Jill Flo*, Kirsten R. Byermoen, Hugrùn Ösp Egilsdottir, Hilde Eide and Lena Günterberg Heyn

Nursing students' experiences of virtual simulation when using a video conferencing system – a mixed methods study

https://doi.org/10.1515/ijnes-2021-0056
Received April 23, 2021; accepted August 20, 2021; published online September 10, 2021

Abstract

Objectives: There is limited knowledge about students' experiences with virtual simulation when using a video conferencing system. Therefore, the aim of this study was to explore how second-year undergraduate nursing students experienced learning through virtual simulations during the COVID-19 pandemic.
Methods: The study had an exploratory design with both quantitative and qualitative approaches. In total, 69 nursing students participated in two sessions of virtual simulation during spring 2020, and 33 students answered online questionnaires at session 1. To further explore students' experiences, one focus group interview and one individual interview were conducted using a video conferencing system after session 2. In addition, system information on use during both sessions was collected.
Results: Changes in the students' ratings of their experiences of virtual simulation with the *Body Interact*™ system were statistically significant. The virtual simulation helped them to bridge gaps in both the teaching and learning processes. Four important aspects of learning were identified: 1) learning by self-training, 2) learning from the software (*Body Interact*™), 3) learning from peers, and 4) learning from faculty.
Conclusions: We conclude that virtual simulation through a video conferencing system can be useful for student learning and feedback from both peers and faculty is important.

Keywords: nursing education; simulation; undergraduate nursing students; videoconferencing; virtual reality.

Introduction

For decades, nursing education has used different types of simulation-based learning to prepare students for their clinical rotations (Aebersold, 2016; Jeppesen, Christiansen, & Frederiksen, 2017). Examples of well-established simulation methods in the clinical skills laboratory are role-playing with students and teachers and simulation with manikins (low-, mid- or high fidelity) (Adib-Hajbaghery & Sharifi, 2017; Shin, Park, & Kim, 2015). In recent years, virtual simulation has developed rapidly (Foronda, Fernandez-Burgos, Nadeau, Kelley, & Henry, 2020; Johnsen, Fossum, Vivekananda-Schmidt, Fruhling, & Slettebø, 2018; Jonson, Pettersson, Rybing, Nilsson, & Prytz, 2017; Padilha, Machado, Ribeiro, & Ramos, 2018; Padilha, Machado, Ribeiro, Ramos, & Costa, 2019). Virtual simulation is a partially immersive, screen-based experience (Foronda et al., 2020), where real people operate screen-based simulated systems that portray virtual patient scenarios for educational purposes (Cant, Cooper, Sussex, & Bogossian, 2019). It is a good complementary pedagogical strategy for teaching clinical reasoning and clinical skills and a learning activity that is well-liked by nursing students (Egilsdottir et al., 2021; Padilha et al., 2019). Over time, virtual simulation can improve knowledge retention, as

***Corresponding author: Jill Flo**, Department of Nursing and Health Sciences, University of South-Eastern Norway, Drammen, Norway, E-mail: Jill.Flo@usn.no. https://orcid.org/0000-0003-3089-9101
Kirsten R. Byermoen, Hugrùn Ösp Egilsdottir, Hilde Eide and Lena Günterberg Heyn, Department of Nursing and Health Sciences, University of South-Eastern Norway, Drammen, Norway. https://orcid.org/0000-0003-1279-2650 (L. G. Heyn)

well as students' satisfaction with learning, and help students develop clinical reasoning skills (Padilha et al., 2019). Using an interactive digital simulation table with a virtual patient (Body Interact™) can be a part of a suit of simulation tools (Verkuyl, Betts, & Sivaramalingam, 2019).

In March 2020, when our university was locked down due to the COVID-19 pandemic, the clinical placements were overloaded, and we were therefore prohibited from welcoming the nursing students in clinical rotation. This applied to unexperienced first-year nursing students, as well as second-year students. The university's response to this challenge was to have students work with a virtual simulator, *Body Interact*™, in a digital classroom as a replacement for clinical hours. In this way, the university could ensure normal learning progression for these students. Furthermore, since the students were not allowed to be physically present at the university, the virtual simulation sessions were carried out using a video conferencing system, namely Zoom, which is a platform for video and audio conferencing, chats and webinars. The focus of the virtual patient scenarios in the virtual simulator *Body Interact*™ (Figure 1) was in line with learning outcomes in each clinical rotation course (first and second year of study).

