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A Comprehensive Study on Student Perception of Learning Outcomes Using Online Clinical Simulation as an Educational Innovation

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ABSTRACT

Background: During the COVID-19 pandemic, virtual clinical simulation workshops were conducted. It became important to understand students' perceptions of how well they absorbed knowledge through online clinical simulation methodology. **Methods:** We conducted a quantitative, descriptive, cross-sectional, multicenter study. A survey was administered to 3,959 students, evaluating their perception of learning through statements. Stratification using STATS was performed, resulting in a sample of 350 subjects. **Results:** Perception of knowledge was rated higher than 4 out of 5. Students from the Health Faculty perceived that online materials facilitated analysis, understanding, and application of content. Perception of professional development was rated higher than 3 out of 5, and perception of interpersonal skills was rated higher than 4 out of 5. Students considered that using online simulation regularly increased their confidence and reduced anxiety when facing a clinical setting, as well as allowing them to share opinions with other students without feeling embarrassed. **Discussion:** Participants reported that online clinical simulation allowed them to learn theoretical concepts, technical skills, and enhance their critical thinking abilities through distance education combining case analysis and videos. However, further studies are needed to analyze the transfer of online teaching to the clinical setting and other methods of assessing learning.

Keywords: Learning; Perception; Clinical Simulation; Online Clinical Simulation; Knowledge.

Conflict of Interest Statement: No conflicts of interest are reported.

Introduction

In response to the changes in the teaching and learning process during the pandemic, Clinical Simulation as a methodology has undergone transformations. Santo Tomás University has taken on the challenge of adapting its in-person workshops, which involve decision-making, clinical judgment, teamwork, and assessment, to an online modality. This

was done with the aim of ensuring the continuity of student education without unnecessary delays and ensuring the acquisition of knowledge while maintaining the quality, effectiveness, and relevance of teaching according to the curriculum of the Faculty of Health programs.

It is crucial to consider the perception of students, who play an active role in the teaching and learning process and are its central focus. Therefore, the evaluation that students make of their own learning in

the online modality, in terms of knowledge acquisition, skills, and values, is an essential element for the continuous improvement of the Clinical Simulation methodology as a didactic tool in undergraduate programs. [1]

In the field of health, professionals are expected to possess not only technical skills to care for users but also demonstrate an appropriate attitude to do so. These competencies are not developed in a specific subject but are acquired throughout different courses included in the curriculum. [2] By nature, they are the responsibility of the entire academic team. According to León-Castelao, [3] "clinical simulation is a methodology that allows individuals to experience a representation of real healthcare situations with the aim of participating, learning, evaluating, testing, or understanding systems or human actions." This methodology facilitates the integration of knowledge and its learning.

For these reasons, this study was carried out to analyze the perception of Nursing, Occupational Therapy, Kinesiology, and Nutrition and Dietetics students from the Faculty of Health at a national level regarding the learning of knowledge using Clinical Simulation in an online modality. These results will be useful for future research, taking into account the addressed dimensions.

Several authors, such as Chabrera [4], have highlighted that the methodology of clinical simulation contributes to reducing the probability of errors in healthcare, promotes safety and quality in user care, and enhances students' confidence and technical skills. This helps bridge the gap between theory and clinical experience.

Although clinical simulation has shown good results, an emerging issue is the standardization of evaluating students' perception of their learning in simulated scenarios. This is a determining factor and an opportunity for improvement in simulation activities and workshops that are part of undergraduate and postgraduate curricular programs. [1]

Various studies have been conducted to understand students' perception regarding procedural simulation workshops, [1] psychiatric and mental health nursing, [5] and emergency care with multiple victims. [6] These studies were carried out in in-person contexts to demonstrate the benefits of clinical simulation from the perspective of undergraduate students.

