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Satisfaction and gains perceived by nursing students with medium and high-fidelity simulation: A randomized controlled trial

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ABSTRACT

Background: The use of simulation to reproduce the experience of health care settings and its use as a strategy in the teaching of nurses has grown at an unprecedented rate. There is little scientific evidence to examine the differences in satisfaction and gains perceived by the students with the use of medium and high fidelity.
Objectives: To analyse and benchmark gains and satisfaction perceived by nursing students, according to their participation in medium- and high-fidelity simulated practice.
Design: Randomized control trial post-test only design with control group.
Setting and Participants: Students of the 4th year of the Bachelor's Degree in Nursing who performed medium and high-fidelity simulated practice in a Simulation Centre environment.
Methods: A satisfaction scale and a scale of perceived gains from the simulation were applied to the students who underwent simulated practice in a medium-fidelity environment (control group) and high-fidelity environment (experimental group). Statistical analysis was performed and a significance level of $p < 0.05$ was established.
Results: Of the 85 students who participated in the study, the majority were female (92.94%), with an average age of 21.89 years (SD = 2.81 years). Satisfaction is statistically significant in the realism dimension and overall satisfaction. In the gains perceived with the simulation there is a statistically significant difference in the dimension recognition/decision.
Conclusion: Students are very satisfied with the realism of high-fidelity simulated practice and consider that this helps them more with recognition and decision compared with the medium-fidelity simulation.

1. Introduction

Simulation as a teaching and learning strategy in health is a tool increasingly used by schools to prepare their students for clinical practice. With the advancement of technology in health and education, schools and teachers can have the most varied simulation strategies, depending on the objectives, fidelity they wish to impose and the economic resources they have.

High-fidelity simulated clinical experiences encourage students to be more active and involved in their learning (Lapkin and Levett-Jones, 2011). These experiences are largely exempt from risk, and by representing the reality of clinical settings, they enable students to build knowledge, develop their assessment, explore different interventional hypotheses and develop psychomotor skills in a secure environment (Foronda et al., 2013).

Some studies indicate that high-fidelity simulation (HFS) improves clinical skills, communication, clinical decision-making and critical thinking and fosters self-confidence and teamwork (Kameg et al., 2010; Shrader et al., 2013). However, these simulators and realistic simulation environments are expensive, they demand a lot of practice and training for teachers, they require specialised maintenance and consume much advance preparation time for each scenario (Kardong-Edgren et al., 2007).

Despite some disadvantages of simulation, there are many positive results that encourage investment in this strategy. From these results, clinical reasoning (Lapkin et al., 2010), student satisfaction (Levett-Jones et al., 2011; Baptista et al., 2014a), knowledge (Brannan et al., 2008) and psychomotor skills (Foronda et al., 2013) stand out.

The scientific evidence produced in different simulated clinical experiences is varied but sometimes conflicting about the advantages or benefits obtained from simulation (Baptista et al., 2014b). Cant and Cooper (2009) report that further experiments with HFS representing

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the reality of health services are needed and that the results obtained with the medium-fidelity are limited as yet.

2. Background

Simulation is a teaching strategy that represents or amplifies the context of real experiences in an interactively controlled environment (Gaba, 2007). In health education, simulation is used for training, research and evaluation purposes in order to meet the demands of society and the challenges of new teaching and health security methods (Alinier and Platt, 2014).

It is necessary to change teaching methods to meet the needs of students who live hand-in-hand with new technologies. Due to its association with this attraction to new technologies, HFS seems to create more enthusiasm and inspiration in students and thus improve the learning environment (Hoadley, 2009). On the other hand, some authors report that students' anxiety levels increase due to the realism and their expectations of managing to follow the scenario until the end (Edgecombe, 2013).

With the scientific evidence already produced, it is still not easy to determine the level of fidelity needed for more effective teaching. It should be noted that high technology does not necessarily equate to high-fidelity. It is acknowledged that the various fidelity levels have different educational values and students perceive them in different ways (Levett-Jones et al., 2011; Norman et al., 2012.).

Fidelity refers to the way the simulator and simulation experience represents the real context (Lapkin and Levett-Jones, 2011). According to Tun et al. (2015), fidelity of a simulated practice is based on three dimensions: (1) the patient dimension, which encompasses all the interactions the student performs with the simulator, such as communication or procedures where the anatomical and physiological realism is important. (2) the clinical setting dimension, which is related to the entire progression of the scenario and its complexity. (3) The health facilities dimension, which is related to all the material, equipment and realistic environment used for the simulation. Associated with fidelity of the environment and equipment used in simulation, Fritz et al. (2007) add psychological fidelity, which includes the degree to which students perceive the simulation as a credible representation of reality.

