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Research

Acquisition of physical assessment skills among undergraduate nursing students using simulation-based assessment: A mixed-methods study

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ABSTRACT

Background: The ABCDE (Airway, Breathing, Circulation, Disability, and Exposure) approach is a valid model for teaching physical examination skills.
Aim: Evaluate how physical examination is carried out based on the ABCDE approach using simulation training.
Methods: Mixed-methods study on undergraduate nursing students during the 2022 to 2023 academic year at University of Barcelona. For the quantitative analysis, the Clinical Simulation Evaluation Tool was used.
Results: About 887 students evaluated in 45 simulation sessions with high-fidelity manikins in second year, and 90 scenarios in third and fourth year respectively. Pulmonary auscultation was not performed as students advanced through the degree ($p < 0.001$). Instead, they became more competent in identifying changes in the patient ($p < 0.001$). Seven categories emerged from the qualitative analysis: previous experience, importance of physical assessment, feelings and emotions generated by the simulation, learning enablers, learning obstacles, personal knowledge gaps and autonomous study time.
Conclusions: By means of more simulation sessions, students gain the capacity to identify changes in the patient's condition, but as more hours of clinical practice are accumulated, pulmonary auscultation is no longer performed.

Introduction

Physical assessment skills are techniques such the inspection, palpation, percussion and auscultation of a patient with the purpose of gathering information about their physiological state. Instruction and training in physical assessment skills in undergraduate nursing education is essential to facilitate decision making on which nursing procedures should be followed for optimum patient care. A proper physical examination allows the patient's condition to be identified and the outcome of the nursing procedures undertaken to be evaluated.

Despite the evident need, there is a lack of consensus in the literature on what physical assessment skills should be taught at undergraduate level (Morrell et al., 2021). Furthermore, the evidence suggests that the physical examination skills taught at university level are out of sync with the skills required when students are engaged in clinical practice. Kohtz et al. (2017) interviewed 193 nurses in a teaching hospital about which physical assessment skills they regularly used, finding that only 30 of the 126 (23.8%) explored in the survey were routinely applied in clinical practice.

In the most recent review on which physical assessment skills to teach, Morrell et al. (2021) outline 11 skills that nurses regularly use in clinical practice and that are also taught in the undergraduate curricula of the universities examined, namely: assess mental status and level of consciousness, evaluate breathing, evaluate speech, inspect abdomen, inspect chest shape, inspect overall skin colour, inspect skin lesions, inspect/palpate extremities for oedema, inspect wounds, palpate distal pulses for circulation and palpate extremities for temperature.

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In the study by Fusner et al. (2020) with university lecturers, similar findings were obtained, although they grouped physical assessment skills by system, with teachers identifying the integumentary, central nervous and cardiovascular systems as the most relevant systems to teach.

Tan et al. (2021) highlights in their review that nurses are still taught physical assessment skills based on the biomedical model of body systems assessment. While the physician performs an assessment focused on making a tentative diagnosis based on signs and symptoms, nurses perform a more holistic assessment focused on identifying nursing problems as a means of planning the necessary care. The use of the ABCDE (Airway, Breathing, Circulation, Disability and Exposure) approach is proposed by Douglas et al. (2016) to agree on a minimum set of physical examination skills that nurses should routinely apply in clinical practice. It contains the 11 skills identified in Morrell's review (Morrell et al., 2021).

Background

Tan et al. (2021) also proposes that the evidence-based ABCDE rote model, designed to achieve focused and systematised data collection, should be taught using simulation exercises. Simulation is a learning methodology that has experienced a boom in the last ten years and has consequently been regulated in different countries (Bogossian et al., 2019). According to a study in 17 universities, simulation allows nursing procedures to be taught by combining theory with the practical training received in undergraduate education. The Nursing Intervention Classification (NIC) (Bulechek et al., 2013) with Respiratory monitoring (3350), Vital signs monitoring (6680) and Neurologic monitoring (2620), applied in the ABCDE model, could be taught using simulation with high-fidelity manikins, which reproduce the functions of the human body with a high degree of realism (Raurell-Torredà et al., 2020).

In addition, simulation allows the practice to be repeated many times to ensure knowledge and/or skills retention. The same simulation needs to be repeated, with changes made but addressing the same issue to achieve an optimal learning curve (Hung et al., 2021).

