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Research Article

SimCapture for Skills®: Mobile-based web skills training for undergraduate nursing students: A randomized clinical trial

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KEYWORDS
Clinical skill;
Deliberate practice;
Mobile applications;
Nursing education;
Simulation

Abstract
Background: Emerging mobile-based technologies offer self-learning teaching strategies for technical skills training.
Methods: In a randomized clinical trial with nursing students, all participants received traditional classroom and SimCapture-assisted training. Checklist scores for self-assessment, satisfaction and self-confidence were compared for each learning scenario. Costs were also compared.
Results: In the traditional training session self-assessments, scores were higher when students received the traditional training after SimCapture than before it (75 [67.6–76] vs 73 [61.4–76], $p = .006$, d = 0.54). Satisfaction and self-confidence were higher with SimCapture. Training with SimCapture saved 12538 euros compared to traditional classroom training.
Conclusions: SimCapture for Skills® is an effective and financially feasible instruction method.

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Introduction

Higher education is essential for socio-economic and cultural development worldwide. Evidence shows that changes need to be made in undergraduate nurse education and that continued research in this area is necessary (López-Entrambasaguas et al., 2019). The past decade has seen a marked increase in the use of simulation as a teaching and assessment method for nursing students as an option to replace or complement clinical practice (Bogossian et al., 2019). Both technical skills (procedures) and non-technical skills (decision-making, clinical criteria/judgment, teamwork and communication) can be learnt through simulation (Lioce, 2020). According to a recent meta-analysis (Li et al., 2022), which showed high heterogeneity among the studies, the use of high-fidelity simulators improved the acquisition of knowledge compared with clinical practice, while also achieving a more in-depth integration of non-technical skills. The same authors acknowledged that the cost of replacing clinical practice with simulation should be evaluated, taking into account manikin maintenance and teaching staff costs in the development of simulated cases and of teaching for small groups of students. Cant et al. (2022) made the same observation concerning the use of virtual reality simulation: since student numbers are limited, simulation has to be combined with other teaching methods that are less resource intense. In addition, simulation methods should meet the quality standards defined by the International Nursing Association of Clinical and Simulation Learning (INACSL) (INACSL Standards Committee, 2021), which requires training teachers on how to use simulation methods appropriately. Furthermore, another meta-analysis evaluated whether simulation-based learning was associated with increased stress among students due to feeling observed and being surrounded by technology (Oliveira Silva et al., 2022). These authors concluded that simulation was not associated with increased stress compared with conventional teaching methods such as case analyses and clinical practice. On the contrary, self-confidence was significantly higher. The authors suggested the increased self-confidence occurred because students could make mistakes during simulation without consequences. It is important to remember, however, that simulation is not synonymous with technology. As Bryant et al. (2020) noted, "the goal of simulation-based education is not to introduce the latest technology into training but to develop practice-ready professionals" (p.34). Evidence now shows that simulation is effective for undergraduate students (Hegland et al., 2017). The learning effect is greater when students are unfamiliar with the context and task, and therefore, simulation may be more effective among students without experience, before they start clinical practice placements (Chernikova et al., 2020).

Emerging technologies now offer self-learning teaching strategies that enhance the teaching of technical nursing skills. Although information is easy to access on handheld devices, such as phones or tablets, some instructors are still reluctant to incorporate this methodology to their curricula due to fear of technology problems, issues with internet connection and cost (Carter-Templeton et al., 2018). One such innovation is SimCapture for Skills®, a digital assessment and evaluation solution that complements teaching, based on peer-to-peer self-learning. The tool empowers students to become more competent and confident as they train repeatedly on fundamental technical skills (Laerdal Medical, 2025).

Universities, in turn, are committed to efficient and quality teaching and learning, while incorporating new technologies. Although new learning technologies often imply a financial burden, effective face-to-face classroom teaching and practicing of technical skills in small groups is also onerous, due to faculty fees (Benavides et al., 2020). Areas such as industry and biotechnology are fully engaged in researching ways to transfer technology to practice. In contrast, research is still at early stages in technology strategies related to education, learning and competence acquisition (Carter-Templeton et al., 2018).

Based on the hypothesis that the use of the SimCapture for Skills® program (Laerdal Medical, 2025) may achieve greater student satisfaction and self-confidence than traditional classroom-based teaching in the presence of an instructor, the aim of this study was to evaluate the effectiveness of the SimCapture for Skills® digital solution for the acquisition of competencies in technical skills through peer-to-peer self-learning among undergraduate nursing students .

Methodology

This was a prospective, open-label, parallel-group, randomized clinical trial with a 1:1 allocation ratio involving

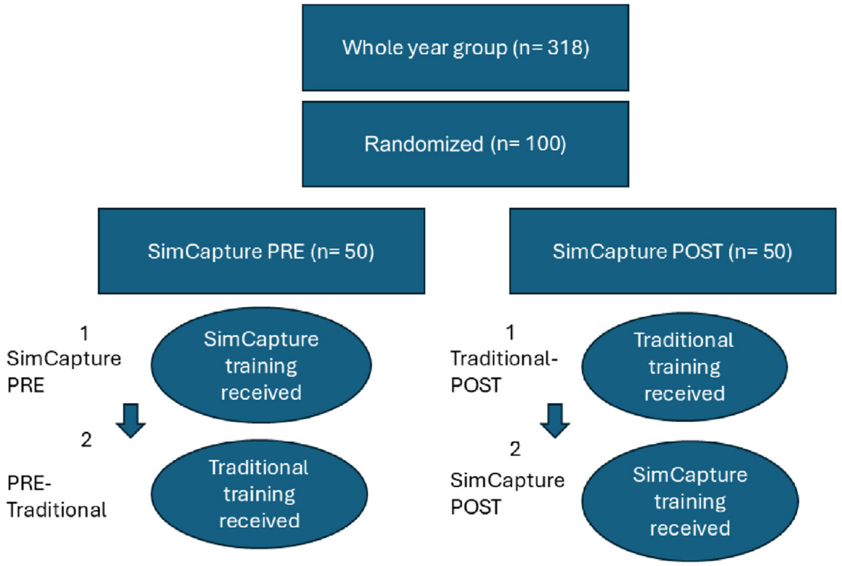

Figure 1 Training design.

second-year undergraduate nursing students at University of Barcelona, before they started clinical practice placements. The study protocol was published before recruitment was initiated (ClinicalTrials.gov, NCT06225401) and the CONSORT checklist was used to inform the study.

