can train our critical thinking and reasoning. I think this feature of virtual simulation is the most important and makes for the most unique experience."* The students were confident that the clinical reasoning skills acquired through the virtual simulation training could benefit their clinical practice in the future. A student (P4) said, *". . . when I practice nursing skills on the real patient, I would feel very nervous; however, if I have practiced in virtual simulation beforehand, I have a more prepared mindset, at least to handle the nursing care. Even if I am very nervous, I am confident that I would still know how to perform nursing care safely and make fewer mistakes."*

3.3 Preparedness for clinical practice

The students pointed out that the debriefing session was detailed and covered different areas of nursing care, which helped them to reflect on and learn from their experience. This helped them greatly to prepare for future clinical practice.

3.3.1 *Feedback and evaluation*

The students highly appreciated the effectiveness of the debriefing session. A student (P6) said, *"The debriefing session not only summarizes what I have learned but also provides hints for me to think one step ahead. It helped me to reflect on the whole scenario in a logical way, and I can now work on it without the teacher besides me. I can get feedback from the virtual simulator immediately after I finish the game."* In the debriefing sessions, the students' performance was reviewed and practical suggestions provided. A student (P5) expressed, *"The debriefing provided in the virtual simulation training lets me know which procedures might be redundant and which were missed."*

3.3.2 *Preparedness to practice in a clinical setting*

During the pandemic, the students' clinical practicum was halted. This lack of clinical practice for a long duration may cause them stress when the practicum resumes. Virtual simulation training games can provide realistic scenarios that mimic real-life clinical situations and help the students to gain knowledge and develop skills, such as those required in nursing assessment, planning, implementation, and patient communication, before working with real patients. A participant (P5) said, *"We can learn clinical cases in virtual simulation; then when we face real patients in the ward, we won't panic."*

4. Discussion

This study aimed to explore nursing students' experiences of learning through virtual simulation and to gain insights into their process of developing and applying clinical reasoning skills. The students appreciated the experience of learning via the virtual simulation game-like format and enjoyed the geographic and time flexibility that virtual simulation offered. This study confirmed that the instruction, guidance, and debriefing provided through virtual simulation can improve students' clinical reasoning skills, thereby preparing them for the challenging clinical practicum.

First, this study revealed that the game-like format of the virtual simulation training promoted students' engagement in learning. The literature has also shown that game-based learning is highly interactive and engaging, making the learning experience enjoyable and memorable. Gamification has been described as a strategy for increasing knowledge retention while engaging learners in an immersive learning environment,[18] and it is well proven to promote student engagement, critical thinking, enjoyment,[19] and attention.[20]

In this study, game-based virtual simulation provided nursing students with a risk-free and stress-free learning environment. The students expressed that the virtual simulation allowed flexibility regarding time and location and reduced failure of attempts. The students could thus learn at their own pace. These findings are consistent with the literature.[21–23] Previous studies have also reported that virtual simulation reduced students' stress induced by the teachers' presence[21–23] and embarrassment from the mistakes they made.[21]

Virtual simulation has the potential to become a major paradigm in nursing education, given that digital native-generation students are used to applying information technologies daily. Indeed, the virtual reality technology has undergone a significant growth recently.[23] In the future, it may be developed into an interdisciplinary approach, for example, in nursing education to help students learn clinical

skills and enhance communication and quality of health care when working with members of other disciplines.[24,25]

Another objective of this study was to explore students' perceived efficacy of virtual simulation training in developing their clinical reasoning skills. Virtual simulation training provides students with realistic scenarios that they might encounter in a clinical setting. The scenarios are designed to imitate real-life situations to help develop students' clinical reasoning skills in a safe and controlled environment. In the simulated scenario, they make decisions, take actions, and observe the consequences of their actions, which helps them to develop critical thinking and learn to make better decisions in the real-life clinical setting.[10] Another randomized controlled trial reported that virtual simulation training with briefing, simulation, and debriefing enhanced nursing students' knowledge retention and clinical reasoning abilities by 20.4% compared with low-fidelity simulation.[26] A study in Korea that compared the impact of virtual simulation with that of high-fidelity simulation on clinical reasoning indicated that nursing students who received virtual simulation had higher scores in clinical reasoning and problem solving than those who received high-fidelity simulation.[27] Given that virtual simulation for nursing education is specifically designed to enhance students' clinical reasoning skills, its gaming features match the digital natives' interests, making the learning of clinical reasoning fun for them. Our finding is consistent with those of the above-mentioned studies.

Our participants pointed out that the step-by-step guidance provided by the virtual simulator promoted the development and application of their clinical reasoning skills, which may help them prepare for the clinical practicum, especially during the COVID-19 pandemic. To follow social distancing measures and protect the students, most of the on-site clinical nursing training had to be suspended or shortened, forcing nursing academics to update their curriculum to include more online and virtual simulation-based educational training.[28] This would also address students' concerns about interruption of their education.[29] Our findings indicate that the students appreciated the virtual simulation-based learning approach. In particular, they liked the flexibility regarding timing and location and the realistic clinical scenarios that virtual simulation offered. The simulator showed the consequences of their actions and provided appropriate feedback. This helped the students to identify the areas that needed improvement and modification. The teaching faculty can use virtual simulation to provide consistent and timely debriefing for students in the classroom. Additionally, virtual simulation could facilitate students' self-learning and can be adopted in pre-clinical workshops to prepare them for clinical practicum.

With face-to-face classes resumed in the new normal post-COVID-19 era, hybrid teaching that includes the use of innovative technology (virtual simulation) for education has become an indispensable approach. The main goals of the hybrid teaching mode in nursing education are to train nursing students in basic skills, such as communication skills, clinical reasoning, group work, and collaboration, and develop their knowledge and application of the relevant nursing concepts required for real-life clinical practice. The findings of this study suggest that virtual simulation should be integrated into the nursing curriculum to enhance student learning.

This study has certain limitations. It included participants from one local institute only, which limits the generalizability of the findings as they may not be representative of the experiences of nursing students receiving virtual simulation training in other institutes. The research design and recruitment of participants may have led to bias because the participants were limited to those who "showed an interest". It may have missed valuable feedback from passive or less interested students. The qualitative findings were limited to self-reporting and thus may be susceptible to social desirability bias. Further studies are warranted to provide a comprehensive understanding of teaching faculty's experience of instructing students using virtual simulation.

5. Conclusions

This study's findings indicate that virtual simulation training promotes student engagement and learning due to its game-like format and flexible learning environment and enhances students' clinical reasoning skills due to the safe learning environment, thereby preparing them for clinical practice. The students' experiences of learning through virtual simulation were positive, and they appreciated the innovative and interactive learning format. The findings suggest that virtual simulation should be integrated into the nursing curriculum in the post-COVID-19 era. Further quantitative studies are warranted to examine the combined effects of virtual simulation and high-fidelity simulation training on clinical reasoning and critical thinking skills of nursing students. Future studies should further explore the effects of structured virtual simulation training to maximize the effects of simulation in nursing education.

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Authors contributions

The authors' contributions are as follows, BL, JY and KY carried out the study conception and design. JY, OP, PW

and JF conducted the interviews. BL, JY, OP, PW and JF worked together to analysis and interpret data. BL drafted the manuscript. JY and KY critical revised the manuscript for important intellectual content. All authors read, approved and agreed with the final manuscript.

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