In the nursing degree at our university, we implemented a cross-cutting training programme (second, third and four years) based on simulation with high-fidelity manikins to teach physical assessment skills using the ABCDE approach. After four years consolidating the training programme, the aim of this study was to evaluate how physical assessment based on the ABCDE approach is carried out and, through a qualitative design, to explore nursing students' perceptions of the learning outcomes.

Methods

A cross-sectional descriptive and phenomenological study was carried out using a mixed methodology in which both quantitative and qualitative data were analysed with the intention of evaluating simulation performance on undergraduate nursing students during the 2022 to 2023 academic year at University of Barcelona. Inclusion criteria: Second-, third- and fourth-year students who perform simulation sessions with high-fidelity manikins in accordance with the academic programme (second year, a single session; third and fourth year, two sessions in the same semester). Exclusion criteria: Students who do not provide their consent to participate in the study.

Description of the training

The simulation-based training programme includes an initial self-study phase, conducted online using the virtual campus, in which students do the presimulation exercises (review of theoretical content related to the clinical cases to be handled in the simulation scenarios). Subsequently, they visit the simulation laboratory in line with the academic programme, to participate in the different simulation phases, in accordance with the quality standards recommended by the International Nursing Association of Clinical and Simulation Learning (INACSL Standards Committee, 2021).

- Prebriefing phase: The learning objectives are explained, the confidentiality document and the fictional contract—what they can do with the manikin—are agreed, and five minutes are set aside for familiarizing themselves with the environment (screens and clinical equipment).

- Scenario phase: The students interact with the manikin for 15 minutes, handling one of the clinical cases they have worked on in the online theory. Three students take on the role of nurses and the remainder of the group (three/four students) are observers.

- Debriefing phase: The PEARLS (Promoting Excellence and Reflective Learning in Simulation) model (Eppich & Cheng, 2015) is applied. Feelings are determined (how they felt during the scenario), a description is given of what happened during the scenario, the gaps in knowledge identified in the description phase are analysed and the session is concluded by commenting on what lessons can be learned for future sessions.

These simulation sessions are for training purposes only and constitute a requirement set out in the teaching plan for the subject to achieve a minimum score of 8 out of 10 in the presimulation exercises and to attend the scheduled session in accordance with the previously communicated timetable. All the simulation sessions used the Human Patient Simulator (HPS), SIM MAN 2G®, Laerdal Medical, Wappingers Falls, NY, USA, to perform patient assessment.

Study variables

Socio-demographic and academic background: age, sex, health work experience, hours of clinical practice prior to the simulation session.

Overall score on the evaluation grid of physical assessment skills. The Clinical Simulation Evaluation Tool (CSET) was employed, validated by Henneman et al. (2007) and Wolf et al. (2011) with an inter-observer reliability of 95%. It assesses student competence in the following categories (University of Massachusets Amherst, 2010): patient safety and communication, patient assessment, recognition of signs and symptoms, problem identification, and nursing diagnostics and interventions used to address the problem. To guarantee maximum objectivity, each section was scored using a simple dichotomous point system. If the behaviour is observed, the student is awarded 1 point for that item; otherwise, the score for that behaviour is 0. For each category, the points were totalled, and a score calculated from the total possible points.

Only items referring to patient assessment and recognition of signs and symptoms were used to evaluate the physical assessment using the ABCDE approach (Appendix A. Supplementary Material). In each session, one of the teachers participating in the session assessed the three students working together in the scenario.

Students' comments on the training received using the data collection method known as the focus group with a purposive and opinionated sample. The focus group makes it possible to collect the opinions, thoughts, feelings and experiences of the participants based on their accounts. It facilitates the spontaneity of the respondents' answers, allowing their contributions to be explored in greater depth.

Sample size calculation

Expecting a moderate effect of training (0.6) between the different years in the undergraduate degree (Creswell & Guetterman, 2019), with a confidence level of 95%, 45 sessions per degree year had to be

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evaluated. For the qualitative analysis, no sample size calculation was carried out, but different focus groups were conducted for each year until data saturation was reached.