It is important to analyse the assessments and perceptions that students have of the simulation, in order to develop and improve this teaching strategy in nursing. Its growing use justifies the need to analyse how students perceive different scenarios and simulation strategies (Kardong-Edgren et al., 2012; Tosterud et al., 2013).

The objective of this study is to analyse and comparatively assess gains and satisfaction perceived by nursing students, depending on their participation in medium and high-fidelity simulation practices.

3. Methods

3.1. Question and Research Hypothesis

How does medium and HFS influence the gains and satisfaction of the 4th year students of the Bachelor's Degree in Nursing in the assessment of and intervention with patients in critical condition?

Hypothesis I. The level of satisfaction of students who participated in simulated clinical experiences with HFS is significantly higher than those who participated in medium-fidelity simulation (MFS).

Hypothesis II. Gains expressed by students who participated in simulated clinical experiences with HFS are significantly higher than those who participated in MFS.

3.2. Design and Participants

This randomized control trial with a post-test only design control group was conducted to compare the satisfaction and perceived gains with medium and HFS. The study followed the guidelines of the Consolidated Standards of Reporting Trials (CONSORT) to carry out the report (Schulz et al., 2010).

Students of the 4th year of the Bachelor's Degree in Nursing School of Coimbra (Escola Superior de Enfermagem de Coimbra – ESEnfC) from Portugal, were invited to participate in the study by mail (personal school mail). Students were invited to participate in a training session on "Evaluation and intervention for people in critical condition". Interested parties enrolled on the school's electronic platform, after reading all the information related to the study and expressing in writing their availability and interest in participating.

3.3. Data Collection

Data collection was carried out on 7th and 14th December 2013, without interfering with the academic schedule of the participants. It was carried out at the end of each training day, after the simulated clinical experiences with medium and high-fidelity. All participants were asked to answer three questionnaires: (1) Questionnaire of sociodemographic characterisation; (2) Satisfaction Scale for simulated clinical experiences and (3) Scale of Gains perceived with HFS. The average response time for the three questionnaires was 10 min.

3.4. Interventions

15 days prior to the training session all students enrolled were sent a PowerPoint presentation with the theoretical support, designed for the evaluation and intervention in a patient in critical condition with problems related to the airway (A), breathing (B), circulation (C) and neurological dysfunction (D).

Since the studies of simulated practice focus on one or two scenarios and because there is little scientific evidence involving students in multiple scenarios (Kaddoura et al., 2016), eight different scenarios were used in this study.

For the training day, eight clinical files were digitally designed on PowerPoint, version 2010 for Windows and enabled students to consult them in presentation mode (full screen), according to their needs. Each file included a clinical diary, nursing log, prescriptions, supplementary diagnostic tests and vital signs.

A trainer's guide with the objectives of the training, the programme, the distribution and students' rotation between the rooms and the scenarios to perform was drawn up. The scenarios were designed to be problem situations for a patient in critical condition:

Airway ($\mathbf{A_1}$) – Pneumonia with presence of secretions
Airway ($\mathbf{A_2}$) –Anaphylactic shock with oedema of the glottis
Breathing ($\mathbf{B_1}$) –Acute pulmonary oedema
Breathing ($\mathbf{B_2}$) –Breathing difficulty by removal of nasal oxygen cannula/chest pain on inhaling
Circulation ($\mathbf{C_1}$) –Hypovolemic shock
Circulation ($\mathbf{C_2}$) –Bradycardia with signs of severity
Neurological dysfunction ($\mathbf{D_1}$) – Hypoglycemia
Neurological dysfunction ($\mathbf{D_2}$) – Convulsion

Each scenario was composed of the goals, problem situation, the context of the situation, the critical factor, assessments expected by students, presence or absence of medical support, interventions expected by students, development of the scenario, preparation of the environment and simulator, necessary materials and equipment and items to reflect upon in the debriefing, fulfilling the steps proposed by Coutinho et al. (2014).

At the start of the day, participants were delivered a training programme with the sequence of activities and rotations between the rooms.

