

# Online-Synchronized Clinical Simulation: An efficient teaching-learning option for the COVID-19 pandemic time and beyond.

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## Research Article

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# Abstract

**Introduction:** A powerful methodology for teaching, learning, and researching is clinical simulation, which has positioned itself in recent decades in health science education. However, due to the COVID-19 pandemic, social distancing has forced institutions to leave simulation centers and make use of new alternatives that allow the continuation of educational programs through virtual environments.

**Methods:** We carried out a before-and-after design study that used online-synchronized clinical simulation (OSCSim) in three Latin American clinical simulation centers (Colombia, Ecuador, and Mexico). The educational intervention included briefing, COVID-19 simulated cases, and structured debriefing through a meeting platform. We assessed the participants' learning and performance in diagnosis, treatment, and nontechnical skills for the management of patients with COVID-19. Satisfaction and learning perception were measured. The debriefing quality was evaluated from the student's perspective.

**Results:** We had 106 participants. 46.2% from Colombia, 31.1% from Mexico, and 22.6% from Ecuador. A total of 51.9% were men, and the median age was 23 years (IQR: 22-26). A total of 34.9% were fourth-year students of medicine, 38% were fifth-year students, and 21.7% were anesthesia residents. Fourteen OSCSim sessions were performed; cognitive engagement was 43.4%, mainly interactive. A relationship was found between cognitive engagement, learning, situational awareness, and realism in the simulation. The quality of debriefing was ranked high by the participants, and they also agreed with the OSCSim methodology.

**Conclusion:** OSCSim is an active and social learning activity that enables training and improvement of nontechnical skills and declarative knowledge about COVID-19 management. Nevertheless, it needs to be complemented in the procedural aspect in simulation centers.

## Introduction

Clinical simulation is a teaching, learning and research strategy that has achieved an important place in health science education (1,2). This educational methodology attempts to represent reality without putting patients at risk. It is constantly developed by working with learning theories, didactics, cognitive psychology, industrial engineering, technology, and human resources (3–5).

In these times of the pandemic caused by coronavirus disease 2019 (COVID-19) (6), social distancing forced universities and training centers to close their classrooms and migrate to virtual environments (7). An estimated 1.3 billion students withdrew from their daily academic routines in 186 countries, including all of Latin America (8). According to UNESCO, this represents 70% of the worldwide student population (9). The pandemic has accelerated the digital transformation of medical education, allowing students to review concepts and build knowledge through webinars and other virtual strategies without having to suspend classes or expose themselves to the risk of contagion. Nevertheless, it has limitations that are perceived by students, mainly those who should already be in clinical practice, possibly affecting their motivation to learn (10,11).

Non-presential simulation has been developed in the last decade with terms such as remote simulation (12,13), online simulation, which can be synchronous or asynchronous (14), and telesimulation (15,16), among others. These presents promising results in student satisfaction, concept learning, and psychomotor skill development when a task trainer is available. During this pandemic, non-presential simulation began to be used more frequently in Latin America to maintain the teaching-learning processes in medical schools; nevertheless, the limitations of virtual environments can have a negative impact on the learning of medical students in low- and middle-income countries, where the available technological and connectivity resources are possibly fewer due to the existing inequality (17).

We carried out a study with online-synchronized clinical simulation with the help of information and communication technologies in undergraduate and graduate medical students from three Latin American countries. The aim was to evaluate the learning and performance of students faced with cases of COVID-19 and determine the quality of the online structured debriefing.

## Methods

We conducted a before-and-after study with a mixed design between 13 and 25 May 2020 in three Latin American clinical simulation centers (Colombia, Ecuador, and Mexico). A simulation-based educational intervention with cases related to COVID-19 was proposed in both the emergency room (ER) and the operations room (OR).

The main objectives of the study were to evaluate the learning and performance of the participants in the diagnosis, treatment, and nontechnical skills for case management of patients with COVID-19 during online simulation in real time.

The secondary objectives were to determine the satisfaction level that medical students and residents had regarding the webinar-based education they received during the pandemic and the perception of learning with the OSCSim strategy. In addition, the quality of structured debriefing from the student's perspective was evaluated.