Sample selection

Of the 318 students enroled in the subject *Clinical Practicum I*, 100 volunteers were selected and randomized into SimCapture PRE (n = 50) and Sim Capture Post (n = 50). These 100 students received both the traditional and the SimCapture training methods, in a different order (Figure 1). One of the modules in this subject is 'Clinical Skills', where students learn various technical skills using task trainers, which are low-fidelity simulators. The study focused solely on blood draws, which is one of the techniques in this module. The task consists of drawing blood in three ways: with a collection needle and syringe, with a collection needle and integrated Vacutainer® holder, and with a Vacutainer Safety-Lok® butterfly and preattached holder.

Students were randomized 1:1 to the PRE group (teaching with SimCapture before attending the traditional instructor-based session) or to the POST group (teaching with SimCapture after attending the traditional instructor-based session) (Figure 1). All measurements were recorded at the end of each training type (traditional teaching and SimCapture teaching).

Inclusion criteria

Enrolment in *Clinical Practicum I*, a compulsory subject for second-year undergraduate nursing students, and agreement to participate in the study.

Exclusion criteria

Students who failed *Human Anatomy* in their first year.

Teaching description

Prebriefing phase (before practicing the skill with the simulator) in both learning scenarios, i.e. traditional learning with an instructor and SimCapture training without an instructor. All students enroled in the subject *Clinical Practicum I* (n = 318), including the 100 clinical trial volunteers, studied the full procedure on the virtual campus to learn how to correctly perform the blood collection protocol and technique (indications, contraindications, objective, step-by-step protocol and possible complications). Afterwards, they watched a video showing an instructor performing the simulated technique. To evaluate the level of theoretical knowledge acquired for this technique, and before starting the simulator practice, the students took a test in each learning scenario (in the SimCapture training without an instructor and in the traditional learning with an instructor).

Simulation phase (practice with the simulator):

In the traditional training for all students (n=318), the instructor started the class with a verbal presentation, reminding students of the theoretical concepts related to the blood collection procedure. The instructor then showed the group how to perform the technique with the simulator, with the students as onlookers. Finally, the students got into pairs and practiced the technique with the simulator. Each pair had a needle-insertion arm simulator. The instructor supervised the student pairs and answered any questions. At the end of the simulation practice, each student completed a self-assessment with a checklist with the items comprising the technique, marking their performance of each item as correct or incorrect. The training session lasted two hours and instructors had 7-8 students per session.

In the SimCapture training, only the 100 study volunteers took part. They were randomized to SimCapture PRE (before the traditional training, n = 50) or POST (after the traditional training, n=50). The PRE-group received SimCapture training before the traditional training: first SimCapture training -SimCapture PRE - and then traditional training - PRE-traditional sequence. The POST-group received SimCapture training after the traditional training: first traditional training – Traditional-POST sequence - and then SimCapture training - SimCapture POST. Figure 1. The students started the session by practicing directly with the simulator. They also had one needle-insertion arm kit per pair of students, and after signing in to the SimCapture for Skills® program with the username and password provided by the instructor, they could access the step-by-step procedure checklist on their own phones. One student observed their partner performing the technique, describing each step out loud and marking each item as correct or incorrect. Then they switched roles: the student who had been the observer practiced the procedure, while their partner, who was now the observer, completed the checklist with their own username and password. They could opt to record a video of each checklist practice using their phones, and the video was saved by the program together with the self-assessment. Afterwards, they could access the program as many times as they wished to review the videos. The instructor supervised the student pairs as they practiced in the classroom and answered any questions. The training session lasted two hours and instructors had 14-16 students per session.

Variables

Primary dependent variable:

- Students' self-assessments using the step-by-step procedure checklist in each learning scenario (SimCapture PRE, PRE-traditional, Traditional-POST, SimCapture POST). The checklist had 76 actions. The final score is calculated from the sum of correctly completed actions divided by the total of all actions to be completed (n/76).

Secondary dependent variables:

- Satisfaction and self-confidence acquired by the students in each learning scenario (SimCapture PRE, PRE-traditional, Traditional-POST, SimCapture POST). The Student Satisfaction and Self-Confidence in Learning Scale evaluation instrument was used. The Spanish version had previously validated by Farrés-Tarafa et al. (2021). The scale has 13 items (5 referring to satisfaction and 8 to self-confidence), scored on a Likert scale, where 1 is strongly disagree and 5 is strongly agree. Students completed the questionnaire immediately after the SimCapture or traditional teaching with the instructor in the room.
- Number of times each student performed the technique using the simulator in each learning scenario (SimCapture PRE, PRE-traditional, Traditional-POST, SimCapture POST). This was obtained from the number of checklists completed by each student, considering that the checklist covers three practical parts that can be repeated independently according to the three ways of drawing blood: needle and syringe, needle and vacutainer, and butterfly and vacutainer.
- Financial cost by teaching type, extrapolated to the whole year group, i.e., to the 318 students enrolled in *Clinical Practicum I.* After completing the study data collection phase, the costs of faculty fees were calculated. It was found that in the traditional teaching group (where the ratio of instructors to students was 1:7–8), 40 instructors would be needed for the whole year group and in the SimCapture® teaching group (where the ratio was 1:14–16), a total of 20 instructors would be needed. The costs of consumables (syringes, test tubes, lines, etc.) and equipment (simulators and replacement parts) were also calculated for each learning scenario (traditional versus SimCapture). The SimCapture training costs included the cost of software licenses for the total number of students enrolled in this subject.