The training took place in a simulation centre environment at the ESEnfC, in four rooms prepared for this purpose: two of them dedicated

to MFS and two for HFS. In the HFS rooms, the environment was prepared to simulate a real context, providing more realism. *Adult Resusci Anne* simulators with *VitalSim*® and *iStan*® were used for medium and high-fidelity training, respectively.

The day of the training started with a 15-minute theory lecture on the evaluation of people in critical condition according to the ABCD methodology, followed by eight practice sessions. At the end of the day, students answered the questionnaires.

The scenarios were developed by four participants and observed by the other members of the group who had been allocated to the same room. In each scenario, the trainer presented the situation of the "patient" and the four students evaluated and intervened according to the greater or lesser responsiveness of the simulators. Each scenario has an average duration of 15 min. In the medium-fidelity environment, the reactions and responses of the simulators were replaced by verbal input of the trainers. At the end of each scenario, all students, participants and observers participated in the debriefing. All students had the hypothesis to participate in scenarios.

Six trainers participated in this training, two in the medium-fidelity rooms and four in the high-fidelity rooms. Despite the fact that these trainers teach in the curricular unit of Emergency in Nursing of the 4th Year and they know the methodologies used in the simulation centre, they all received previous training on the objectives and strategies for the development of the training and carrying out of the study.

3.5. Instruments Used to Collect Data

Questionnaire of sociodemographic characterisation – which includes age, gender and the presence of subjects in arrears.

Satisfaction with clinical experience simulation scale (Baptista et al., 2014a) – Scale with 17 items in which the student expresses his/her opinion, on a Likert-type scale, with a variation from one to ten, in which one is the lowest level of satisfaction and ten is the highest. Scale items are divided into three dimensions: Practical dimension (9 items); Cognitive dimension (3 items) and Realism dimension (5 items). The alpha value determined by the authors was 0.914 and in this study it was 0.893.

Gains perceived with high-fidelity simulation scale (Baptista et al., 2013) – Scale with 26 statements in which the students express their opinion, on a Likert-type scale, with five possible answers: "I was worse", "I was the same", "I improved slightly", "I improved considerably" and "I improved a great deal". Scale items are divided into five dimensions: Recognition and decision dimension (14 items); Cognitive dimension (3 items); Interventional dimension (3 items); Attitudinal dimension (3 items), Technical and practical dimension (3 items). The alpha value determined by the authors was 0.951 and for this study it was 0.912.

3.6. Sample Size

The sample size was determined prior to the study. Inclusion/exclusion criteria were established: (1) All students of the 4th year of the Bachelor's Degree in Nursing who agreed to participate in the study voluntarily were admitted and (2) students who said they had participated in practices or courses with medium and high-fidelity simulators would be excluded.

The calculation of sample size was determined using the OpenEpi programme (Dean et al., 2015). For the Satisfaction Scale, total sample size would be 68 subjects (34 each group), with a standard deviation of 6.87 and an average of 87.47. For the Gains Scale the total sample size would be 276 subjects (138 for each group), with a standard deviation of 0.31 and an average of 3.99. For both scales a 95% confidence interval, 80% power and a ratio of 1 in the relationship between the two groups (experimental and control) were considered.

3.7. Randomization

Different randomization processes were generated, using the Statistical Package for Social Sciences (SPSS). After the registration of each student on the electronic platform of the school, a serial number was automatically assigned and it was used to carry out the first randomization on the day of training. The second randomization allocated students to different groups (experimental and control). As the training took place in four rooms with the respective rotation in pairs, the groups to determine which of the rooms would start the training were randomized. Each trainer was assigned a random number and they were randomized by rooms. A plan of rotations was set so that all students had the same contact time with the trainers, in order to avoid the biases of each trainer.

The whole process of randomization was performed by one of the authors of this study.

3.8. Ethical Considerations

The study was approved by the Ethics Committee of the Research Unit in Health Sciences: Nursing of the ESEnfC (P182-09/2013) and authorized by the President of the ESEnfC. The participants were informed about the study and expressed their consent in writing. Confidentiality was ensured throughout the whole process and at no time were the participants identified. All data collection instruments were stored in their own envelopes, to which authors had exclusive access.

3.9. Statistical Methods

For the statistical treatment of the data the program SPSS® version 20.0 for Windows was used. The process of descriptive analysis was performed using average, standard deviation, minimum and maximum, and frequency and percentages distribution. For the inferential analysis, Fisher's exact test and the *t*-test were used to assess the equivalence of demographic data in both groups, and the normality of the data was tested by the Kolmogorov-Smirnov test (Marôco, 2011). As the data had a non-normal distribution, non-parametric tests were used. The Mann-Whitney *U* test was used to analyse significant differences in satisfaction and gains with the clinical experiences simulated in the control and experimental groups. A value of $p < 0.05$ was considered statistically significant.