The COVID-19 pandemic has caused a shift in the educational paradigm worldwide, with a massive restriction on in-person educational activities. This has led to a reformulation of curriculum contents and the implementation of distance learning modalities, where clinical simulation has changed its format to an online

platform. [7] Given the increasing use of online clinical simulation as an educational methodology, it is necessary to evaluate not only students' performance but also their perception of learning in virtual environments. [8]

Some studies have used focus group interviews to describe the perception of Nursing students regarding the use of virtual simulation as an alternative to clinical practice during the pandemic. [9] Others have described the rapid conversion of interprofessional disaster simulations from in-person to online format, using Internet-based tools that allow real-time collaboration among students from different health disciplines. [10] Interviews, self-assessment, and small group discussions have also been used to describe the perception of nursing students in mental health and psychiatric settings regarding a virtual simulation teaching methodology using online simulations with standardized patients as part of an asynchronous online course. [11]

Virtual clinical simulation has been demonstrated as an effective teaching method, as evidenced in recent studies. One study highlights that distance learning combining seminars and virtual simulations can meet learning requirements in a safe and flexible environment, allowing students to gain theoretical knowledge and develop their clinical thinking ability. [12] To achieve this, a high commitment and academic self-efficacy are crucial. Furthermore, it has been observed that the use of virtual simulation in rural interprofessional teams, through a long-term plan and constant commitment, allows them to be better prepared for serious and low-frequency events, as well as to have continuous access to medical education. [13]

These studies agree that to achieve learning objectives in clinical practice using virtual simulation, high-quality learning experiences are required, which are carefully planned and effectively delivered to students. Additionally, activities must be appropriately selected and connected to learning outcomes, demonstrating the transfer of learning to clinical practice. [14] Peachey, [15] refers to the fact that during health restrictions, online simulation has allowed the continuity of training for qualified professionals. However, having properly prepared facilitators has been a challenge during the pandemic. Each clinical practice required experienced individuals to provide guidance, support, and structure to virtual simulation through prior informational sessions, virtual simulation enactment, and formative phases.

In the development and implementation of virtual clinical simulation, the INACSL standards have been used as a guide. Online simulation has provided students with safe and interactive learning, with fidelity in the representation of clinical scenarios and the possibility to interact with different types of

patients and other students. It has also provided experience in various areas such as psychiatry, cardiology, and emergencies. The interactive team-based approach has fostered collaboration, real-time feedback from experienced professionals, and the opportunity to create a shared mental model among participants throughout the scenario. [16]

The importance of reducing transactional distance is also highlighted, which refers to the social, psychological, and relational distance between teachers and students in distance learning environments. This distance is shortened when there is a fluent and structured dialogue between both parties. [17]

Some studies have shown that students require less time to acquire knowledge using clinical simulation compared to a traditional clinical setting. Although they spend less time applying activities in simulation, they spend more time in the process of recalling what they have learned (the "know-how" according to the Miller's pyramid). [18] Furthermore, it has been observed that interaction with simulated patients in clinical simulation improves communication skills, teamwork, confidence, autonomy, and self-efficacy of students regarding cross-cutting competencies. [13] Although various methodologies and approaches have been mentioned, the analysis of using virtual videos, video conferences, virtual simulated participants, and interactive didactics based on information and communication technologies (ICT) in online clinical simulations has not been highlighted. These tools can have a positive impact on simulated clinical practice as an effective training and learning tool for knowledge acquisition.

Material and Methods

Study Design and Sample Selection

This quantitative, descriptive, non-experimental, cross-sectional, multicenter study is based on the analysis of responses to a questionnaire completed by students from the Faculty of Health at University in Chile, following their participation in online clinical simulation workshops.

A stratified random sampling using random number generation was employed. Using the STATS calculator, it was determined that for a population of 3959 individuals, a sample size of 350 students from the Faculty of Health across the 13 campuses throughout the country (Arica, Iquique, Antofagasta, La Serena, Viña del Mar, Santiago, Talca, Concepción, Los Angeles, Temuco, Valdivia, Osorno, and Puerto Montt) would be appropriate. To stratify the sample by program, a constant fraction of 0.0884 was determined. Accordingly, the total number of students in the Nursing stratum is 245, 22 for Nutrition and Dietetics,

36 for Kinesiology, and 47 for Occupational Therapy. These students participated in the online clinical simulation methodology in the first semester of 2020. Students who did not belong to the Faculty of Health and those who did not take part in online clinical simulation were excluded, which is why programs such as Medical Technology and Speech Therapy were excluded.