### *Instruments*

Six simulation cases related to COVID-19 were designed:

*Colombia:* Case 1: Young woman with upper gastrointestinal bleeding due to NSAIDs. Background of mild cough, headache, unquantified fever, and contact with a patient with severe respiratory symptoms. Case 2: Elderly male patient with respiratory distress, cough, fever, and anosmia. Admitted to ER in shock and acute respiratory failure.

*Mexico:* Case 1: A 76-year-old man with heart disease has had a hip fracture for two weeks on treatment with ketorolac. He was admitted to the emergency room for abdominal pain, upper gastric bleeding, and unquantified fever. Case 2: A 68-year-old man, diabetic, smoker, and multiple allergies. He was admitted to the ER with acute respiratory failure and high fever.

*Ecuador:* Case 1: A 32-year-old woman who was 40 weeks pregnant was admitted to the operating room for respiratory failure and loss of fetal well-being. Case 2: A 39-year-old woman who was 36 weeks pregnant was admitted to the operating room with placental abruption and respiratory failure.

Laerdal's ALS® and SimMom® simulator patient monitors were used, which were already present in our simulation centers prior to the pandemic. The data from these simulators was shared through the Zoom® video-meeting platform (Zoom Video Communications, Inc. USA). The teachers and students were at home during the online simulation scenarios.

The briefing was carried out; the simulated scenarios were developed in teams. Standardized patients and actors were present for the simulation. A structured debriefing session was held after each simulated case.

We used a 9-point performance scale (1: Very, very poor; 9: Very, very good), and the evaluators were trained in the usage of this scale. The participants' cognitive compromise was evaluated in accordance with the ICAP framework (interactive, constructive, active, and passive) (18).

To understand the perception of learning and quality of the educational intervention, we designed an instrument made up of three parts. The first part consisted of two five-point satisfaction scales for participants to rate both the online activities based on conferences (webinars) and the online-synchronized clinical simulation received. It also contained two open questions for participants to express their takes on the strengths (question A) and weaknesses (question B) of the OSCSim. For the second part, we developed a Likert-type survey of 20 statements and five options (1: Totally disagree; 5, Totally agree) related to the perception of learning with the implemented methodology.

The third part consisted of the Debriefing Assessment for Simulation in Healthcare (DASH)® Student Short-form scale, which was used to assess the quality of debriefing. This scale contains six elements that encompass the instructor's behaviors: Introduction to the simulation environment, the engaging context for learning, organized debriefing structure, provoked reflection of performance, identification of what was done well and poorly, helped determine how to improve or sustain good performance. Element ratings are based on a

7-point effectiveness scale (1: extremely ineffective/detrimental; 7: extremely effective/outstanding) [17]. The students were instructed in its use. Both instruments were sent to participants in Google Forms® (Google LLC, USA).

### *Pilot*

For the pilot, we carried out the cases and the OSCSim inventory. The Likert scale was consistent, with a Cronbach's alpha of 0.73.

### *Statistics*

Atlas. Ti V8.1 (Scientific Software Development GmbH, Germany) software was used for the qualitative analysis of open questions related to OSCS strengths and weaknesses. Statistical analysis was performed in SPSS 26® (IBM, USA). The normality of the distribution of the data was evaluated with the Kolmogorov-Smirnov test, the qualitative variables were summarized with proportions, and the quantitative variables were summarized with measures of central tendency and dispersion; statistical significance was expressed as a function of  $p. <0.05$ .

### *Ethics*

Participation was voluntary, and all participants were informed about the characteristics and scope of the study. They signed an informed consent form. This work did not represent any type of economic incentive for the participants or researchers. A committee of ethics in research approved the study.

## **Results**

### *Sample*

We had 106 participants. 46.2% from Colombia, 31.1% from Mexico, and the remaining 22.6% from Ecuador. A total of 51.9% were men, and the median age was 23 years (IQR: 22-26). Regarding the academic level, 34.9% were fourth-year students of medicine, 38% were fifth-year students and 4.7% were 6-year students. 21.7% were anesthesia residents.

### *Times*

14 Online Synchronized Clinical Simulation (OSCSim) sessions were performed with a total duration of 25.1 hours with a mean of 102.7 minutes. In each session, two clinical cases were executed with structured briefing and debriefing. The relationship of debriefing time with simulation time (D/S index) was 1.33. In Table 1, we present the educational activities' times.