Independent variables:

Sociodemographics (age, sex), work experience as a nursing associate, score obtained in the pre-simulator theory test.

Sample size calculation

Anticipating that the training with the new SimCapture technology would have a moderate effect size (d = 0.6), with a confidence level of 95%, it was calculated that 45 students needed to be enrolled in each group (SimCapture PRE [simulation before traditional training] and SimCapture POST [simulation after traditional training]), taking into account that all students also received traditional classroom training with an instructor. Allowing for a 10% loss to follow-up, a total of 50 students needed to be recruited for each group.

Recruitment, randomization, sequencing and blinding

All students enrolled in *Clinical Practicum I* (n = 318) who were scheduled to receive traditional training with an instructor in the academic year 2023-24 were contacted by the subject coordinator when the traditional teaching groups were being set up (with 7 or 8 students per session), and they were asked verbally if they would like to participate in the study, which would involve receiving complementary teaching with the SimCapture for Skills® program. Students who agreed to participate and signed the informed consent form were added to a randomisation list. A total of 100 students were selected from the list using a random number sequence function in Excel, since 100 was the number of students needed according to the sample size calculation. The 100 students were then randomized to the PRE or POST group using a new number sequence. The lists and sequences were generated by an investigator who did not teach the subject.

The regular teachers of the subject were informed about the study but did not participate in the SimCapture for Skills® teaching sessions and were unaware which of the students participated in the complementary sessions. The investigators who performed the statistical analysis for the dependent variables worked with anonymous data. The study therefore had a double-blind design, as neither the instructors nor the investigators knew which groups the students were assigned to.

Data analysis

An intention-to-treat analysis was conducted. Categorical variables were expressed as frequency and percentage using Fisher's or Chi-Square test to compare groups. Quantitative variables were described using the median and standard deviation or median and interquartile range (P25–P75), depending on the distribution of the data. The variables were compared with Student's t-test or Mann-Whitney U test, respectively. The Wilcoxon test was performed for paired data (SimCapture PRE vs PRE-Traditional group and SimCapture POST vs Traditional-POST group). A p-value of <.05 was considered significant. Cohen's d was used to examine effect size differences, with the strength of the relationship rated as weak (d = 0.20–0.49), moderate (d = 0.50–0.79), or strong (d > 0.79). All analyses were performed using IBM SPSS Statistics software (IBM Statistics®, Markham, ON, Canada).

Ethical considerations

The university's Ethics Committee approved the research project. All students who participated signed the informed consent form and were told that receiving complementary training with SimCapture would not have any impact on their academic record. Students who were not selected by random sequence to participate in the study were informed that after the study ended, they would be offered two hours of simulation practice, to give them the same opportunity to learn as the others in their class. The videos recorded by the students themselves during class were saved on the SimCapture for Skills® platform and were accessible only by students with a username and password.

Results

Of the 318 students enrolled in the course subject, six had exclusion criteria and 169 declined to participate. A further 43 were ruled out in the randomised selection process. Of the 100 randomised students, 48 received training in the PRE group and 50 in the POST group, in addition to the traditional teaching received by all students enrolled in the subject. The reasons for the drop-outs are described in Figure 2.

There were no differences in the socio-demographic and academic variables between the two teaching groups (Table 1).

Despite having less prior knowledge, the students' self-assessments were significantly better when they did the SimCapture sessions compared to the traditional teaching sessions (Table 2). In the traditional training session assessments, scores were higher when students received the traditional training after the SimCapture training than before it (PRE-Traditional 75 [67.6–76] vs Traditional-POST 73 [61.4–76], p = .006, d = 0.54). The largest effect size change occurred when students received the SimCapture training after the traditional training with an instructor (SimCapture POST 75 [72.9–76] vs Traditional-POST 73 [61.4–76], p < .001, d = 0.66) (Table 2). More practices were done with the simulator in the SimCapture sessions than in the traditional teaching sessions, in the PRE and POST groups alike, but there were no significant differences (Table 2). Two pairs in the SimCapture training sessions completed two full checklists each, in both the PRE and POST groups. In the traditional training sessions, one pair did not complete any checklists and no pairs repeated any parts of the checklist (Table 2).

Student satisfaction with the learning scenario (item 2 on the SCLS scale) and teaching materials (item 4) was higher in the SimCapture sessions, and the comparison was statistically significant between the traditional groups. More students marked *strongly agree* for satisfaction with the learning scenario when they received traditional teaching after had practiced with SimCapture. (Table 3). Student self-confidence scores showed that the mastery acquired by performing the technique (item 6) tended to be higher in SimCapture training, and also after practicing with SimCapture. The students acknowledged that SimCapture was a valid simulation instructor (items 12 and 13), especially when used first, before the traditional classroom teaching with instructor (Table 3).