There is limited knowledge about students' experiences with virtual simulation in a digital classroom using Zoom, and we therefore wanted to investigate students' experiences participating in virtual simulation in this specific context.

Aim

The aim of this study was to explore second-year undergraduate nursing students' experiences of learning during virtual simulation in a digital classroom when using a video conferencing system. The research questions were as follows: a) What were the students' experiences and perceptions of learning in virtual simulation? b) What were the barriers to and facilitators of learning in a virtual simulation?

Materials and methods

Design

The study had an exploratory design using mixed methods. Quantitative and qualitative methods were used to explore the study aim from different perspectives, which strengthens the study design (Creswell & Clark, 2018). To explore student experiences, we collected data through online questionnaires, one focus group interview, one individual interview with a student, and system use data.

Figure 1: Patient scenario in the virtual simulator Body Interact™.

Description of the virtual simulation learning intervention

We used the virtual simulator *Body Interact*™ system, which has a variety of virtual patient cases and a physiological algorithm that creates dynamic clinical situations in which the virtual patient responds to user actions, interventions, or lack of thereof. Students can interact with the virtual patient through dialogues (a choice of specific questions); by monitoring different physiological parameters such as respiratory rate (breath/min), oxygen saturation (%), heart rate (bpm), and blood pressure (mm Hg); by performing a physical examination; and by initiating nursing interventions. It is also possible to consult complementary examinations and prescription(s) of different medical intervention(s) (diagnostic imaging) and/or pharmacological treatment, and to call the "physician" for further instructions. The virtual patient cases offer a dynamic learning environment. Each patient case starts with a short briefing and ends with a debriefing session. The briefings were conducted in a breakout room with the students who were designated active participants. The idea was to create a safe space by pointing out that learning is the result of reflection, not just choosing all the right actions. Immediately after completing the simulation, the system presents different diagnosis alternatives and students are asked to choose the "right" one. There is also a debriefing tool with three categories of information: the simulation report, the simulation timeline, and the performance report. The simulation report presents the correct differential diagnosis and the option chosen by the user, as well as the results of the physical examination and therapeutic activities with scientific references that support the virtual patient case. The simulation timeline shows all actions and their hemodynamic consequences. The performance report gives an overview of students' actions and categorizes them as first priority, second priority or non-prioritized. The report gives the students feedback on their level of knowledge and achieved competencies. In the debriefing, the students reflected upon their assessments and actions coached by the facilitator who also encouraged them to think about what other actions could have benefited the situation.

Before the virtual simulation took place, we invited the students to a webinar introducing and explaining how to use the software, and they were encouraged to train by themselves in preparation for the virtual simulation sessions. About a week before the facilitated group simulation session, three virtual patient cases with the same educational focus were made available to the students. This information was presented in the university's learning management system, Canvas. There were two group simulations; one specific patient case was selected, and the students were informed in advance which case had been selected for simulation in the student group facilitated by faculty. At the beginning of the virtual simulation, three students were appointed by the faculty to actively take part in the simulation; students did not know beforehand who would be chosen. The reason for this was to ensure that all students who participated were prepared. The rest of the students observed the simulation and could contribute with questions or input through the chat function in Zoom. Two experienced faculty members participated; one navigating the software The *Body Interact*™ and the dialogue with the students the other helping stimulate the discussions. The virtual simulation was performed via Zoom. All simulations were video recorded so that the students who participated could go back and watch the virtual simulation afterwards for further learning. Using Zoom as the platform for the virtual simulation made it possible for students and instructors to see each other and to use the chat function; students were encouraged to have the camera on. The sessions lasted 90 min per group.