### *Performance*

Two evaluators in each center assessed the performance of the participants in session one and session two; this is summarized in Table 2. No difference in performance was found by sex. However, a statistically significant difference was found by educational level, which was greater before and after the intervention in the anesthesia residents ( $p < 0.05$ ). The cognitive engagement was Passive: 10.4%, Active: 11.3%, Constructive: 34.9% and Interactive 43.4%

### *Perception*

Out of the 106 participants, 100 answered the survey (94.3%), and the characteristics of the respondents were very similar to those of the original sample. The satisfaction score for webinar-based education during the COVID-19 pandemic was lower than that for OSCSim: 3 (IQR: 3-4) vs 5 (IQR: 4-5). A difference by country was found, being lower in Colombia for online education ( $p < 0.001$ ), and the level of satisfaction with OSCSim was lower in Mexico ( $p = 0.021$ ).

A high agreement level was found with the Online-Synchronized Clinical Simulation inventory in all its items (Figure 1). This instrument showed good internal consistency with a Cronbach's alpha of 0.87.

The questions were grouped into four categories: realism, learning, nontechnical skills training (NTS), and active learning strategy (ALS). The answers were grouped into three agreement levels: low, middle, and high. The level of agreement was mainly high: realism (88%), learning (89%), NTS training (94%), and ALS (95%).

No statistically significant difference was found for age, sex, or educational level. Differences were found by country in the perception of realism ( $p = 0.030$ ) and learning obtained ( $p = 0.037$ ), being lower in Mexico. However, this was not true for the perception of nontechnical skills training ( $p = 0.12$ ) or active learning ( $p = 0.8$ ).

### *Debriefing assessment*

The evaluation of the debriefing's quality was high (Figure 2). No significant differences by sex or age were found. Fourth-year students and resident physicians rated element 1 higher than fifth- and sixth-year students ( $p = 0.023$ ). In the analysis by country, in Colombia, the scores were higher for element 1 ( $p < 0.001$ ), element 2 ( $p = 0.04$ ) and element 3 ( $p = 0.033$ ). No statistically significant difference was found for the other elements.

### *Bivariate analysis*

In the bivariate analysis, a correlation was found between cognitive engagement and the categories related to simulation-based learning, being stronger with realism ( $p < 0.001$ ). Another correlation was found between cognitive engagement and performance, which was stronger with communication ( $p < 0.001$ ). In Table 3, we summarized the correlations with Spearman's Rho.

### *Qualitative analysis*

Open and selective coding of the texts written by participants (n: 100) was carried out. Regarding the strengths, 12 codes were found that represented the students' thinking, with 256 citations. Forty-one percent of the students highlighted realism, and 36% highlighted social interaction (Figure 3). The most common code concurrences were found between perception of realism and real-time interaction (26 concurrences), realism and theory-practice integration (13 concurrences), and realism with the opportunity to carry out social practice (10 concurrences).

Regarding the weaknesses of online-synchronized clinical simulation, 36.4% of students recognized the intermittency of communication due to the saturation of the platform when they spoke at the same time, 35% described the dependence on internet speed, and 32.3% considered the lack of practice of motor skills such as orotracheal intubation, donning and doffing of personal protective equipment, among others, as a limitation (Figure 4). No strong concurrences were found.

## **Discussion**

The COVID-19 pandemic has become a great challenge for humanity. Social distancing is a measure of protection against contagion; nevertheless, it pushed us out of our comfort zone. In the teaching and learning processes, it forced both teachers and students to adapt in a short time to continue building knowledge through new mediums.

One of the main actions undertaken to face this crisis was the transfer of health sciences education to virtual settings through webinars on conference platforms and social networks. (9,19). In our study, we found a low level of satisfaction with this methodology. In contrast, a high level of satisfaction was found for learning with online-synchronized clinical simulation. This can be explained from the qualitative analysis by the interaction and the social practice that gave participants the possibility of making decisions and integrating the theory with the practice.

An interesting finding with this interactive methodology was the time needed to achieve the learning objectives. OSCSim requires more time than we used in face-to-face simulation for case development. The debriefing time

was similar to that we used in the simulation center. However, the debriefing and simulation relationship was lower than that found in another study (20). This could be due to the participants describing what they did during the online simulation and the turns taken to speak.