By extrapolating the data to the whole group of 318 students, we found that the cost of consumables would be higher in the SimCapture teaching group compared to the traditional group. In addition, arm kit skins had to be replaced more frequently because students practiced more,

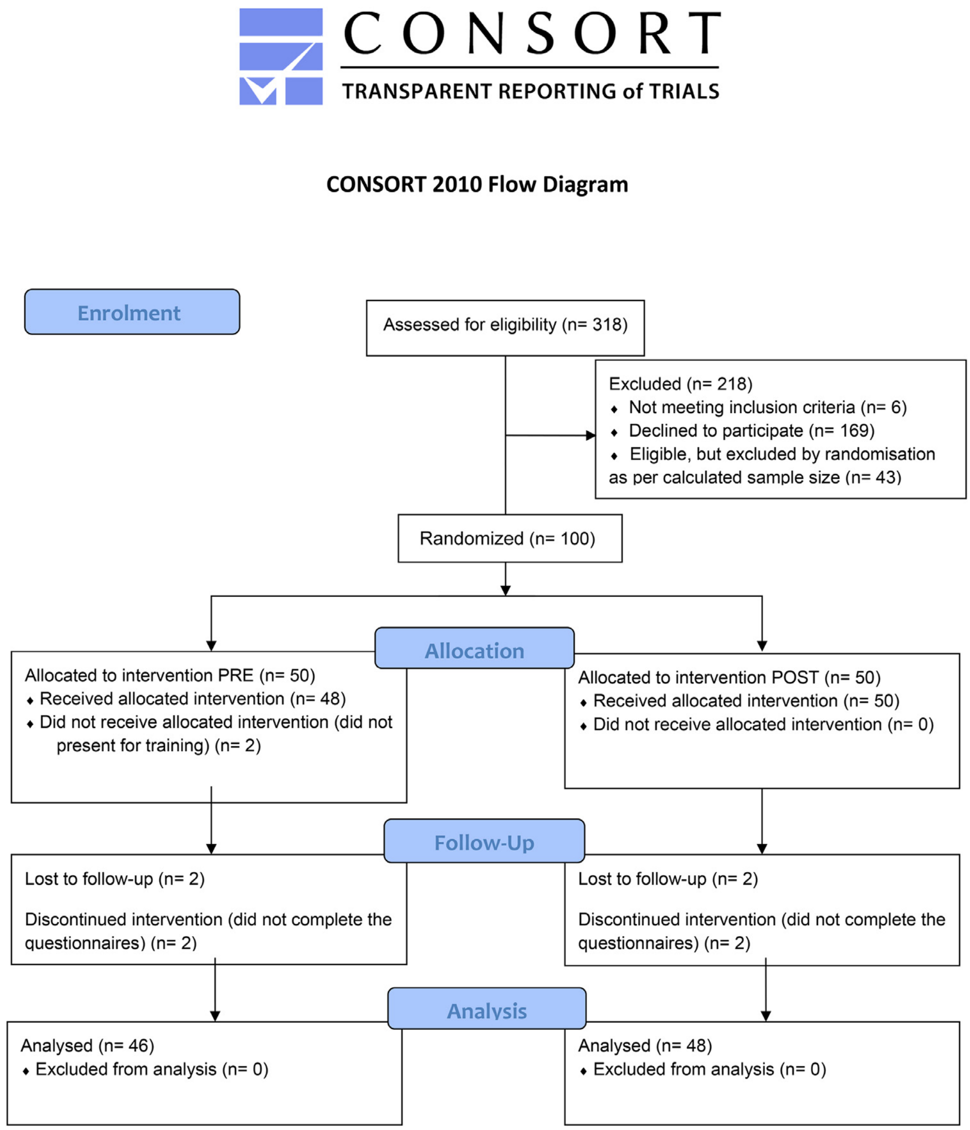

Figure 2 consort-2010-flow-diagram_EN_rev.

Table 1 – Socio-Demographic and Academic Characteristics of Each Group.

	Simcapture pre group (n = 46)	Simcapture post group (n = 48)
Age	19 (18–21)	19.5 (19–24.1)
Sex (female)	40 (87)	45 (93.8)
Experience as a nursing associate	1 (2.2)	3 (6.3)

Data are expressed as median (P10–P90) or frequency and percentages.

increasing the number of holes in the skin, leading to fluid leakage and making it harder to perform the simulation. However, even after adding the cost of the software licenses, SimCapture teaching was less expensive than traditional teaching with an instructor, because SimCapture required half the number of instructors, as the students could practice the technique themselves and the instructor only had to answer any questions that the students may have (Table 4).

Discussion

Student satisfaction with the learning scenario and teaching materials was higher with the SimCapture program than with the instructor. In addition, SimCapture gave students more self-confidence when performing the technical skill than when the instructor delivered the classroom training, because they were able to practice more with the simulator, and choose which technical part of the checklist to

Table 2 – Self-Assessments and Number Of practices for Each Learning Scenario.

	SimCapture-PRE	PRE-traditional	SimCapture-PRE vs PRE-traditional comparison	Traditional-POST	SimCapture-POST	Traditional-POST vs SimCapture-POST comparison#	Comparison of SimCapture groups	Comparison of traditional groups
	n = 46, 23 pairs			n = 48, 24 pairs				
Pre-simulation knowledge test (prebriefing)	3 (2–4) 2.9± 0.7	3 (2–4) 3.3± 0.7	0.021†	4 (3–4) 3.6 ± 0.6	4 (3–4) 3.6 ± 0.6	0.879†	<0.001‡	0.051‡
Completed checklist score*	76 (73–76) 75 ±1.6	75 (67.6–76) 73.9 ± 3.2	0.053† d = 0.43	73 (61.4–76) 69.5 ± 11.1	75 (72.9–76) 74.8 ± 1.8	<0.001† d = 0.66	0.263‡ d = 0.12	0.006‡ d = 0.54
	Number of practices							
Completed checklist	51/46 (110.9%)	45/46 (97.8 %)	0.770§	47/48 (97.9%)	53/48 (110.4%)	0.775§	1§	1§
Needle and syringe	62/46 (134.8 %)	46/46 (100 %)	0.321§	48/48 (100%)	63/48 (131.25%)	0.401§	1§	1§
Needle and Vacutainer	59/46 (128.3 %)	46/46 (100 %)	0.394§	48/48 (100%)	59/48 (122.9%)	0.484§	0.890§	1§
Butterfly and Vacutainer	53/46 (115.2%)	45/46 (97.8%)	0.663§	47/48 (97.9%)	57/48 (118.75%)	0.571§	1§	1§

* The score ranges from 0 to 76 (correct items/total number of items [76]). For students who entered more than one completed checklist, the score of the last checklist was selected. Data are expressed as median (P10–P90) and mean ± standard deviation. Cohen's d (d) for effect size.