Characteristics of Online Workshops

Due to the pandemic, in March 2020, the Faculty of Health at University had to shift to an online format for the semester. In order to continue with the clinical simulation workshops, an international literature review was conducted in March to gather evidence on the outcomes achieved through online or virtual simulation. [19, 20, 21, 22, 23, 24] This evidence supported the notion that learning outcomes can be achieved through activities involving decision-making, clinical judgment, teamwork, and assessment. Building upon this evidence and preserving the learning outcomes, didactic materials (script, pre-readings, workshop format) for the disciplines were transformed into a format that includes videos, sound-enhanced images, and voice recording, using PowerPoint and iSpring Suite software. These materials were then presented to each member of the faculty's management committee, and a decision was made to digitize all workshops that aimed to achieve the aforementioned learning outcomes. This was followed by working meetings with all the expert teachers in their respective fields and clinical simulation, who designed, reviewed, and validated the prepared materials for the activities.

The online simulation workshops were scheduled to be conducted on different days and delivered to each student's homes via the Microsoft Teams software. It is worth mentioning that the facilitators received training in online simulation and Microsoft Teams to deliver the learning experience through the online platform.

Procedure

Considering that the teaching and learning process using this active-participatory methodology takes into account the students' perception of their learning, it became necessary to measure this component (perception) in the simulation workshops once they were completed. After all the online clinical simulation workshops were finished, data were collected from the 13 participating campuses using a questionnaire created by the researchers and administered through an electronic form on Google Forms, which was shared with the study participants via their institutional email addresses. The responses were monitored daily using the same software. To prevent students from submitting multiple responses, only one response per user was allowed.

Data Collection and Analysis

The researchers administered a questionnaire to the participants, which was designed based on the studies by Astudillo, [20] Simón, [22] Hart, [25] and Sotomayor. [26] The questionnaire consists of 15 statements related to the students' perception of the online clinical simulation methodology. Each statement was grouped according to different "types of knowledge" that contribute to competency development: items 1 to 6 correspond to "Knowing," items 7 to 11 to "Knowing How," items 12 to 13 to "Knowing Being," and items 14 to 15 to "Knowing How to Coexist with Others." A Likert-type response format was used, consisting of five response options, ranging from 1 (completely disagree) to 5 (completely agree).

The evaluative scale and final score for each knowledge type were determined using the following criteria: 1 - very poor, 2 - poor, 3 - fair, 4 - good, and 5 - excellent.

The questionnaire underwent content validation by three experts in the field of education and curriculum, based on criteria such as clarity of wording, content, and response induction. A pilot study was conducted with 60 individuals to validate the clarity of the language.

To establish the coefficient of reliability, internal consistency was calculated using Cronbach's alpha, resulting in a value of 0.934, indicating that the questionnaire statements have appropriate reliability. Split-half reliability analyses were also conducted, resulting in a correlation of 0.918 between forms. After correcting with the Spearman-Brown coefficient, the reliability value was 0.957, indicating that the questionnaire is reliable and consistent.

Descriptive reasoning was used for the analysis of the results, which involved measuring the data through frequency tables, measures of central tendency, and dispersion. The data were analyzed using SPSS software, version 0.10.1, April 2016, and the results were presented in tables.

Ethical Considerations

The study was approved by the ethics committee of University, following the criteria of the Helsinki Declaration. [27] Prior to administering the questionnaire, all students provided signed consent to participate in the study.

Participation in the questionnaire regarding students' perception of learning under the online clinical simulation methodology was entirely voluntary and independent. Digital questionnaire files were

stored on a password-protected computer, and physical files were kept in a locked cabinet in the researcher's office. After five years, the stored data will be deleted.