Participants and data collection

Nursing students in their second year (fourth semester) at a university in Norway participated in the study. Due to the COVID-19 pandemic, clinical placement was not an option so these students were in a theoretical module. In April 2020, a simulation was held using a virtual COVID-19 patient (session1) and in May 2020, a second simulation was held using a virtual surgical trauma patient (session 2); both simulations were situated in a hospital environment. Participation in the simulation was mandatory for the students. A cohort of 36 nursing students simulated in April 2020 (session 1) divided into three learning groups (group A1=11 students, group A2=12 students, and group A3=13 students). In May 2020, 33 nursing students participated (session 2), divided into two learning groups (group B1=15 students and group B2=18 students). The same students participated in both sessions 1 and 2 (three students did not participate in session 2). One week after the virtual simulation, the nursing students in session 2 (groups B1 and B2) were invited to participate in focus group interviews (Figure 2).

The pre- and post-session with Body Interact questionnaire: The instrument used was an online questionnaire created by *Body Interact*™ that consisted of two parts: before (pre) and after (post) the virtual simulation. Both parts included 22 items scored on a 7-point Likert scale either from 1 (totally disagree) to 7 (totally agree), or from 1 (low expectation) to 7 (high expectation). The items had to do with students' individual learning process (six items), the pedagogical process (seven items), and students' expectations of the *Body Interact*™ simulator (nine items). A link to the online questionnaire was sent to the students via email before and immediately after the virtual simulation. In addition, socio-demographic questions (gender, age, work experience before starting nursing education, total years of work experience, other kinds of work experience, amount of work per week in addition to studies) were included in the first questionnaire before the simulation.

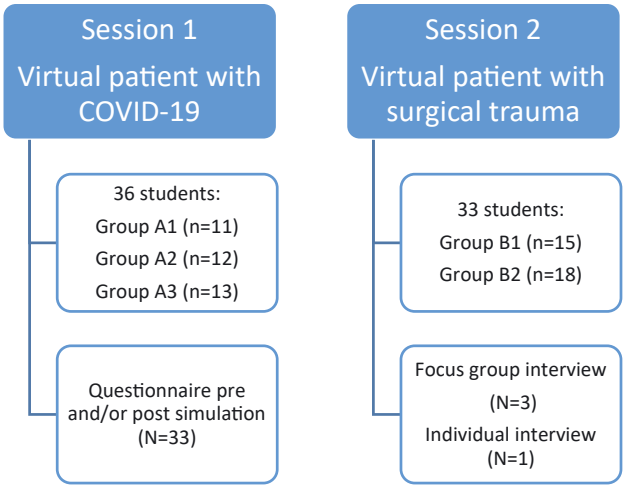

Figure 2: Participants and data collection.

Interviews: A semi-structured thematic interview guide was developed. Data from the qualitative part of the study were collected in a focus group interview with three students and one individual student interview. Both the focus group interview and the individual interview were conducted through Zoom due to COVID-19 and were video-recorded. The interviews were transcribed verbatim.

System data: The virtual simulator *Body Interact*™ also generated system data on the students' performance when simulating individually in preparation for the group simulation sessions. These system data were also used in this study.

Ethical considerations

The participants received written information through Canvas and verbal information before the group simulation started in April 2020. They were informed that participation in the study was voluntary and the online questionnaire was answered anonymously to protect students' identities.

Information about the focus group interview with an invitation to participate was sent to the students that participated in the group simulation (session 2) in May 2020 via email. Due to a low response rate to the first email, a reminder was sent to the students a week later. The videos of the interviews were stored in a secure research domain at the university. The Norwegian Centre for Research Data approved the study (674,624).

Data analysis

Questionnaire data: Statistical analysis of the questionnaires was conducted using IBM SPSS Statistics 26.

Descriptive statistics (Mean, SD) were used, and statistical significance was calculated by paired sample t-test. The significance level was set at 0.05.

Interview data: The qualitative data were analyzed using content analysis in line with Graneheim and Lundman (Graneheim & Lundman, 2004). The transcribed material from the interviews was read several times to gain a comprehensive understanding. The *meaning units* consisted of words, sentences or paragraphs whose content was related to the research question. The next step was *condensation*, a process of shortening the meaning units, and each meaning unit was then given a *code*. Thereafter, the codes were sorted into *categories*. In the final phase, *themes* were created.

Two authors (JF and LGH) conducted the content analysis process and reached consensus following reflection and discussion on shared understanding.

Analyses of the system data: The system data from *Body Interact*™ for the self-training simulation scenarios were analyzed automatically.