† Wilcolxon test for paired data.

‡ Mann-Whitney U-test.

§ Fisher's test.

Table 3 – Comparison of the Student Satisfaction and Self-Confidence Scale in Each Learning Scenario.

		SimCapture PRE	PRE-TRADITIONAL	PRE-traditional comparison	TRADITIONAL-POST	SimCapture POST	Traditional-POST comparison	Comparison of SimCapture groups	Comparison of traditional groups
Satisfaction with current learning (n[%])		n = 46			n = 48				
1. The teaching methods used in this simulation were helpful and effective	Strongly	0 (0)	1 (2.2)	0.522	1 (2.1)	1 (2.1)	0.507	0.581	0.721
	disagree	0 (0)	0 (0)		0 (0)	1 (2.1)			
	Disagree	0 (0)	0 (0)		1 (2.1)	0 (0)			
	Undecided	11 (23.9)	13 (28.3)		16 (33.3)	11 (22.9)			
	Agree	35 (76.1)	32 (69.6)		30 (62.5)	35 (72.9)			
	Strongly agree								
2. The simulation provided me with a variety of learning materials and activities to promote my learning during my training	Strongly	0 (0)	1(2.2)	0.184	0 (0)	0 (0)	0.086	0.118	0.013
	disagree	0 (0)	0 (0)		1 (2.1)	1 (2.1)			
	Disagree	0 (0)	0 (0)		3 (6.3)	1 (2.1)			
	Undecided	4 (8.7)	9 (19.6)		21 (43.8)	11 (22.9)			
	Agree	42 (91.3)	36 (78.3)		23 (47.9)	35 (72.9)			
	Strongly agree								
3. I enjoyed how my instructor taught the simulation	Strongly	0 (0)	1 (2.2)	0.740	1 (2.1)	0 (0)	0.429	0.867	0.867
	disagree	0 (0)	0 (0)		0 (0)	0 (0)			
	Disagree	2 (4.3)	3 (6.5)		2 (4.2)	2 (4.2)			
	Undecided	13 (28.3)	12 (26.1)		10 (20.8)	16 (33.3)			
	Agree	31 (67.4)	30 (65.2)		35 (72.9)	30 (62.5)			
	Strongly agree								
4. The teaching materials used in this simulation were motivating and helped me to learn	Strongly	0 (0)	1 (2.2)	0.457	0 (0)	1 (2.1)	0.167	0.597	0.052
	disagree	0 (0)	0 (0)		0 (0)	0 (0)			
	Disagree	1 (2.2)	0 (0)		4 (8.3)	1 (2.1)			
	Undecided	8 (17.4)	11 (23.9)		18 (37.5)	12 (25)			
	Agree	37 (80.4)	34 (73.9)		26 (54.2)	34 (70.8)			
	Strongly agree								
5. The way my instructor(s) taught the simulation was suitable to the way I learn	Strongly	0 (0)	0 (0)	0.657	0 (0)	0 (0)	0.544	0.640	0.547
	disagree	0 (0)	0 (0)		0 (0)	1 (2.1)			
	Disagree	2 (4.3)	3 (6.5)		1 (2.1)	3 (6.3)			
	Undecided	10 (21.7)	13 (28.3)		13 (27.1)	13 (27.1)			
	Agree	34 (73.9)	30 (65.2)		34 (70.8)	31 (64.6)			
	Strongly agree								

(*continued on next page*)

Table 3 (continued)