Clinical simulation is possibly superior to traditional passive educational practice for developing skills and integrating learning (3,21,22) because it has had an essential technological advance to emulate clinical environments (23). Nonetheless, the evidence is not conclusive with more fidelity of the simulators, more learning is achieved (24), and similar results were found in other studies with online simulation (14,15). This is consistent with our study. The perception of realism was high; we think that this was due to the great social interaction in real-time with peers, standardized patients, staff, immediate feedback shown on hemodynamic monitoring, and complementary diagnostic aids, which was favored by the briefing and structured debriefing.

The posttest learning levels were high, which corresponded to the perception of learning, this is perhaps more related to constructive and interactive cognitive engagement, social interaction and the environment created by the instructors during the briefing and debriefing (25).

Crisis management requires the development of nontechnical skills (NTS), such as communication, leadership, and situation awareness (26,27). In the COVID-19 pandemic, the NTS is needed for patient and healthcare workers' safety (28–30). The cognitive load of healthcare professionals is high. Procedures such as airway management and donning-doffing personal protective equipment increased the intrinsic cognitive load and the risk of contagion. Interaction with others and gaps in communication increased the extrinsic cognitive load. Training with clinical simulation is helpful in minimizing cognitive load and improving efficiency (31), with special usefulness during the COVID-19 pandemic.

In this work, the declarative component of knowledge about safe airway management and the correct use of PPE as well as mastery of communication strategies and situational awareness improved significantly. This we attribute to the changes in the conceptual model of biosafety of the participants, the use of checklists for donning and doffing, distributing the attention, using the strategy of pause and think, making a call to the sterile cockpit, and improving the closed communication loop.

The online debriefing (teledebriefing) in this work obtained a very good rating from the students, this is consistent with the study by Ahmed et al., who carried out teledebriefing, which was evaluated using the DASH scale in the student version with satisfactory results (32).

## Limitations

This study had some limitations: the dependence on the quality of the internet could be involved in the low cognitive engagement of some participants; however, the evaluation of the activity was high. The sample consisted only of physicians and medical students. Although the study was multinational, for each country, only one center participated. A fundamental limitation was that only the declarative aspect of the procedures could be worked on. The limitations of this work can be addressed in future studies with a multidisciplinary sample, with more centers participating in each country, and with a performance evaluation after the online simulation in the simulation centers.

## Conclusion

The COVID-19 pandemic has promoted social distancing and online conference-based education. Nevertheless, the level of student satisfaction tends to decrease with this methodology. Active learning is required in health sciences education.

Online-synchronized clinical simulation can be performed, reaching high levels of learning; for this, it is essential to do an adequate briefing, allocate more time for cases and carry out structured debriefing, as would be done in the face-to-face simulation.

Online-synchronized clinical simulation is an active and social learning activity that enables the training and development of nontechnical skills, as well as improving declarative knowledge of medical students, without increasing costs or sacrificing the perception of realism by learners during the COVID-19 pandemic, and an efficient alternative for teaching and learning in health sciences in the new normalcy. Nonetheless, in a face-to-face modality, the procedural aspects must be complemented in the simulation centers with appropriate biosafety protocols.

These findings should be tested in other studies.

## Declarations

**Statement of ethics approval:** This study was approved by the research ethics committee of the VitalCare Clinical Simulation Center with registration # CEIC-005-05-2020.

**Competing interests:** The authors declare no competing interests

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## Tables

|                             | Briefing 1  | Case 1       | Debriefing 1 | Briefing 2  | Case 2       | Debriefing 2 |
|-----------------------------|-------------|--------------|--------------|-------------|--------------|--------------|
| <b>Colombia</b>             | 4.08        | 21.24        | 24.16        | 2.09        | 22.53        | 25.90        |
| <b>México</b>               | 5.63        | 20.38        | 32.15        | 2.87        | 20.51        | 34.40        |
| <b>Ecuador</b>              | 2.83        | 18.00        | 25.00        | 1.07        | 21.00        | 23.00        |
| <b><math>\bar{x}</math></b> | <b>4.18</b> | <b>19.87</b> | <b>27.10</b> | <b>2.01</b> | <b>21.35</b> | <b>27.77</b> |

**Table 1.** Educational activities time.

|                      | Case 1 |     | Case 2 |     |
|----------------------|--------|-----|--------|-----|
|                      | Median | IQR | Median | IQR |
| <b>Performance**</b> |        |     |        |     |
| Diagnosis            | 4      | 3-6 | 8      | 7-8 |
| Treatment            | 4      | 3-7 | 8      | 7-9 |
| Donning*             | 3      | 1-5 | 8      | 7-8 |
| Doffing*             | 3      | 1-5 | 8      | 6-9 |
| Awareness            | 4      | 3-6 | 8      | 7-8 |
| Communication        | 4      | 4-5 | 7      | 6-8 |

**Table 2.** Performance (Wilcoxon test) at different components of simulation.

\*\*In all comparisons  $p < 0.001$  was found.