4. Results

4.1. Sample (Flow of Participants)

From a total of 298 students who are part of the 4th year of the Bachelor's Degree in Nursing, 102 (34.22%) signed up for this training. These were randomized for the two days of training, and subsequently subjected to new randomization for allocation to different groups (experimental and control). On both days there were dropouts due to failure to attend, with 46 students attending on the 7th December and 39 students on the 14th December. 85 students (28.52%) participated in the study, 36 from to the control group and 49 from the experimental group (Fig. 1)

4.2. Sociodemographic Characteristics

Of the 85 nursing students who participated in the study, the majority were female (92.94%), with an average age of 21.89 (SD = 2.81 years) and ranging between 20 years and 37 years of age. Most students (88.23%) had no subjects in arrears. The two groups have similar demographic characteristics and there were no statistically significant differences between them ($p > 0.05$ for Fisher's exact test and *t*-test) (Table 1).

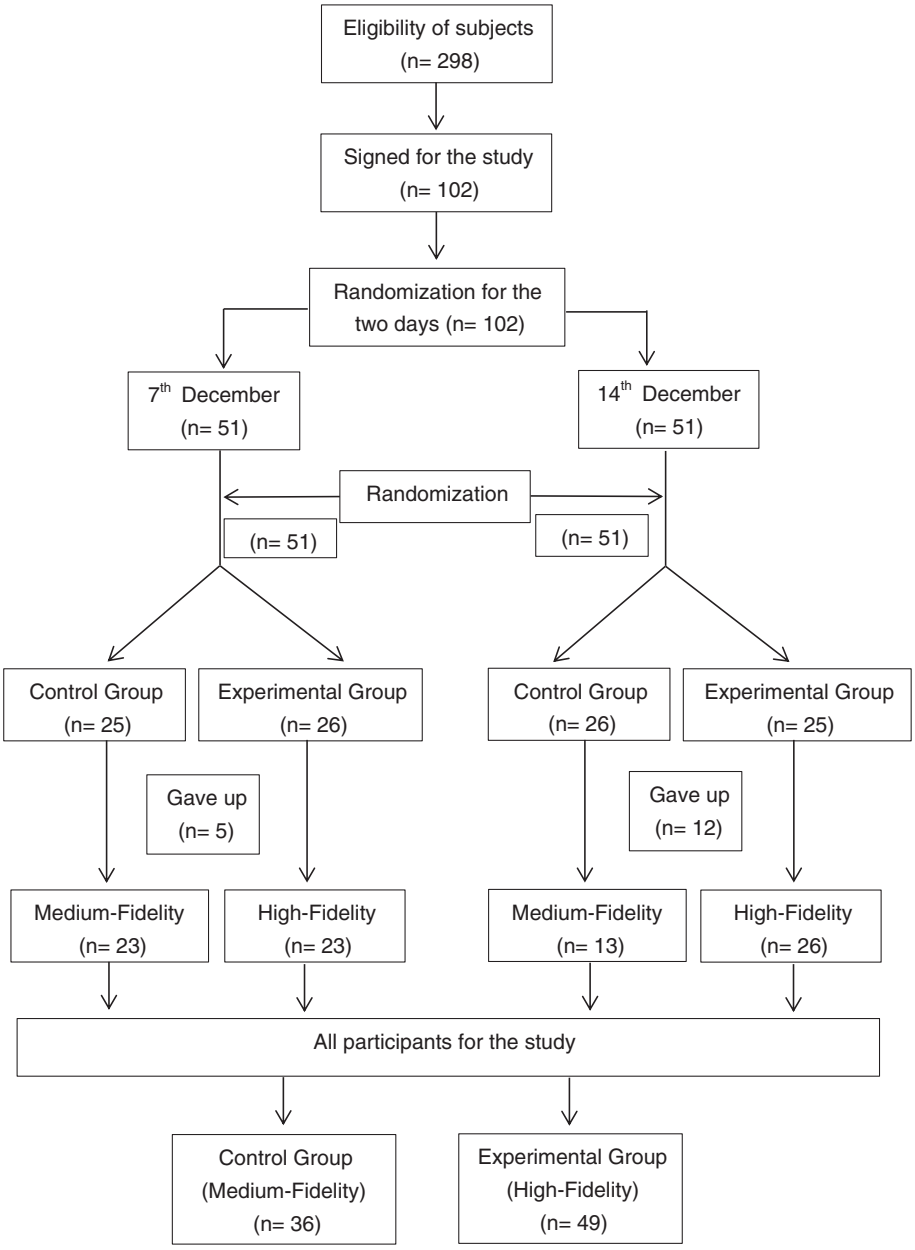

Fig. 1. Flow of the participants of the study.