		SimCapture PRE	PRE-TRADITIONAL	PRE-traditional comparison	TRADITIONAL-POST	SimCapture POST	Traditional-POST comparison	Comparison of SimCapture groups	Comparison of traditional groups
Self-confidence in learning (n[%])		n = 46			n = 48				
6. I am confident that I am mastering the content of the simulation activity that my instructors presented to me	Strongly disagree	0 (0)	0 (0)	0.767	0 (0)	0 (0)	0.066	0.913	0.088
	Disagree	0 (0)	1 (2.2)		0 (0)	0 (0)			
	Undecided	4 (8.7)	3 (6.5)		11 (22.9)	4 (8.3)			
	Agree	21 (45.7)	21 (45.7)		22 (45.8)	20 (41.7)			
	Strongly agree	21 (45.7)	21 (45.7)		15 (31.3)	24 (50)			
7. I am confident that this simulation covered critical content necessary for the mastery of medical surgical curriculum	Strongly disagree	0 (0)	0 (0)	0.240	0 (0)	0 (0)	0.707	0.368	0.682
	Disagree	0 (0)	0 (0)		0 (0)	1 (2.1)			
	Undecided	0 (0)	2 (4.3)		1 (2.1)	2 (4.2)			
	Agree	12 (26.1)	8 (17.4)		11 (22.9)	10 (20.8)			
	Strongly agree	34 (73.9)	36 (78.3)		36 (75)	35 (72.9)			
8. I am confident that I am developing the skills and obtaining the required knowledge from this simulation to perform necessary tasks in a clinical setting	Strongly disagree	0 (0)	0 (0)	0.563	0 (0)	1 (2.1)	0.206	0.571	0.341
	Disagree	0 (0)	0 (0)		0 (0)	1 (2.1)			
	Undecided	0 (0)	1 (2.2)		3 (6.3)	0 (0)			
	Agree	16 (34.8)	14 (30.4)		19 (39.6)	15 (31.3)			
	Strongly agree	30 (65.2)	31 (67.4)		26 (54.2)	31 (64.6)			
9. My instructors used helpful resources to teach the simulation	Strongly disagree	0 (0)	0 (0)	0.969	0 (0)	1 (2.1)	0.712	0.637	0.527
	Disagree	0 (0)	0 (0)		0 (0)	0 (0)			
	Undecided	2 (4.3)	2 (4.3)		1 (2.1)	1 (2.1)			
	Agree	10 (21.7)	11 (23.9)		16 (33.3)	13 (27.1)			
	Strongly agree	34 (73.9)	33 (71.7)		31 (64.6)	33 (68.8)			
10. It is my responsibility as the student to learn what I need to know from this simulation activity	Strongly disagree	0 (0)	0 (0)	0.536	0 (0)	0 (0)	0.735	0.443	0.733
	Disagree	1 (2.2)	1 (2.2)		1 (2.1)	0 (0)			
	Undecided	0 (0)	2 (4.3)		1 (2.1)	1 (2.1)			
	Agree	10 (21.7)	11 (23.9)		16 (33.3)	14 (29.2)			
	Strongly agree	35 (76.1)	32 (69.6)		30 (62.5)	33 (68.8)			

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Table 3 (continued)

		SimCapture PRE	PRE-TRADITIONAL	PRE-traditional comparison	TRADITIONAL-POST	SimCapture POST	Traditional-POST comparison	Comparison of SimCapture groups	Comparison of traditional groups
Self-confidence in learning (n[%]) (cont.)		**SimCapture PRE**	**PRE-TRADITIONAL**	**PRE-traditional comparison**	**TRADITIONAL-POST**	**SimCapture POST**	**Traditional-POST comparison**	**Comparison of SimCapture groups**	**Comparison of traditional groups**
11. I know how to get help when I do not understand the concepts covered in the simulation	Strongly disagree	0 (0)	0 (0)	0.804	0 (0)	0 (0)	0.200	0.717	0.330
	Disagree	0 (0)	0 (0)		0 (0)	1 (2.1)			
	Undecided	1 (2.2)	2 (4.3)		5 (10.4)	2 (4.2)			
	Agree	12 (26.1)	13 (28.3)		17 (35.4)	11 (22.9)			
	Strongly agree	33 (71.7)	31 (67.4)		26 (54.2)	34 (70.8)			
12. I know how to use simulation activities to learn critical aspects of these skills	Strongly disagree	0 (0)	0 (0)	0.550	0 (0)	0 (0)	0.164	0.569	0.028
	Disagree	0 (0)	0 (0)		0 (0)	0 (0)			
	Undecided	0 (0)	1 (2.2)		1 (2.1)	1 (2.1)			
	Agree	12 (26.1)	10 (21.7)		23 (47.9)	14 (29.2)			
	Strongly agree	34 (73.9)	35 (76.1)		24 (50)	34 (68.8)			
13. It is the instructor's responsibility to tell me what I need to learn of the simulation activity content during class time*	Strongly disagree	0 (0)	0 (0)	0.778	0 (0)	0 (0)	0.019	0.763	0.006
	Disagree	0 (0)	0 (0)		0 (0)	1 (2.1)			
	Undecided	2 (4.3)	1 (2.2)		7 (14.6)	3 (6.3)			
	Agree	12 (26.1)	14 (30.4)		23 (47.9)	12 (25)			
	Strongly agree	32 (69.6)	31 (67.4)		18 (37.5)	32 (66.7)			

* Prebriefing: explanation of how to proceed during the simulation.

Table 4 – Costs of Consumables, Equipment and Instructors' Fees for Each Learning Scenario.

Consumables	Traditional teaching with an instructor (n = 318)	Cost in EUR	Teaching with SimCapture (n = 318)	Cost in EUR
Consumables*				
Underpad	17	5.08	17	5.08
Intravenous needle	387	6.09	1049.4	16.51
Blue butterfly with 23G Vacutainer adapter	425	207.24	699.6	341.15
Vacutainer needle	407	76.83	699.6	132.06
Tape	2	0.69	25.44	8.80
Non-sterile gauze	1400	22.02	1431	22.51
Nitrile gloves, L	100	4.72	286.2	13.51
Nitrile gloves, M	200	9.44	1399.2	66.03
Nitrile gloves, S	1000	47.19	1399.2	66.03
10 ml syringe	410	19.35	922.2	43.52
Vacutainer shield/holder	727	45.74	795	50.02
Vacutainer tube	1081	260.95	2385	575.73
		705.34		1340.95
Equipment				
Simulator (needle-insertion arm kit)†	1 per pair (857.89), 12 used	10294.68	1 per pair (857.89), 12 used	10294.68
Skin replacements for needle-insertion arm kits†	Twice yearly; 325,49 per skin replacement (12×325.49)/2	1952.94	Annual replacement anticipated in half the arms; 6×325.49	1952.94
SimCapture software license‡	0	0	-	8105.8
		12247.62		20353.42
Instructors' fees				
Gross salary for 5 months of teaching§ (212.96 × 5 = 1064)	1064 × 40 instructors	42560	1064 × 20 instructors	21280
TOTAL TEACHING COST		55512.96		42974.37

* All prices include VAT, as per university's usual supplier.
† Prices as stated in January 2024 on Laerdal website.
‡ As per Laerdal's estimate sent to the university. The item varies according to the technical equipment available at the university.
§ Published on the university's website.

repeat. SimCapture lets student pairs learn at their own pace, while making sure that both students are active all the time. Students can rewatch their videos of technique performance whenever they need to refresh their learning.