\* Performance in donning and doffing was evaluated from the declarative aspects of knowledge.

| <b>Learning</b>                           | <b>Rho</b>  | <b><i>p</i></b>  |
|---|-------------|------------------|
| Learning - Cognitive Engagement           | 0.30        | <b>0.007</b>     |
| Learning - Realism                        | <b>0.60</b> | <b>&lt;0.001</b> |
| Learning - NTS Training                   | 0.30        | <b>0.002</b>     |
| Learning - Active Learning Strategy       | 0.28        | <b>0.003</b>     |
| <b>Cognitive Engagement - Performance</b> |             |                  |
| Cognitive Engagement - Diagnosis          | 0.28        | <b>0.004</b>     |
| Cognitive Engagement - Treatment          | 0.45        | <b>&lt;0.001</b> |
| Cognitive Engagement - Donning            | 0.30        | <b>0.002</b>     |
| Cognitive Engagement Doffing              | 0.30        | <b>0.002</b>     |
| Cognitive Engagement - Awareness          | 0.45        | <b>&lt;0.001</b> |
| Cognitive Engagement - Communication      | <b>0.71</b> | <b>&lt;0.001</b> |

**Table 3.** Bivariate analysis of the components for simulation. In bold, the high correlation and differences are statistically significant.

## Figures

## Online-Synchronized Clinical Simulation Perception Inventory

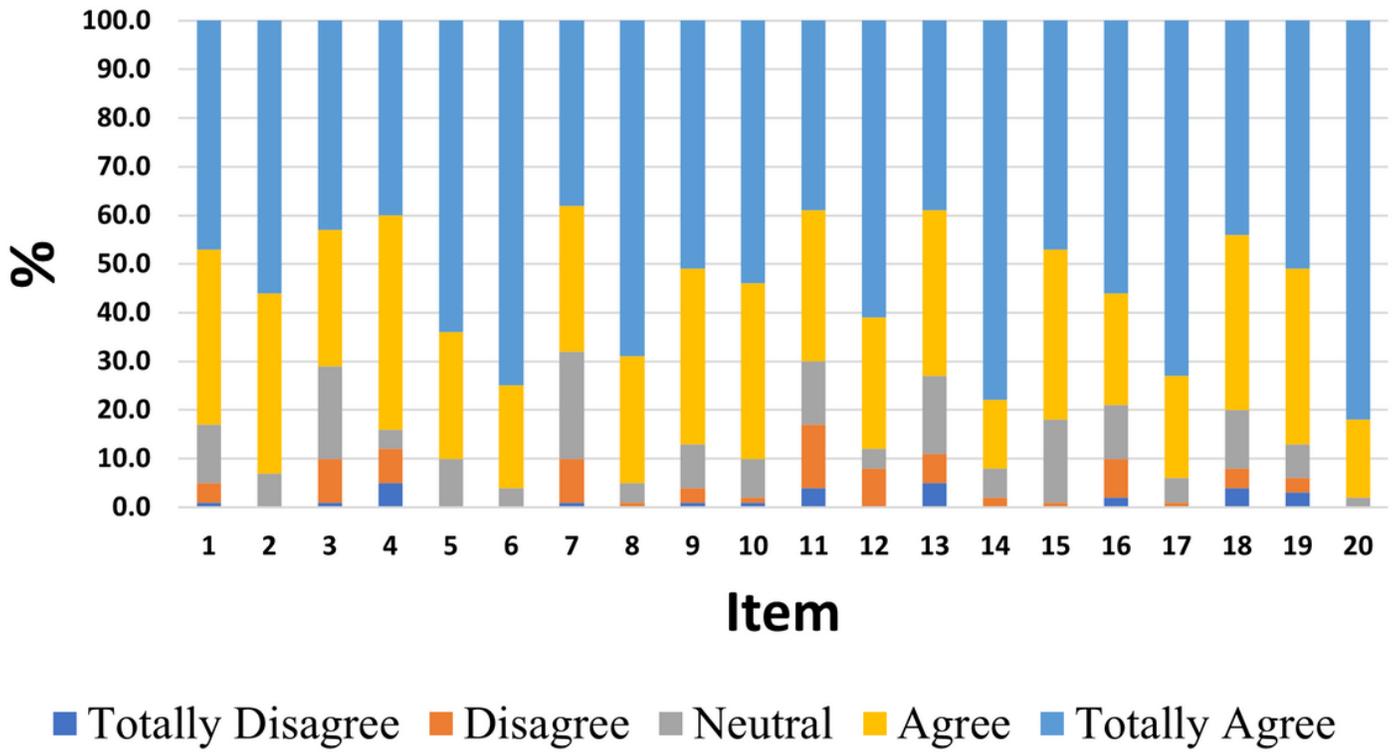
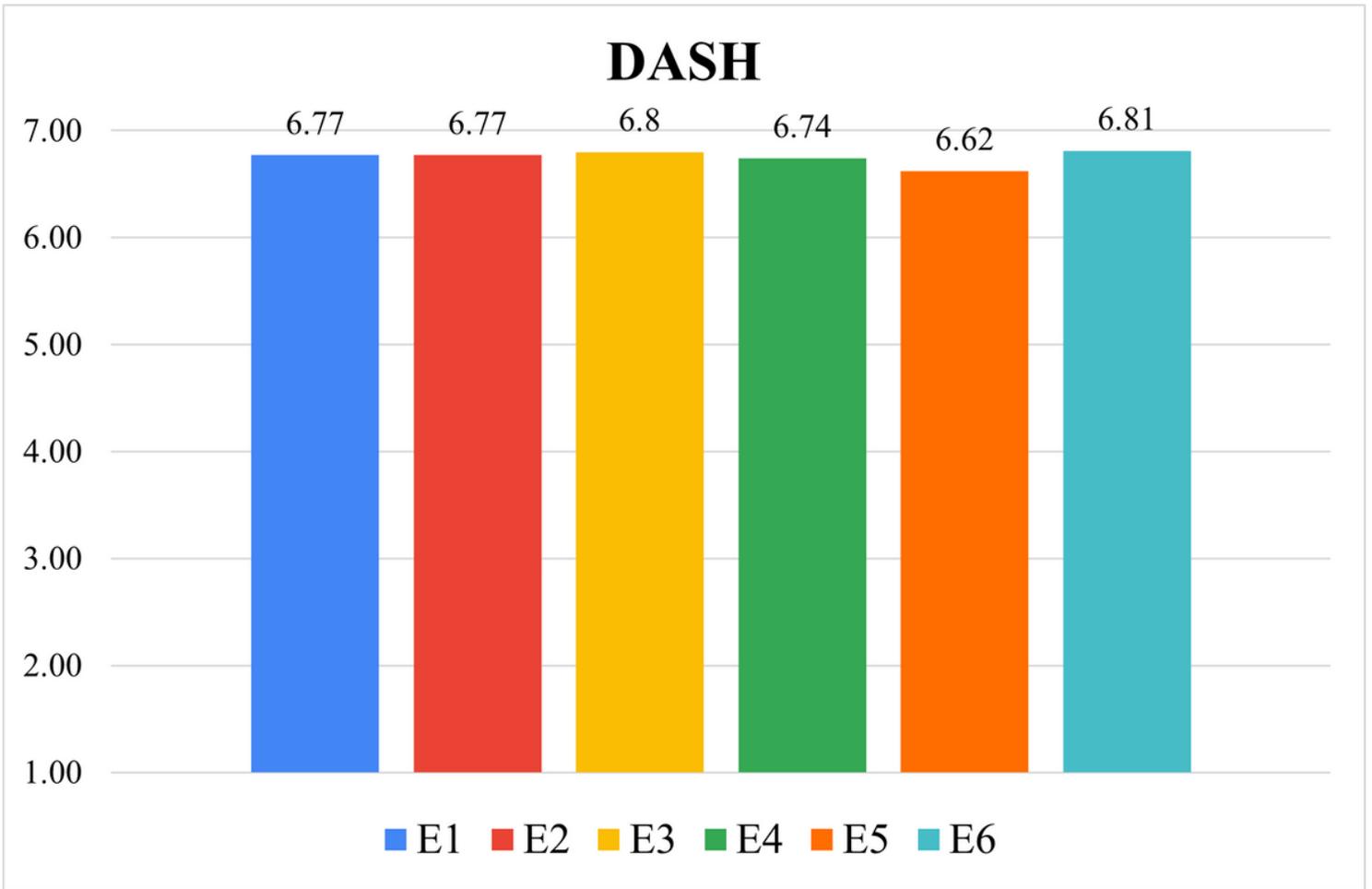