Each focus group comprised six to eight students and lasted 60 to 90 minutes. A group interview script was used with a list of topics to be explored related to the research objectives: What experience did you have of physical assessment prior to the simulation exercises? What is the importance of physical assessment for you? How did this physical assessment simulation exercise make you feel? What made learning about physical assessment easier for you? What made learning about physical assessment more difficult for you? What do you think you still need to learn about physical assessment?

The number of focus groups to be held depended on the saturation of the data provided. To ensure the quality of the qualitative research, Lincoln and Guba's criteria of rigor were followed (Lincoln & Guba, 1985): 1-Credibility: the transcript of each focus group was sent to the participants so that the results are recognized as true by the informants themselves; 2-Transferability: the type of sampling, which was purposive and opinionated, was taken into account. 3-Consistency: to ensure this criterion, in the focus groups there were two members of the research team (one conducted the group interview and the other was the observer) and two researchers independently analyzed the data obtained and then pooled them. 4-Confirmability: the two researchers who conducted the focus groups and data analysis were external to the University of X and had no relationship with the participants.

Statistical analysis

Categorical variables were represented as frequencies and percentages, using Fisher's test for group comparison. The results of quantitative variables were expressed as the mean and standard deviation (SD) or the median and interquartile range (P25-P75), depending on the normality of distribution. Groups were compared using analysis of variance, the ANOVA test. Post-hoc analysis was performed using Dunnett's test. A P-value < 0.05 was considered significant. To study the correlation between quantitative variables, Pearson or Spearman was used.

For the analysis of the data obtained in the focus groups, the following steps were followed: transcription, coding, categorisation and interpretation of the data. For coding and categorisation, ATLAS.ti software was used.

The following categories of analysis were determined:

- Category 1: Previous experience.
- Category 2: Importance of physical assessment.
- Category 3: Feelings and emotions generated by the simulation.
- Category 4: Learning enablers.
- Category 5: Learning obstacles.
- Category 6: Personal knowledge gaps.
- Category 7: Autonomous study time.

Ethics

The project was sent to the bioethics committee of the University of Barcelona, obtaining the necessary permission.

For the quantitative study, all students were informed and asked if they wanted to take part in the study. They were given informed consent for this concept.

For the qualitative study (focus groups), potential respondents were informed of the objectives of this research study and invited to participate. Those who agreed to participate were asked to sign an informed consent form. They were also asked for permission to be audio-recorded. In the transcription, and in order to guarantee the anonymity of the participants, each participant was assigned a code consisting of the letter P for participant, a number followed by the letter G for group and the number of the focus group, and in brackets the year to which they belonged. Thus, for example, a participant in the first focus group was assigned the code P1G1 (2nd year) because he was a second-year student. The students were identified with a code known only to the principal investigator of the study. The researchers who analysed the results of the different sessions did not have access to this personal data. The focus groups were conducted in conditions of privacy and confidentiality appropriate for the participants and were held in a room provided by the university.

Results

The cross-sectional study involved 304 second-year, 299 third-year and 284 fourth-year students evaluated in 45 simulation scenarios in second year, and 90 scenarios in third and fourth year respectively, because they participated in two consecutive sessions in the same semester.

They were predominantly female, aged between 21 and 23 years and with more work experience in other health professions in the latter years of the degree programme Table 1.

The same table shows the number of hours of clinical practice they had completed before participating in the simulation session.

They scored between 6.2 and 6.7 in patient assessment, with 10 being the highest score, with no differences between the different groups and sessions (p = 0.23) Table 2. No correlation was found between the hours of clinical practice and score during the simulation session (Rho = 0.08, p = 0.21).

The qualitative analysis of completion of the different items (Table 3) shows that heart rate (HR) and blood pressure (BP) was always monitored and consciousness was assessed, as well as whether the patient was breathing and had a patent airway. Bowel sounds were not auscultated in any session of any year. Fourth-year

Table 1
Socio-demographic and academic background of the students.

	2nd year N = 304 45 sessions	3rd year N = 299 45 sessions (Two consecutive sessions in the same semester)		4th year N = 284 45 sessions (Two consecutive sessions in the same semester)	
Sex	91.3% female	89.3% female		89.1% female	
Age	21.72±6.3	23.3 ± 7.7		23.4 ± 5.1	
Health work experience	16.1%	27.4%		40.1%	
		1st session	2nd session	1st session	2nd session
Clinical practice carried out	0 h*	180 h 2nd year*	180 h 2nd year 200 h 3rd year	180 h 2nd year 400 h 3rd year 120 hours 4th year	180 h 2nd year 400 h 3rd year 300 hours 4th year

* In second year and the 1st session of third year, the simulation is scheduled to take place before the start of clinical practice.