Results

Characteristics of the sample

Of the 36 students (groups A1, A2 and A3) who were invited to answer the online questionnaire, 33 (91.7%) students answered both the pre- and post-questionnaires. The students ranged in age from 20 to 41 years old (mean of 24.33), and 23 (69.7%) were younger than 23 years of age; 31 (93.9%) of the students were female. Nine (26.5%) of the students had no work experience, 2 (5.9%) had other health professional backgrounds, 12 (35.3%) were nurse assistants with vocational degrees, and 10 (29.4%) had another type of education. Most of the students (22 or 64.7%), had no experiences of clinical practice. However, 15 (44.1%) of the students worked up to 7.5 h per week in addition to school, and 5 (14.7%) of them worked up to 15 h a week. Of the 33 students, 13 (38.2%) did not work at all. Some students did not complete all items in the online questionnaires before (pre) and after (post) the simulation; therefore, only results from the items that the students answered both pre and post will be presented in the following sections.

No demographic data were collected from the students participating in the interviews in an effort to maintain their anonymity.

Results from the questionnaires

The students' expectations and learning experiences before and after simulation

The students' ratings of their expectations regarding the *Body Interact*™ simulation tool and their evaluation of their learning experiences showed a significant difference in all the items except statement 16 (Table 1). This indicates that the virtual simulator *Body Interact*™ supported the students in identifying learning gaps and bridging gaps in both the teaching and learning processes.

The students rated their individual learning process pre- and post-virtual simulation on a scale from 1 to 7. Only item one showed a significant difference before and after the virtual simulation. However, the ratings on items three to six had a range of 5.2–5.7 pre-simulation and 5.5–6.0 post-simulation, whereas only item two had a low mean (3.8–3.5) (Table 2).

When the students rated their current pedagogical process pre- and post-virtual simulation, there were no significant differences between the items (Q7–11). However, only items 12 and 13 showed a significant difference pre- and post-virtual simulation (Table 3).

Students' self-training – system data from sessions 1 and 2

Data received from the *Body Interact*™ system in April showed that the students completed 79 virtual simulations individually in preparation for the group simulations. The correct diagnosis was assessed in 81% of these simulations whereas all interventions and assessments were managed correctly in only 10%. The physical examination was structured around the airway, breathing, circulation, disability and exposure approach, and the average score was 85%. The diagnostic activity included dialogues and tests, and the average score was 53%. Treatments included medication, interventions, and calls, and the average score was 62%.

Data received from the *Body Interact*™ system in May showed that the students performed 104 virtual simulations. The correct diagnosis was made in 50% of these cases, but all interventions and assessments were managed correctly in only 19% of simulations. The average score related to the physical examination was 73%. In the diagnostic activity, the average score was 54%, whereas in the treatments section the average score was 69%.

Table 1: Students' ratings of their expectations regarding the Body Interact simulator (BI) and their learning experiences after using the simulator.

		PRE			POST		
		n	Mean	SD	Mean	SD	p-Value
14	I expect that BI will help to fill in the learning gaps in the teaching process. (pre) *BI allowed me to bridge the learning gaps in the teaching process. (post)*	25	5.1	1.2	5.6	1.2	0.020*
15	I expect that BI will help to fill in the individual gaps in my current learning. (pre) *BI helped me to bridge my learning gaps. (post)*	25	4.8	1.2	5.6	1.2	0.001*
16	I expect that BI will provide real feedback on my learning. (pre) *BI provided real feedback on my learning. (post)*	23	4.8	1.5	5.4	1.4	0.091
17	I expect that BI will help me identify individual weaknesses in my competencies. (pre) *BI enabled me to identify individual weaknesses in my competencies. (post)*	24	5.2	1.2	5.7	1.2	0.046*
18	I expect that BI will give me clinical experience (through simulation). (pre) *BI gave me clinical experience. (post)*	25	5.2	1.2	6.0	1.1	0.002*
19	I expect that BI will validate the competencies I have already acquired (through simulation). (pre) *BI validates the competencies I have already acquired. (post)*	24	5.3	1.3	5.9	1.1	0.022*
20	I expect that BI will help me practice decision-making strategies. (pre) *BI helped me practice decision-making strategies. (post)*	25	5.6	1.1	6.1	1.0	0.016*
21	I expect that BI transform clinical decision-making errors into constructive learning process (pre) *BI turned clinical decision-making errors into a constructive learning process. (post)*	25	5.7	1.3	6.3	1.1	0.010*
22	I expect that BI will become an important learning tool. (pre) *BI is an important learning tool. (post)*	25	5.4	1.5	6.1	1.2	0.002*

*Indicates significance p<0.05.