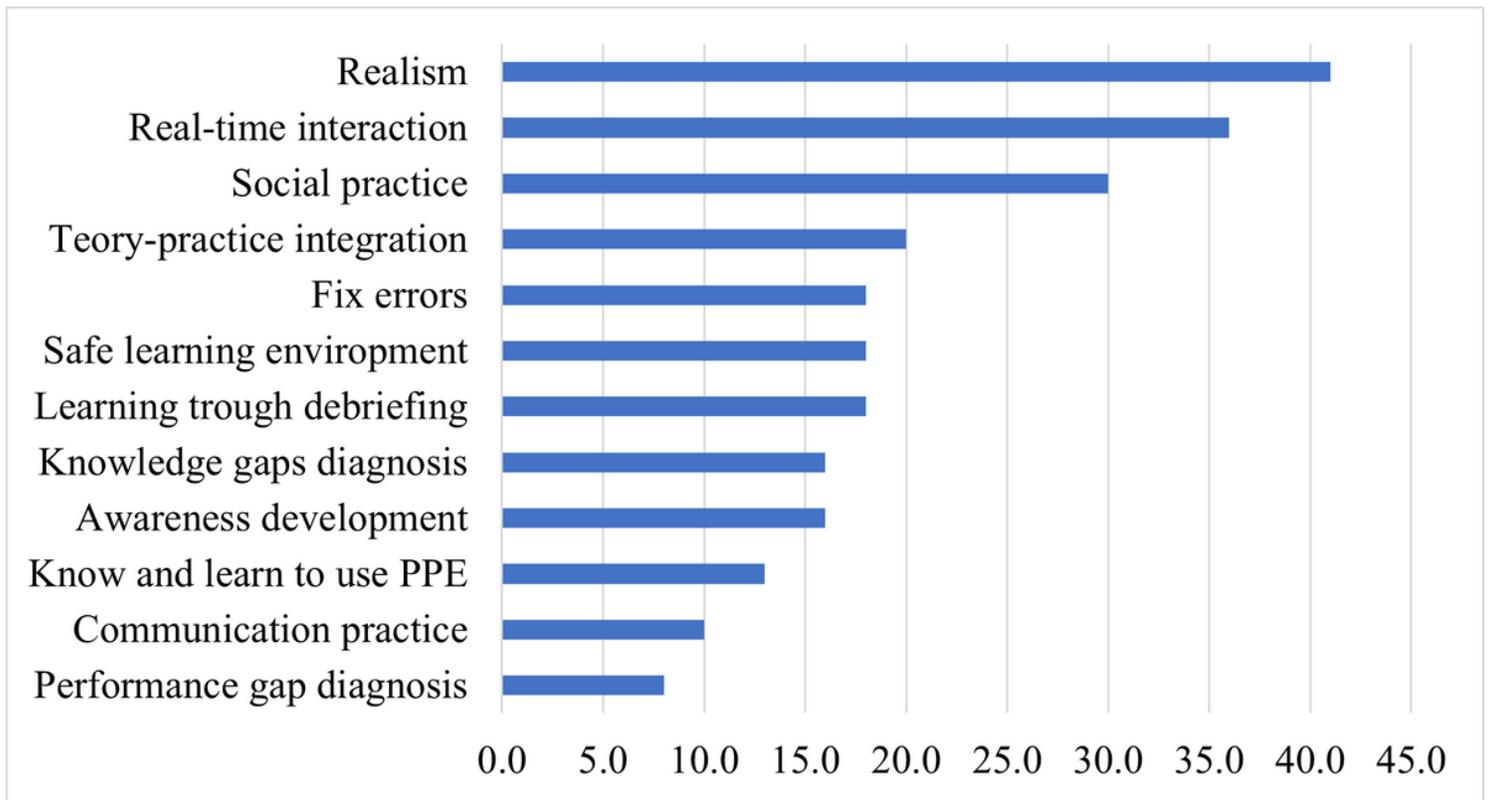
Figure 1

Agreement proportion to OSCSim.