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Table 2
Comparison between different years and simulation sessions.

	2nd year $N = 45$	3rd year 1st session $N = 45$	3rd year 2nd session $N = 45$	4th year 1st session $N = 45$	4th year 2nd session $N = 45$	p-value*
CSET score† (Mean ± SD)	6.2 ± 1.4	6.2 ± 1.3	6.1 ± 1.1	6.7 ± 1.3	6.3 ± 0.9	0.23

Clinical Simulation Evaluation Tool assessment (Appendix A. Supplementary material).
* ANOVA test.

students neglected to take the patient's temperature, but instead assessed pulses, heart rate and extremities compared to second- and third-year students. Initially, four-year students (1st session) also failed to calculate the respiratory rate (RR) but rectified this in the 2nd session. Something similar happened at the beginning of third year regarding pain assessment.

Students ceased to perform the auscultation of lung sounds as they progressed through the years of the degree programme. On the other hand, the more simulation sessions they had completed, the more proficient they became at identifying hemodynamic changes in the patient Table 3.

Seven focus groups were conducted with second-, third- and fourth-year nursing students. Data saturation was reached with this number. Of these focus groups, there were a total of 44 participants (10 second-year students, 13 third-year students and 21 fourth-year students).

The findings for each of the categories were as follows:

- Category 1: Previous experience

Second-year students stated that their experience with regard to physical assessment was only theoretical, acquired in seminars in some subjects of the degree programme. On the other hand, third- and fourth-year students, in addition to this theoretical experience, emphasised that they had acquired experience through simulations carried out in previous years and through clinical practice.

Verbatim:

P1G5 (4th year): *Classroom theory and what we have seen in clinical practice.*
P3G5 (4th year): *In simulations we carried out in previous years.*

- Category 2: Importance of physical assessment

Participants in all years stressed that the physical assessment procedure is of paramount importance for good patient care.

Verbatim:

P2G1 (2nd year): *I think it is very important because it is the first contact with the patient and if you conduct a proper examination, you can make a better diagnosis.*
P2G2 (2nd year): *I believe it is essential, because it is the first thing we must assess in a patient.*
P4G5 (4th year): *It is what helps you decide what to do and what not to do. It helps you make decisions.*

- Category 3: Feelings and emotions generated by the simulation

For second-year students, the simulation generated more nervousness, anxiety, confusion and uneasiness because they did not know what to do. Some third- and fourth-year students expressed stress, fear and apprehension, mainly for not considering the manikin to be a patient and having to verbalise their actions. However, most of the respondents from these years, as they were already familiar with the dynamics of the simulations, revealed that the debriefing, above all, had given them more self-confidence and more self-assurance to go on placement and to take the role of nurse.

Verbatim:

P4G3 (3rd year): *The debriefing makes us realise what we've neglected and what we haven't done, but also what we've done well, and all this reassures us.*
P3G5 (4th year): *It has given me more confidence because if it were to happen to me in the future, I would know what to do, at least the steps to follow.*

- Category 4: Learning enablers

The participants highlighted that the simulation was an exercise that greatly facilitated their learning of the physical assessment procedure, but they pointed out that performing simulations before going on placement would have proven more beneficial, as they felt it would have enhanced their knowledge. Furthermore, they believed they carried out very few simulations. They also stated that the previous knowledge acquired in the theoretical subjects and in seminars, as well as the material available on the virtual platform, had helped them acquire knowledge in this domain.

Verbatim:

P2G3 (3rd year): *I think that up until I did the simulation, I didn't know how to keep it so structured.*
P6G5 (4th year): *... it's useful to do simulations before clinical practice, to go on placement and understand what's going on.*
P1G6 (4th year): *Repetition and doing it... Performing, applying and doing it.*
P2G6 (4th year): *Doing more simulations would facilitate our learning process.*
P2G5 (4th year): *You learn from the theory, although you may forget it. But with simulation, as you are doing it, everything sticks with you much better, you internalise it.*

- Category 5: Learning obstacles

The second-year students felt that their learning was hindered by the lack of videos demonstrating how to carry out an ABCDE assessment and a prior theoretical explanation. Moreover, they pointed out that the time dedicated to the simulation session was insufficient.