Results

The 350 students who constituted the sample participated in online clinical simulation workshops, and none of them refused to take part in the study. They all belong to the Health Faculty of Santo Tomás University at a national level. The program with the highest participation, calculated by stratum, is Nursing with 245 students (70%), followed by Nutrition and Dietetics with 47 students (13%), Physiotherapy with 36 students (10%), and Occupational Therapy with 22 students, corresponding to 6% (see Table I).

The statements regarding the perception of the "Knowing How" competence in the learning developed through online Clinical Simulation yielded an average score above 4.2 out of 5 (SD 0.84). According to the students' responses, the audiovisual material used in the simulation sessions facilitated the analysis and comprehension of the content, allowing them to place it in a context similar to real-life situations and enhancing their learning (see Table II).

The "Knowing How to Do" competence resulted in an average score of 4 out of 5 (SD 0.860). Students perceive that online clinical simulation enabled them to apply the knowledge and skills acquired in different clinical situations, prioritize activities, and make correct decisions regarding patient care (see Table II).

The students' perception of the "Knowing How to Be" competence yielded an average score of 3.7 out of 5 (SD 1.004). According to the students' responses, they consider the increase in confidence and reduction of anxiety when facing a real clinical environment through the use of online clinical simulation to be moderate (see Table II).

The "Knowing How to Coexist" competence resulted in an average score of 4.2 out of 5 (SD 0.916). According to the students' responses, online clinical simulation allowed them to share opinions with group members without feeling embarrassed, thereby fostering communication among them (see Table II).

Overall, the variability of the data is small, indicating that the dispersion of the data is lower among each grouping of statements representing each competence.

Table I: Participation by career of the national Faculty of Health.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Nursing	245	50	70	70
	Kinesiology	36	7,3	10,3	80,3
	Occupational Therapy	22	4,5	6,3	86,6
	Nutrition and Diet	47	9,6	13,4	100
	Total	350	71,4	100	
Missing	System	0	28,6		
Total		350	100		
Statistics	Valid	Missing	Mean	Median	Mode
	350	0	1,63	1	1

Table II: Mean scores of the statements grouped by competence.

affirmations	Mean	Std. Deviation	C. of variation	Competence
The online clinical simulation was performed in a logical and sequential order (introduction, scenario execution, closure).	4,37	0,92	21	KNOW Mean: 4,2 (DE 0,841) C. variation: 20
The audiovisual material used in the simulation sessions made it easier for me to analyze and understand the contents.	3,92	0,97	25	
The scenarios developed during the online clinical simulation allowed me to situate myself in a context similar to reality.	3,33	1,238	37	
In the online clinical simulation, the debriefing (discussion guided by the teacher) allowed me to externalize feelings, as well as the development of a critical and reflective analysis of the simulation actions.	3,97	0,948	24	
The Learning Results proposed in the simulation activity were fully developed.	3,9	1,008	26	
In general, the experience of working with online clinical simulation improved my learning.	3,46	1,149	33	
The online clinical simulation will help me prioritize the activities to be carried out with the user, for safe and quality care.	3,66	1,129	31	KNOW TO DO Mean: 4,04 (DE 0,860) C. variation: 21
The online clinical simulation has allowed me to apply the knowledge acquired in the chair.	3,83	0,99	26	
Online clinical simulation will allow me to improve my ability to apply knowledge and skills in different clinical situations.	3,57	1,062	30	
The online clinical simulation will allow me to make correct decisions regarding patient care.	3,63	1,006	28	
During the online clinical simulation, I received real and accurate feedback from the professor, which will allow me to improve my performance in similar clinical situations in the future.	3,98	0,987	25	
Practicing the online clinical simulation will increase my confidence and reduce my anxiety to face the real clinical environment.	3,12	1,231	39	KNOW TO BE Mean: 4,04 (DE 0,860) C. variation: 27
Online clinical simulation allows errors to be used as learning tools in a safe environment.	3,95	1	25	