A decade has passed since Cook et al. (2013) and Shin et al. (2015) concluded, in two meta-analyses, that simulation modifies knowledge very little, but is very effective for the acquisition of technical skills. In 2020, a meta-analysis by Chernikova (Chernikova et al., 2020) corroborated those results, showing that technical skills improve most, and that students become more competent, when they arrive at simulation sessions with more prior theoretical knowledge. This explains the students' high level of satisfaction and self-confidence with SimCapture in our study, because they can practise more and therefore acquire better competence at performing the technical skill. Instructors, in turn, spend less time repeating theoretical concepts because students learn the theory themselves through the teaching material available on the virtual campus. However, this knowledge should always be assessed to ensure that students have prepared sufficiently before starting the simulation. Indeed, students who started with SimCapture (SimCapture PRE) arrived at the simulation session having studied little theory because they knew this part of the study would have no impact on their academic record, which demonstrates the need for assessment of theoretical knowledge. A systematic review by Oliveira Silva et al. (2022) found that simulation helped students develop self-confidence before they started clinical practice because exposure to the simulator promoted problem-solving. During simulation, students can make mistakes without harming patients and they can learn from those mistakes, thus saving them from mistakes in clinical practice (Breitkreuz et al., 2016).

SimCapture allows students to repeat technical parts that are the most challenging for them, because the program provides more practice time and less theory than in traditional classroom teaching with an instructor. In addition, observers also play an active role by describing each step out aloud and evaluating how their partners are performing the technique, whereas in traditional teaching observers may lose concentration due to their passive observer role. The passivity in therefore twofold, involving observing both the instructor and the partner performing the technique. Students are active only when practicing, and according to the results in our traditional teaching sessions, there is only time to complete the entire checklist once. According to El Hussein and Ha (2023), the observer role is effective because it causes less anxiety than the active role and allows students to focus more on learning, providing they are occupied with at least some activity, which is indeed the case with SimCapture.

The higher self-assessment scores in the SimCapture training sessions are explained by more practice taking place with the SimCapture program as instructor. The higher scores achieved by students receiving the traditional teaching session after the SimCapture (PRE-traditional session) than those starting with the traditional teaching (Traditional-POST session) are explained by the concept of deliberate practice, which is repeating a task after reflecting on one's performance (Motola et al., 2013). In our study, deliberate practice helped students memorize the checklist steps, leading to perceptions of higher self-confidence among the students who received the SimCapture training after the traditional teaching session. Su et al. (2023) showed that the more times a suturing technique was performed with a mobile-based web application, the higher the score awarded by the instructors. Hernon et al. (2024) found that self-confidence was associated with increased learning, observing low levels of self-confidence in final-year undergraduate nursing students who practised venipuncture only once with task trainers.

SimCapture has been proven to be cost-effective. Despite requiring more investment in materials and software licences, instructors do not have to be hired for small groups of 7–8 students. This study shows that students' self-confidence does not improve in a passive learning role (when the students observe instructors demonstrating a technique). When performing the technique repeatedly themselves with SimCapture, in an active role, self-confidence increases. Students are able to interact with a task trainer, which also gives automatic feedback. In our study the task trainer, the SimCapture for Skills® program, therefore enhanced students' self-confidence.

Limitations

Since the study was conducted at a single university with its own teaching characteristics, the data can be extrapolated only to similar academic settings. However, our results corroborate those reported in the literature and therefore reinforce the role of technology in simulation, and specifically with SimCapture.

The assessment methodology applied in the teaching plan for this subject prevented the teaching staff from assessing the students carrying out this complementary teaching. For this reason, we were only able to compare student self-assessments in the learning scenarios. Comparing this self-assessment with teaching staff assessments would be an interesting way to continue this line of research.

Conclusions

SimCapture for Skills® is an effective and financially feasible mobile-based instruction method for technical skills training in undergraduate nursing students.

Ethical approval

The study was approved by the Barcelona University's Ethics Committee under code IRB00003099.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Dra. Marta Raurell reports financial support was provided by University of Barcelona. Marta Raurell reports a relationship with University of Barcelona that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Marta Raurell-Torredà: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. **Carmen Obejo-Alamillos:** Investigation, Methodology, Supervision, Validation. **Concepción Turégano-Duaso:** Investigation, Methodology, Supervision, Validation. **Sílvia Esteban-Sepúlveda:** Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Roser Adalid-Villaronga:** Investigation, Methodology, Validation, Visualization. **Joan Maria Estrada-Masllorens:** Investigation, Methodology, Supervision, Validation. **José Antonio Sarria-Guerrero:** Investigation, Methodology, Supervision, Validation. **Luís Basco-Prado:** Conceptualization, Data curation, Formal analysis, Supervision, Validation, Writing – original draft, Writing – review & editing. **Ignacio Zaragoza-García:** Conceptualization, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Ana Belén Fernández-Cervilla:** Investigation, Methodology, Supervision, Validation.

References

Benavides, L., Tamayo Arias, J., Arango Serna, M., Branch Bedoya, J., & Burgos, D. (2020). Digital transformation in higher education institutions: a systematic literature review. *Sensors*, *20*(11), 3291. https://doi.org/10.3390/s20113291.

Bogossian, F. E., Cant, R. P., Ballard, E. L., Cooper, S. J., Levett-Jones, T. L., McKenna, L. G., Ng, L. C., & Seaton, P. C. (2019). Locating "gold standard" evidence for simulation as a substitute for clinical practice in prelicensure health professional education: A systematic review. *Journal of Clinical Nursing*, *28*(21-22), 3759-3775. https://doi.org/10.1111/jocn.14965.