The third- and fourth-year respondents acknowledged that performing few simulation exercises posed an obstacle to their learning.

Verbatim:

P2G1 (2nd year): *... A video of how to perform the ABCDE. A video of a specific case of how to perform the ABCDE.*
P2G4 (3rd year): *... Doing it only once a year isn't enough. It should be done more often instead of other stuff.*
P4G5 (4th year): *Doing it more often would give us a lot more confidence when we are on placement. We wouldn't be so apprehensive and embarrassed; we would know how to perform better.*

- Category 6: Personal knowledge gaps

The participants reported that they lacked self-confidence and would gain this confidence by performing more simulations as they would be able to internalise and automate the procedure.

The second-year students stated that they lacked communication skills to interact with the patient.

Verbatim:

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Table 3
Completion of the different items according to the number of simulation sessions.

	N (%)					*p*-value*									
	2nd year *N* = 45	3rd year 1st session *N* = 45	3rd year 2nd session *N* = 45	4th year 1st session *N* = 45	4th year 2nd session *N* = 45	2nd vs 3rd-1st	2nd vs 3rd- 2nd	2nd vs 4th- 1st	2nd vs 4th-2nd	3rd-1st vs 3rd-2nd	3rd-1st vs 4th-1st	3rd-1st vs 4th-2nd	3rd-2nd vs 4th-1st	3rd-2nd vs 4th-2nd	4th-1st vs 4th-2nd
Temperature	39 (86.7)	33 (73.3)	35 (77.8)	25 (55.6)	24 (53.3)	0.19	0.41	**0.002**	**0.001**	0.81	0.12	0.08	**0.04**	**0.02**	1
HR	44 (97.8)	43 (95.6)	44 (97.8)	45 (100)	44 (97.8)	1	1	1	1	1	0.49	1	1	1	1
BP	44 (97.8)	45 (100)	44 (97.8)	44 (97.8)	45 (100)	1	1	1	1	1	1	1	1	1	1
RR	37 (82.2)	40 (88.9)	35 (77.8)	31 (68.9)	36 (80)	0.55	0.79	0.22	1	0.26	**0.04**	0.4	0.47	1	0.33
Oxygen saturation	45 (100)	45 (100)	45 (100)	45 (100)	45 (100)	1	1	1	1	1	1	1	1	1	1
Assess pain	31 (68.9)	18 (40)	37 (82.2)	31 (68.9)	28 (62.2)	**0.01**	0.22	1	0.66	**<0.001**	**0.01**	0.06	0.22	0.06	0.65
Identify changes[†]	Not assessable	25 (55.6)	30 (66.7)	41 (91.1)	40 (88.9)	-	-	-	-	0.39	**<0.001**	**<0.001**	**0.009**	**0.02**	1
Airway patency	44 (97.8)	42 (93.3)	45 (100)	40 (88.9)	41 (91.1)	0.61	1	0.20	0.36	0.24	0.71	1	0.05	0.12	1
Breathing	41 (91.1)	43 (95.6)	41 (91.1)	42 (93.3)	41 (91.1)	0.68	1	1	1	0.68	1	0.7	1	1	1
Circulation (pulses)	23 (51.1)	32 (71.1)	26 (57.8)	35 (77.8)	39 (86.7)	0.08	0.67	**0.01**	**<0.001**	0.27	0.63	0.13	**0.07**	**0.004**	0.41
Consciousness	41 (91.1)	42 (93.3)	43 (95.6)	41 (91.1)	43 (95.6)	1	1	1	1	1	1	1	0.68	1	0.68
Lung sounds (e.g. abnormal)	34 (75.6)	28 (62.2)	29 (64.4)	19 (42.2)	6 (13.3)	0.25	0.36	**0.002**	**<0.001**	1	0.09	**<0.001**	0.06	**<0.01**	**0.004**
Bowel sounds (e.g. hyperactive)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1	1	1	1	1	1	1	1	1	1
Heart rate (e.g. irregular)	9 (20)	10 (22.2)	7 (15.6)	25 (55.6)	21 (46.7)	1	0.78	**0.001**	**0.01**	0.59	**0.002**	**0.02**	**<0.001**	**0.003**	0.52
Extremities (e.g. oedema)	34 (75.6)	32 (71.1)	32 (71.1)	41 (91.1)	42 (93.3)	0.81	0.81	**0.09**	**0.04**	1	**0.03**	**0.01**	**0.03**	**0.01**	1
Check intravenous equipment and drains	Not assessable	Not assessable	Not assessable	Not assessable	Not assessable	-	-	-	-	-	-	-	-	-	-