Table 2: The students' ratings of their individual learning process.

		PRE			POST		
		n	Mean	SD	Mean	SD	p-Value
1	I am able to organize my reasoning.	24	4.6	0.7	5.3	0.8	0.001*
2	My studies are mainly focused on theory.	18	3.8	1.8	3.5	1.4	0.345
3	My studies balance theoretical studies with the practical application of knowledge.	23	5.7	1.3	6.0	0.8	0.088
4	My learning process allows for suitable development of my communication skills.	24	5.5	0.8	5.8	0.9	0.612
5	My learning process allows me to build my confidence.	25	5.3	0.9	5.6	0.9	0.059
6	My learning process allows me to develop my skills in group and conflict management.	22	5.2	0.9	5.5	1.0	0.110

*Indicates significance p<0.05.

Table 3: The students' ratings of the current pedagogical process.

		PRE			POST		
		n	Mean	SD	Mean	SD	p-Value
7	In my course, the contents are well integrated and connected.	21	4.8	1.3	5.2	0.9	0.119
8	In my course, there are opportunities to apply new learning to practical clinical cases.	24	5.3	1.1	5.9	1.1	0.056
9	In my course, we have the opportunity to participate in clinical situations.	24	6.1	0.9	6.4	0.7	0.110
10	In my course, there is adequate training in communication techniques.	23	5.4	1.2	5.8	0.7	0.119
11	In my course, there is discussion/debate of clinical decisions in a controlled learning environment.	22	5.4	1.0	5.8	0.7	0.083
12	My course helps me build the personal confidence necessary to function as a future professional.	24	5.1	1.1	5.6	1.0	0.004*
13	I consider the teaching method in my course appropriate.	24	5.3	1.3	6.0	0.9	0.004*

*Indicates significance p<0.05.

Findings from the qualitative data

Four themes emerged from the content analyses: 1) learning by self-training, 2) learning from the software (Body Interact), 3) learning from peers, and 4) learning from faculty.

Learning from self-training

All students were prepared before the group virtual simulation. Most of the students said that they had only practiced on the scenario assigned for the virtual simulation, but some had also practiced on the other two virtual patients.

> *I mostly prepared for the one scenario that we would simulate in the group simulation. I did several repetitions of this one to improve my understanding of what actually happens.*

They talked about how this preparation improved their learning outcome by allowing them to try to understand what happened in the scenario before it actually took place in the group. It enabled them to try different approaches and see how the situation played out.

Learning from the software (Body Interact)

The students had mostly positive experiences with the software. They described it as a fun learning activity that provided them with systematic training in a realistic patient situation. Many emphasized how it helped them understand how to assess their patients in a structured way, which was something they hoped to learn.

> *[You learn how to be systematic] from the beginning, when you talk to the patient and then determine what to consider and which assessments to proceed with.*

The students valued the realistic learning opportunity virtual simulation provided a in a situation where they were unable to take part in clinical rotation due to COVID-19 restrictions. They also talked about how the virtual simulation would be a great supplement to the normal clinical rotation as the number of learning situations they might encounter in the different clinical sites could vary.

> *I think the strength is to be able to use it for some time. For example, like now, when we didn't get out in clinical rotation, we got to practice the scenarios. It is not always [the case], even if you are in clinical rotation, that you come across those types of cases. And often we are at different clinical sites, too. So, I think it can provide broader knowledge, and then you get to practice without actually killing a patient in real life.*

The students also talked about some barriers of the software. These were technical, first and foremost, and related to the speed of the software.

> *It seemed to almost overheat the computer. I think it could be a demotivating factor for some.*

Some students pointed out that they were unable to interpret the virtual patients' non-verbal signs and also that they were unable to multitask as they probably would have done in a real situation. The fact that the software was in English and not Norwegian was not seen as a problem for most of the students, although one wished it would be in Norwegian.