Breitkreuz, K. R., Dougal, R. L., & Wright, M. C. (2016). How Do Simulated Error Experiences Impact Attitudes Related to Error Prevention? *Simulation in Healthcare: The Journal of the Society for Simulation in Healthcare*, *11*(5), 323-333. https://doi.org/10.1097/SIH.0000000000000174.

Bryant, K., Aebersold, M. L., Jeffries, P. R., & Kardong-Edgren, S. (2020). Innovations in simulation: nursing leaders' exchange of best practices. *Clinical Simulation in Nursing*, *41*, 33-40.e1. https://doi.org/10.1016/j.ecns.2019.09.002.

Cant, R., Cooper, S., & Ryan, C. (2022). Using virtual simulation to teach evidence-based practice in nursing curricula: A rapid review. *Worldviews on Evidence-Based Nursing*, *19*(5), 415-422. https://doi.org/10.1111/wvn.12572.

Carter-Templeton, H., March, A. L., & Perez, E. (2018). Use of mobile computing devices among nursing students for information seeking in simulation. *CIN: Computers, Informatics, Nursing*, *36*(1), 1-4. https://doi.org/10.1097/CIN.0000000000000411.

Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. (2020). Simulation-based learning in higher education: A meta-analysis. *Review of Educational Research*, *90*(4), 499-541. https://doi.org/10.3102/0034654320933544.

Cook, D. A., Hamstra, S. J., Brydges, R., Zendejas, B., Szostek, J. H., Wang, A. T., Erwin, P. J., & Hatala, R. (2013). Comparative effectiveness of instructional design features in simulation-based education: Systematic review and meta-analysis. *Medical Teacher*, *35*(1), e867-e898. https://doi.org/10.3109/0142159X.2012.714886.

El Hussein, M. T., & Ha, C. (2023). Experiences of nursing students in observer roles during simulation-based learning and the impact on patient safety: A scoping review. *Clinical Simulation in Nursing*, *78*, 7-17. https://doi.org/10.1016/j.ecns.2023.02.003.

Farrés-Tarafa, M., Bande, D., Roldán-Merino, J., Hurtado-Pardos, B., Biurrun-Garrido, A., Molina-Raya, L., Raurell-Torredà, M., Casas, I., & Lorenzo-Seva, U. (2021). Reliability and validity study of the Spanish adaptation of the "Student Satisfaction and Self-Confidence in Learning Scale" (SCLS). *PLOS ONE*, *16*(7), Article e0255188. https://doi.org/10.1371/journal.pone.0255188.

Hegland, P. A., Aarlie, H., Strømme, H., & Jamtvedt, G. (2017). Simulation-based training for nurses: Systematic review and meta-analysis. *Nurse Education Today*, *54*, 6-20. https://doi.org/10.1016/j.nedt.2017.04.004.

Hernon, O., McSharry, E., Simpkin, A. J., MacLaren, I., & Carr, P. J. (2024). Evaluating nursing students' venipuncture and peripheral intravenous cannulation knowledge, attitude, and performance: A two-phase evaluation study. *Journal of Infusion Nursing*, *47*(2), 108-119. https://doi.org/10.1097/NAN.0000000000000539.

INACSL Standards Committee (2021). Healthcare Simulation Standards of Best Practice®. *Clinical Simulation in Nursing*. https://doi.org/10.1016/j.ecns.2021.08.018.

Laerdal Medical. (2025). Simcapture for Skills. https://laerdal.com/us/information/simcapture-for-skills/. Accessed January 14, 2025.

Li, Y. Y., Au, M. L., Tong, L. K., Ng, W. I., & Wang, S. C. (2022). High-fidelity simulation in undergraduate nursing education: A meta-analysis. *Nurse Education Today*, *111*, Article 105291. https://doi.org/10.1016/j.nedt.2022.105291.

Lioce, L. (2020). *Healthcare simulation dictionary* (Second). Agency for Healthcare Research and Quality. https://doi.org/10.23970/simulationv2.

López-Entrambasaguas, O. M., Calero-García, M. J., Díaz-Meco-Niño, A. M., & Martínez-Linares, J. M. (2019). Quality assurance in nursing education: A qualitative study involving students and newly graduated nurses. *International Journal of Environmental Research and Public Health*, *17*(1), 240. https://doi.org/10.3390/ijerph17010240.

Motola, I., Devine, L. A., Chung, H. S., Sullivan, S. E., & Issenberg, S. B. (2013). Simulation in healthcare education: a best evidence practical guide. AMEE Guide No. 82. *Medical Teacher*, *35*(10), Article e1511-30. https://doi.org/10.3109/0142159X.2013.818632.

Oliveira Silva, G., Oliveira, F. S. E., Coelho, A. S. G., Cavalcante, A. M. R. Z., Vieira, F. V. M., Fonseca, L. M. M., Campbell, S. H., & Aredes, N. D. A. (2022). Effect of simulation on stress, anxiety, and self-confidence in nursing students: Systematic review with meta-analysis and meta-regression. *International Journal of Nursing Studies*, *133*, Article 104282. https://doi.org/10.1016/j.ijnurstu.2022.104282.

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. https://doi.org/10.1016/j.nedt.2014.09.009.

Su, J.-M., Wu, C.-Y., Hong, W.-T., Chen, P.-S., Hung, K.-S., & Wang, C.-J. (2023). Application of mobile-based web app to enhance simple suturing skills of nurse practitioners. *Nurse Education Today*, *131*, Article 105959. https://doi.org/10.1016/j.nedt.2023.105959.