Table 1
Sociodemographic characteristics of the sample ($n = 85$).

Variables	Participants (n = 85)		Experimental group ($n = 49$)		Control group ($n = 36$)		Statistical tests	*p*-Value
	n	%	n	%	n	%		
Age							0.374[a]	0.613
20–25	80	94.11	47	95.92	33	91.67		
26–31	3	3.53	1	2.04	2	5.55		
32–37	2	2.36	1	2.04	1	2.78		
Gender							0.143[b]	0.236
Male	6	7.06	5	10.20	1	2.78		
Female	79	92.94	44	89.80	35	97.22		
Courses in arrears							0.057[b]	0.737
No	75	88.23	44	89.80	31	86.11		
Yes	10	11.77	5	10.20	5	13.89		

$p < 0.05$.
[a] *t*-student.
[b] Fisher exact test.

4.3. Main Results

4.3.1. Student Satisfaction with the Simulated Clinical Experiences

From the analysis of Table 2, it can be seen that students are very satisfied with the simulated clinical experiences in all scale dimensions and also overall, with the average satisfaction in both groups varying between 77.77% (SD = 11.29) and 90.04% (SD = 7.46). When comparing the control group to the experimental, one sees that satisfaction is statistically significant in the realistic dimension (U = 324.50, W = 990.50, $p < 0.001$) and overall satisfaction (U = 557.50, w = 1223.50, $p < 0.01$).

4.3.2. Gains Perceived by Students with High-Fidelity Simulation

From the analysis of Table 2 we can see that students perceive simulated practice as very important to their teaching/learning process with average gains in both groups between 75.55% (SD = 10:45) and 82.99% (SD = 9:13). A comparative analysis of both groups finds that

Table 2
Satisfaction and gains with simulation experience and test scores between study groups.

Instruments and dimensions	Groups	n	Mean	SD	U Mann-Whitney	Wilcoxon	*p*-Value
SCESS							
Practical	Control	36	87.43	6.58	811.00	1477.00	0.527
	Experimental	49	88.09	7.50			
Realism	Control	36	77.77	11.29	324.50	990.50	0.000
	Experimental	49	90.04	7.46			
Cognitive	Control	36	89.44	7.01	813.00	1479.00	0.534
	Experimental	49	90.00	7.16			
Global of SCESS	Control	36	84.88	6.98	557.50	1223.50	0.004
	Experimental	49	89.37	6.18			
GPHSS							
Recognition/decision	Control	36	77.38	5.85	626.00	1292.00	0.022
	Experimental	49	79.88	7.18			
Cognitive	Control	36	80.00	4.78	754.00	1420.00	0.232
	Experimental	49	81.76	8.90			
Intervention	Control	36	81.48	8.88	804.00	1470.00	0.406
	Experimental	49	82.99	9.13			
Attitudinal	Control	36	79.25	7.43	828.50	1494.50	0.611
	Experimental	49	79.04	10.54			
Technical/practical	Control	36	75.55	10.45	704.00	1370.00	0.068
	Experimental	49	80.00	10.00			
Global of GPHSS	Control	36	78.73	4.76	682.50	1348.50	0.076
	Experimental	49	80.73	7.03			

SCESS – Satisfaction with Clinical Experience Simulation Scale; GPHSS – Gains Perceived with High-fidelity Simulation Scale; SD – Standard Deviation.

only the recognition/decision dimension have a statistically significant difference ($U = 626.00$, $W = 1292.00$, $p < 0.05$).

5. Discussion

5.1. Interpretation of Results

The aim of this study was to analyse and benchmark satisfaction and gains perceived by nursing students, depending on their participation in medium and HFS practice. Several studies address student satisfaction (Smith and Roehrs, 2009; Swenty and Eggleston, 2010) and the perception they have of simulated practice (Basak et al., 2016), but are intended primarily for HFS or comparing it with low-fidelity.