Learning from peers

In the virtual simulation session, two or three students were selected to be active participants and the rest were observers. The observers could, however, participate by offering suggestions in the chat function in Zoom. Both observing students and those who were active participants valued this feature.

The group simulation was important, otherwise you would only see your own choices and then you can be stuck and not understand why you should choose one action over another one. It's great to have a platform for discussions.

They talked about the size of the group, and they considered that the best way of being able to participate was if they were no more than 15 students, preferably 10. This was because they valued the teamwork with their peers. They also suggested that they would benefit from taking part in groups with different students rather than fixed groups, as they could learn from different peers' perspectives.

Learning from faculty

Two faculty members were present in the group simulation sessions, one leading the simulation and handling the software and one who took active part in stimulating the debriefing discussions. The students mentioned two reason why facilitation was important: it made the simulation less stressful, and it increased their awareness. When the students simulated as preparation, they were sometimes stressed by the timeline and the fact that they did not know what to do. In the group simulation, the faculty would pause the simulation so students could reflect. This was emphasized as a method that strengthened their understanding and something that would not have been possible in a real situation.

I liked it very much. Because the case on Body Interact often goes fast. Suddenly they are in septic shock and all. But when we stopped, we got to think about it more, and then [faculty's name] asked us some constructive questions as well, so we could connect more information to it instead of stressing ourselves further in the process. And then she could explain. For example, if we had taken X-rays or blood tests, she could explain in detail what we saw – because that is knowledge I don't feel like I have.

The students valued the feedback they received from faculty during the simulation as it gave them increased awareness not only of what to do but of why this was the most suitable action. Also, faculty filled the gaps in their knowledge and helped students think more systematically. The students also appreciated that faculty gave more detailed explanations of what was going on than the software did in the debriefing following the simulation. In fact, several students would have liked the debriefing in the group to be longer.

Discussion

The aim of this study was to use a mixed methods approach to explore second-year undergraduate nursing students' experiences with and perceptions of learning when using Zoom in a clinical virtual simulation. This is an innovative teaching method and research area because different technical methods can be used together giving the students a good learning experience.

One of our findings was that students were able to organize their reasoning after the digital simulation session ($p<0.001$). This is of particular interest as previous literature has shown that nursing students prefer structure in their learning (Hallin, 2014). In our student interviews, the students described how the system, and especially the faculty, helped them to think systematically throughout the virtual patient scenario and how this kind of thinking would be beneficial in clinical rotations. During clinical rotation, nursing students participate in a variety of health care settings and encounter different pedagogical models (Mamhidir, Kristofferzon, Hellström-Hyson, Persson, & ; Manninen, Henriksson, Scheja, & Silén, 2015). Virtual patients provide a learning situation where all students can participate in reflective reasoning with the same faculty member. Given that different clinical supervisors have different pedagogical approaches, virtual simulation would ensure a degree of structure for learning that could be helpful for students in their clinical rotations.

The students in our study also participated in the same learning situations, which is often not the case in clinical rotations where situations can vary widely. This allows for more structured reflections that might strengthen clinical reasoning and be a valuable tool for improving clinical judgement (Weatherspoon & Wyatt, 2012). The system data received from *Body Interact*™ showed that while students simulated by themselves as preparation, they had trouble diagnosing and performing correct interventions and assessments. This was

highlighted in the interviews, where the students verbalized the importance of reflection in action with the faculty. This indicates that group simulation-based learning with faculty and peers is superior to individual digital simulation-based learning.

The novelty of our pedagogical intervention is the fact that the students were able to practice alone as much as they wanted in addition to the group simulation. This allowed students to learn at their own pace and to test their knowledge and fill in the gaps (items 14, 15, and 17). In the interviews, the students explained how this preparation helped them understand what was happening in the virtual patient scenario and play out different interventions. This could explain why the students performed slightly better in May (session 2) than in April (session 1); this finding is also in line with (Aebersold, Tschannen, & Bathish, 2012). There are several areas that nurses need to master, including critical thinking, clinical reasoning, and clinical judgment; they also need to be able to respond quickly to changing clinical conditions (Alfaro-LeFevre, 2017). There is an increasing need to strengthen clinical guidance and supervision, occupational relevance, and motivational learning in a healthcare sector where knowledge is developing rapidly.