Significant *p*-values are marked in black.
* Fisher Test. Significant *P*-values are marked in black.
† In second year, the scenario is static, only the initial programming of the manikin is carried out, which is not modified during the students' simulation exercise, so no evaluation can be made as to whether students identify changes. In third and fourth year there are two scheduled phases (initial and final).

P2G2 (2nd year): *Dealing with the patient, the rapport with them. Knowing what questions to ask them. How to communicate with the patient and talk to them about what we're doing.*
P4G3 (3rd year): *. . . Doing more simulations would be good for us. We would feel more at ease in stressful situations and gain more self-confidence. In every session, you learn. In the last one, I learnt loads and in this one I'm still learning different things.*
P2G5 (4th year): *Internalising it and making it more automated. For it to come naturally without having to think about every single thing. If we did it more often, we would be able to automate our actions.*

- Category 7: Autonomous study time

The participants noted that the hours they had to dedicate to autonomous study time with the materials available on the virtual platform were excessive and they lacked the motivation to do so. They did so out of a sense of obligation and did not perceive its usefulness. They stated their preference for more passive work such as watching videos and, above all, they would have liked to have feedback on the work done. However, they would find it more useful to solve clinical cases on the virtual platform if subsequently they were to handle all of them in the simulation sessions.

Verbatim:

P4G6 (4th year): *In Moodle we have some cases, but they are quite pointless.*
P1G6 (4th year): *We have to devote loads of hours to it and you don't learn... You do it out of obligation but with no motivation.*
P5G7 (4th year): *In the Moodle cases there is no feedback on the answers.*
P5G7 (4th year): *...Since they are cases that are studied because of their importance, it would be great to be able to finish the degree having mastered all these cases, in other words, to have covered them all in simulation exercises.*

Discussion

Obtaining a comprehensive health history and performing an accurate physical examination are critical skills that form the first step in the diagnostic reasoning process (Lee et al., 2019). Student feedback affirms the need to learn how to perform a proper physical examination and their perception of simulation as an excellent methodology, as do Tan et al. (2021); Weaver and Jones (2021) and Tuzer et al. (2016) specifically for lung and cardiac examination training, concludes that high-fidelity simulators are effective, with no difference in skills acquisition when using an HPS or a standardised patient. Goldsworthy et al. (2021) demonstrates that simulator-based training for learning cardiac and respiratory auscultation is excellent but can be improved by adding auscultation learning sessions. Jaberi and Momennasab (2019), provides evidence of the effectiveness of standardised patient simulation for physical examination of the abdomen. However, auscultation was the technique least performed by students during the physical examination with the manikin. Abdominal auscultation was never performed, in any of the years, which can be explained by the fact that they had not been trained to acquire this technical skill, as had been done with the measurement of blood pressure, the respiratory and heart rate, in the second year before the simulation session with the high-fidelity manikin. As for pulmonary auscultation, students in the last year of the degree, i.e. with more hours of accumulated clinical practice, hardly practised it. In fact, auscultation (of the heart, lungs and abdomen) is one of the least performed techniques, as analysed by Egilsdottir et al. (2019) in groups of nursing students. According to Tan et al. (2021) the explanation would be the low use of auscultation in clinical practice, because nurses do not see the need to practise this skill, believing it is the responsibility of other professionals such as doctors, and that in fact, if they do practise it, doctors then repeat the procedure, so it ends up being a futile exercise.

According to Sarıtaş et al. (2024) simulation is an ideal method for learning auscultation skills because it is more sustained over time than traditional education.

The students expressed a lack of confidence in performing physical examinations, as already identified by Maniago in his review (Maniago et al., 2020). According to Bulfone et al. (2021) this lack of self-confidence is a predictive factor of academic failure, so providing an optimum training methodology is essential to fill this gap.