In this study we tried to fill the gap of scientific evidence by comparing medium and high-fidelity as suggested by Arnold (2012).

Randomization precepts for both sample and trainers who participated in the study were met, in order to be able to generalize the survey data (external validity) and minimize bias (internal validity) (Souza, 2009).

From the 102 students who enrolled on the online platform, only 85 participated in the study. The sample has a prevalence of females (92.94%), which is in line with the national data issued by the Ordem dos Enfermeiros (2013). The majority of students (88.23%) had no subjects in arrears, which denotes some homogeneity in the sample.

Several studies have evaluated student satisfaction regarding simulation, but with the use of small samples in restricted contexts and using instruments with no assessment of the psychometric properties of reliability and validity (Lapkin and Levett-Jones, 2011). For this study we used a satisfaction measurement tool with good psychometric properties with an internal consistency of 0.914 (Baptista et al., 2014a).

Regarding Hypothesis I: The level of satisfaction of students who participated in simulated clinical experiences with HFS is significantly higher than those who participated in MFS. We found that in all dimensions of the scale, students of both groups (experimental and control) reported being satisfied with the simulated practices. The mean values obtained for satisfaction in the experimental group were superior in all dimensions of the scale, with a statistically significant difference in the realism dimension ($p < 0.001$) and overall satisfaction ($p < 0.05$).

Not fully corroborating the results of this study, Lapkin and Levett-Jones (2011), there were no statistically significant differences in satisfaction between the experimental group and the control group ($p = 0.546$).

There is a growing concern in nursing schools with increasing the realism of simulated practice, since fidelity of the scenarios provides high levels of satisfaction, it contributes to significant learning, it allows a more active participation of students in class and it is relevant to the clinical context (Swenty and Eggleston, 2010).

The realism of the scenarios stimulates the student's cognitive, psychomotor and affective skills to provide quality nursing care (Cordeau, 2010) and it is important for simulation, as a teaching and learning strategy (Jeffries, 2007).

For the student, simulated practice should be credible. Students should assume the functions of a "nurse" to assess and care for the "patient" according to his/her needs (Campbell and Daley, 2013).

To evaluate the perception of gains with simulation, a scale with 26 items with good psychometric properties of reliability and internal validity with alpha value of 0.951 (Baptista et al., 2013) was used.

With regards to Hypothesis II: Gains expressed by students who participated in simulated clinical experiences with HFS, are significantly higher than those who participated in MFS. We found that in the five dimensions of the scale, students from both groups consider that they obtained gains with simulated practice. However, it is in the recognition and decision dimension that there is a statistically significant difference ($p < 0.05$). Thus, we can consider that HFS helps students perform a better assessment of the patient, establish diagnoses by recognising signs and symptoms of gravity and they are therefore able to have structured thinking and correctly decide the care to provide. This recognition that observation and evaluation of the patient are important was also described by the participants of Buykx et al. (2011) study.

High-fidelity simulation helps students in the evaluation of the "patient" and in decision-making (Kaplan and Ura, 2010), it boosts their confidence and it allows for the application of theoretical knowledge into practice (Jeffries, 2007).

5.2. Limitations/Generalization

The study sample was relatively small for the presentation and discussion of the most significant data on gains with medium and HFS. However, given the scarcity of randomized studies that address the gains perceived by students with simulation, this study can be considered useful.

The study was conducted in only one place and designed for the assessment of and intervention with patients in critical condition, which prevents generalization of the results to other contexts and realities.

5.3. Implications for Practice

This study is particularly important for trainers, due to the interest and motivation that they can develop in students through these teaching strategies, encouraging them to build their learning. It is also of interest to schools, because it helps in the decision to invest in this training strategy, from a cost-benefit perspective, according to the goals and the quality of training they aim to provide to their trainees.

6. Conclusion

In this study, satisfaction with the realism of the scenarios and the gains perceived by students in recognising a patient in critical condition and deciding interventions were higher with HFS. Unlike many studies that found no statistically significant differences between medium and HFS, this study tells us that investment in high-fidelity is advantageous if the nursing schools wish their students to feel more motivated and interested in learning, as well as able to transfer into clinical practice the knowledge they have acquired in a simulated environment.

Although these results are favourable to investment in HFS as a teaching strategy in nursing, we suggest further studies with high levels of evidence to justify when, how and why to use higher fidelity in simulated practice.

Conflicts of Interest

The authors report no conflict of interest.

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