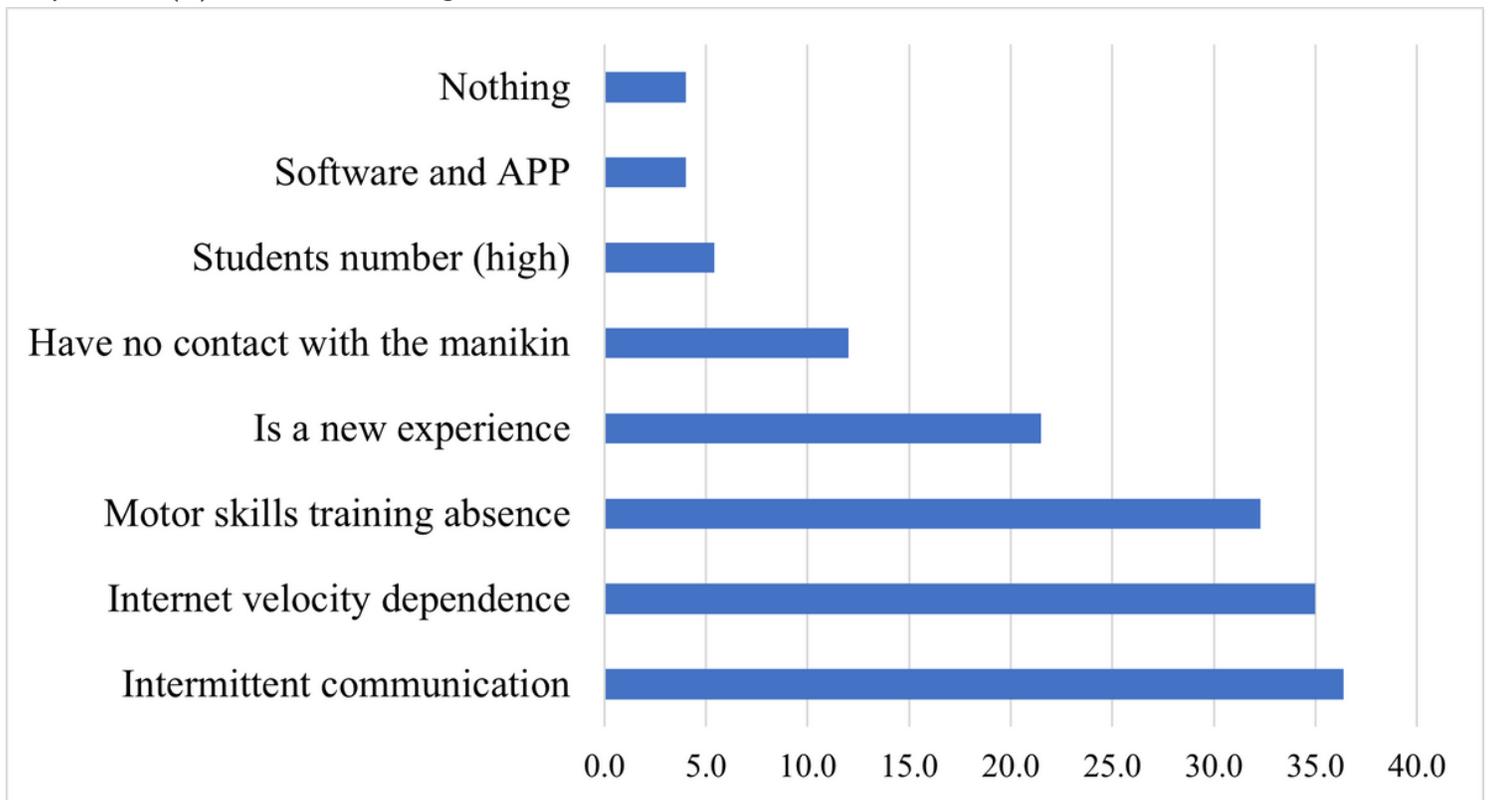
**Figure 2**

Debriefing Assessment (score points).



**Figure 3**

Proportions (%) of OSCSim strengths.



**Figure 4**

The proportion (%) of OSCSim weakness.