They also highlighted the need for more simulation sessions to consolidate learning, as does Wang et al. (2019). Students commented that simulation exercises generated anxiety. However, simulation was positively appraised by the students because, despite the pressure of being observed by the teacher, the mistakes made did not have consequences and also generated a memory of the mistake made, coinciding with Wang et al. (2019). Simulated-based learning improves patient safety because it facilitates learning from mistakes made during the simulation, which in turn minimises the repetition of the same mistakes in clinical practice. In fact, the students redirected mistakes in the second simulation session and in the last year, and by the time they had completed three simulation sessions and accumulated 880 hours of clinical practice, there was clearly an improvement in the capacity to identify changes in the manikin, which demonstrates that they re-evaluated the patient during the simulation session, as they had assimilated the ABCDE approach.

Second-year students claimed that it would have helped them to have a video on how to correctly perform the ABCDE approach in the prebriefing phase. In relation to this request, there are two options to consider for future courses: improving the training content of the prebriefing phase, adding a video to the virtual platform as well as the theoretical content related to the physical examination, or applying the teaching method known as productive failure, described by Palominos et al. (2022) said method consists of two phases: an exploratory phase in which students participate in the simulation without prior instruction, with the teacher's explicit permission to make mistakes, and a consolidation phase (second simulation session) in which the teacher presents the solutions to the problems presented during the debriefing. This phase is an opportunity for students to check their performance against the teacher's input, identifying gaps in knowledge. According to a study by the same authors, (Palominos et al., 2021) students who trained using productive failure improved their explanatory knowledge and transfer knowledge because they adopted more active learning behaviour.

Strengths and limitations

Although the scale chosen for the evaluation of the students' performance during the simulation scenario was validated in our cultural context, and we evaluated interrater agreement in five sessions, calculated using Cohen's Kappa coefficient, and was greater than 0.70, certain subjectivity cannot be ruled out. A convenience sample of nursing students was taken from a single university, and it is therefore possible that the results cannot be generalized for all nursing students. Finally, the results may be affected by the Hawthorne effect, simply because the participants know that they were being evaluated.

Conclusions

Simulation training in the ABCDE approach is excellent for acquiring physical assessment skills. By means of more simulation sessions, students gain the capacity to identify changes in the patient's condition, but as more hours of clinical practice are accumulated, pulmonary auscultation is no longer performed.

Recommendations for further research

Most of the studies on simulation methodology evaluate its effectiveness in level 1 and 2 of Kirkpatrick's hierarchy (reaction—participants view on the learning experience—and acquisition of knowledge and skills—performance in simulator). It would be important to evaluate how these students apply physical examination on the real patient, being observed by the clinical lecturer during clinical placement. There is a need for research in levels 3 and 4 (behavioral change—transfer learning to the practice setting- and benefits to patients—improvement in health or well-being of patients).

Declaration of competing interest

The authors declare that they have no known competing personal relationships or financial interests that may have influenced the study reported in this paper.

CRediT authorship contribution statement

Marta Raurell-Torredà: Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Data curation, Conceptualization. **Luis Basco-Prado:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Data curation, Conceptualization. **Vanessa Fernandez-González:** Writing – review & editing, Investigation. **Marc Bohils-Valle:** Writing – review & editing, Investigation. **Alberto Diz-Martínez:** Writing – review & editing, Investigation. **Joan Maria Estrada-Masllorens:** Writing – review & editing, Investigation. **José Antonio Sarria- Guerrero:** Writing – review & editing, Methodology, Investigation, Data curation, Conceptualization. **Eva Guix-Comellas:** Writing – review & editing, Methodology, Investigation, Data curation, Conceptualization. **Miguel Ángel Hidalgo-Blanco:** Writing – review & editing, Investigation. **Montserrat Lamoglia-Puig:** Writing – review & editing, Methodology, Investigation, Data curation, Conceptualization. **Roser Adalid-Villaronga:** Writing – review & editing, Investigation. **Ana Belén Fernandez-Cervilla:** Writing – review & editing, Investigation.

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Data availability statement

The data would be available on request from a researcher upon submission of a project.

Ethics statement

The study protocol was reviewed and approved by the Ethics Committee of the University of Barcelona (IRB number: 00003099).

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.teln.2025.06.004.

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