As we have both quantitative and qualitative data, our findings provide a nuanced understanding of how learning occurs in virtual simulation. Our qualitative data suggests that learning in large part takes place during briefing and debriefing. The students clearly valued the facilitation from faculty and peers. In addition, the students who were the observers during the group simulations were still able to participate via the chat function in Zoom. This was something the students talked about in the interviews and could be why they felt significantly more confident after the simulation (My course helps me build the personal confidence necessary to function as a future professional, item 12, $p=0.004$). An increase in self-confidence when using virtual simulation was also found in several studies in an integrative review (Foronda et al., 2020). This could be due to debriefing, which yields better retention and deeper learning and increases the likelihood of the transfer of new or reinforced knowledge, skills and abilities to the clinical or broader healthcare setting (INACSL Standards Committee, 2016). However, virtual simulation provides the opportunity to stop and reflect throughout the patient case. This reflection *in* action is in addition to the reflection *on* action that occurs during debriefing. We believe this was an important contribution to the students' learning. Previous literature on virtual simulation has not focused on debriefing practices (Foronda et al., 2020). Hence, further research should look more closely at these practices.

One interesting finding from the qualitative data was that the students suggested mixing up the groups from one simulation to another to be exposed to different perspectives from different peers. This indicates the value of peer support and peer learning. Previous literature indicates that students learn more when they are in a safe setting (Yockey & Henry, 2019). However, a safe setting does not necessarily mean with the same group of students. This was valuable information from the qualitative data, and further research should explore what constitutes a safe learning space. The debriefing phase is emphasized in the International Nursing Association for Clinical Simulation and Learning standards of best practice (INACSL Standards Committee, 2016), and the debriefing may be one reason why the students clearly valued the facilitation.

Strengths and limitations

Few students participated in this study due to the limited time frame, only two sessions were included in April and May. However, with the quantitative, qualitative, and system data from this study, we provide new insight into how students experience virtual simulation in this novel way. The *Body Interact*™ simulation tool developed the self-reported online survey questionnaire used in this study. This can be considered a strength as it makes it possible to compare different classes when using the *Body Interact*™ system. We chose to conduct a focus group interview to get empirical data on a group level with social interaction as the source of data (Halkier, 2010; Parker & Tritter, 2006). This data collection method complements the quantitative data. However, only four students participated in the interviews. This could be because the students had an exam the week after the interview, or because the interviews took place over Zoom. The students that did participate willingly shared their experiences from the clinical virtual simulation, giving us valuable insight.

Conclusion and implications for education

The students' ratings of their learning experiences after the simulation activity showed a significant improvement in several aspects when compared with their ratings of their expectations for virtual simulating with *Body Interact*™ before the simulation activity. Hence, we conclude that virtual simulation over Zoom can be useful for students' learning. The students valued the feedback they received from both their peers and from the faculty and considered it important to their learning. Virtual simulation is a useful pedagogical method that can be beneficial to implement in the nursing education. Although the virtual simulation in this study was a replacement for clinical hours lost due to the pandemic, we see great potential for its use throughout nursing education. Virtual simulation can also be used for teaching and evaluation during clinical rotation and in theoretical courses as a way of combining theoretical and practical knowledge.

Research funding: The research received no specific grant from any founding agency in the public, commercial, or not-for-profit sectors, but was conducted as part of the authors' employment at the University.
Author contributions: All authors have accepted responsibility for the entire content of this manuscript and approved its submission.
Competing interests: Authors state no conflict of interest.
Informed consent: Informed consent was obtained from all individuals included in this study.
Ethical approval: The Norwegian Centre for Research Data approved the study (674624).

References

Adib-Hajbaghery, M., & Sharifi, N. (2017). Effect of simulation training on the development of nurses and nursing students' critical thinking: A systematic literature review. *Nurse Education Today*, *50*, 17–24.

Aebersold, M. (2016). The history of simulation and its impact on the future. *AACN Advanced Critical Care*, *27*(1), 56–61.