During the online clinical simulation, I was encouraged to share my opinion with group members, without feeling embarrassed or humiliated.	4,18	0,927	22	KNOWING TO LIVE TOGETHER Mean: 4,15 (DE 0,916) C. variation: 22
Online clinical simulation favors communication and participation among group members.	3,82	1,07	28	

Discussion

In light of the proposed objectives aimed at analyzing the perception of learning through the methodology of online clinical simulation, it can be mentioned that this online tool has been used as a substitute for in-person simulation, improving student performance, patient safety, accessibility at all times and places, and ensuring person-centered learning. [9] However, in recent years, its use has significantly increased in all healthcare disciplines, making it imperative to evaluate learning from the students' perspective. Although there is evidence that evaluates the perception of learning using online clinical simulation, the results mainly focus on the acquisition of technical skills, [10, 11, 12] and this study allows for a breakdown of competencies through knowledge, where students discern the achievement of skills in decision-making, critical thinking, and clinical judgment.

Students reported perceiving the competency of knowledge as effective, which translates into better analysis and understanding of theoretical content. This aligns with the findings of Kuszajewski [16] and Rhim, [17] who demonstrated that online simulation allows for safe and interactive learning but emphasized that the acquisition of this competency at a distance depends on three fundamental concepts: presence, transactional distance, and independent learners. The present study adds the concepts of standardization and structure in the design of simulations, considering the execution of workshops at a multicenter and national level. Luo [12] corroborates that online clinical simulation led to an improvement in clinical thinking ability. Students showed high levels of academic self-efficacy and student engagement and expressed great satisfaction with the transformation of the methodology. However, our study demonstrates that achieving this requires interactive audiovisual material and pre-recorded videos with simulated patients that contribute to learning outcomes.

Regarding the competency of skill, students perceive that it is achieved by applying the acquired knowledge and skills in different clinical situations, prioritizing activities and making correct decisions regarding patient care. This confirms previous research with undergraduate students, who also reported that online clinical simulation enhances the

ability to perform activities in real clinical settings, understanding that procedural skills are not achieved through this online methodology. [10, 18] Our study demonstrates that this skill is based on demonstrating performance based on procedures and strategies; therefore, it cannot be separated from the knowledge base, where students base their actions on criteria and analysis in decision-making. Furthermore, the constant delivery of feedback by the facilitator throughout the workshop execution process must be considered.

Students perceive that the competency of personal development can be acquired through online simulation when they increase their confidence and reduce anxiety in facing the clinical experience and learning from errors in a controlled environment. Trained facilitators play a fundamental role in this process. It can be inferred that the prebrief and brief stages are critical in developing this knowledge, as they create a space of trust where students communicate their expectations and experiences, which complements session learning without fear. Studies by Chabrera [4] and Peachey [15] indicate that clinical simulation increases self-confidence and that achieving it requires trained teachers who facilitate the learning process.

Regarding the competency of interpersonal skills, it is necessary for students to interact with others through the online platform, where facilitators must encourage communication in an environment of trust and respect so that students can participate safely. The more they are exposed to working with simulated patients in high-fidelity online scenarios, the more they will acquire this competency. Orjuela [2] and Reece [13] state that through peer interaction, students improve communication skills, teamwork, confidence, autonomy, and self-efficacy, which are dimensions that contribute to this competency.

Conclusion

Given the shift from in-person clinical simulation to online format, it has been identified, from the students' perception, that it allows for the development of knowledge. Online Clinical Simulation workshops offer, from a cognitive aspect, the possibility for students to prioritize disciplinary activities, apply knowledge and skills in different clinical situations,

and make decisions regarding patient/user care. However, the execution of motor or kinesthetic skills cannot be replaced through this modality.

Another key factor is the way in which the facilitator provides group feedback, encouraging student participation in the discussion surrounding the case presented during the simulation workshop. This highlights the importance of having facilitators trained in this modality.

The results obtained in this research indicate the need to study the transfer of knowledge in a face-to-face clinical environment, as well as the facilitator's self-efficacy as a relevant factor in competency acquisition.

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