Aebersold, M., Tschannen, D., & Bathish, M. (2012). Innovative simulation strategies in education. *Nursing Research and Practice*, *2012*, 765212.

Alfaro-LeFevre, R. (2017). *Critical thinking, clinical reasoning and clinical judgment – A practical approach* (6th ed.). Philadelphia: Elsevier Inc.

Cant, R., Cooper, S., Sussex, R., & Bogossian, F. (2019). What's in a name? Clarifying the nomenclature of virtual simulation. *Clinical Simulation in Nursing*, *27*, 26–30.

Creswell, J. W., & Clark, V. L. P. (2018). *Designing and conducting mixed methods research* (3rd ed.). Los Angeles: Sage Publications.

Egilsdottir, H. Ö., Heyn, L. G., Brembo, E. A., Byermoen, K. R., Moen, A., & Eide, H. (2021). Configuration of mobile learning tools to support basic physical assessment in nursing education: Longitudinal participatory design approach. *JMIR mHealth and uHealth*, *9*(1), e22633.

Foronda, C. L., Fernandez-Burgos, M., Nadeau, C., Kelley, C. N., & Henry, M. N. (2020). Virtual simulation in nursing education: A systematic review spanning 1996–2018. *Simulation in Healthcare*, *15*(1), 46–54.

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*, *24*(2), 105–112.

Halkier, B. (2010). *Fokusgrupper [Focus groups]*. Oslo: Gyldendal Akademisk.

Hallin, K. (2014). Nursing students at a university—a study about learning style preferences. *Nurse Education Today*, *34*(12), 1443–1449.

INACSL Standards Committee. (2016). INACSL standards of best practice: Simulation SM debriefing. *Clinical Simulation in Nursing*, *12*, S21–S25.

Jeppesen, K. H., Christiansen, S., & Frederiksen, K. (2017). Education of student nurses–A systematic literature review. *Nurse Education Today*, *55*, 112–121.

Johnsen, H. M., Fossum, M., Vivekananda-Schmidt, P., Fruhling, A., & Slettebø, Å. (2018). Developing a serious game for nurse education. *Journal of Gerontological Nursing*, *44*(1), 15–19.

Jonson, C.-O., Pettersson, J., Rybing, J., Nilsson, H., & Prytz, E. (2017). Short simulation exercises to improve emergency department nurses' self-efficacy for initial disaster management: Controlled before and after study. *Nurse Education Today*, *55*, 20–25.

Mamhidir, A.-G., Kristofferzon, M.-L., Hellström-Hyson, E., Persson, E., & Mårtensson, G. (2014). Nursing preceptors' experiences of two clinical education models. *Nurse Education in Practice*, *14*(4), 427–433.

Manninen, K., Henriksson, E. W., Scheja, M., & Silén, C. (2015). Supervisors' pedagogical role at a clinical education ward–an ethnographic study. *BMC Nursing*, *14*(1), 55.

Padilha, J. M., Machado, P. P., Ribeiro, A. L., & Ramos, J. L. (2018). Clinical virtual simulation in nursing education. *Clinical Simulation in Nursing*, *15*, 13–18.

Padilha, J. M., Machado, P. P., Ribeiro, A., Ramos, J., & Costa, P. (2019). Clinical virtual simulation in nursing education: Randomized controlled trial. *Journal of Medical Internet Research*, *21*(3), e11529.

Parker, A., & Tritter, J. (2006). Focus group method and methodology: Current practice and recent debate. *International Journal of Research & Method in Education*, *29*(1), 23–37.

Shin, S., Park, J.-H., & Kim, J.-H. (2015). Effectiveness of patient simulation in nursing education: Meta-analysis. *Nurse Education Today*, *35*(1), 176–182.

Verkuyl, M., Betts, L., & Sivaramalingam, S. (2019). Nursing students' perceptions using an interactive digital simulation table: A usability study. *Simulation & Gaming*, *50*(2), 202–213.

Weatherspoon, D. L., & Wyatt, T. H. (2012). Testing computer-based simulation to enhance clinical judgment skills in senior nursing students. *Nursing Clinics*, *47*(4), 481–491.

Yockey, J., & Henry, M. (2019). Simulation anxiety across the curriculum. *Clinical Simulation in Nursing*, *29*, 29–37.