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REVIEW

Cultivating learning *in vitro*: A meta-ethnography of learning experiences of nursing students regarding high-fidelity simulation

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Abstract

Objectives: To synthesise the experience of nursing students in their final years regarding high-fidelity simulation in acute and critical care.

Background: For the complex and changing healthcare environment, new tools are required to help health students, educational staff and managers to design and present rewarding educational simulations. Due to the complexity and limited learning opportunities in real settings, high-fidelity simulation enables students to acquire skills for the provision of acute and critical care in a controlled environment that closely imitates reality; however, the literature on students' learning experiences with this education methodology is still limited.

Design: This study followed Noblit and Hare's interpretive meta-ethnography, which was written and reviewed for reporting clarity against the EQUATOR checklist using the eMERGe.

Data sources: A comprehensive systematic search strategy was carried out in five databases: PubMed, Scopus, CINAHL, Web of Science and PsycINFO.

Review methods: Ten studies met the research objective and inclusion criteria.

Results: The metaphor 'Cultivating learning *in vitro*' and four themes were developed to describe the learning experiences of nursing students regarding high-fidelity simulation in acute and critical care. The themes were as follows: Learning roots—Ways to learn during high-fidelity simulation; Learning stimulants—Elements that favour learning; Learning impairments—Elements that hinder learning; and Learning flourishing—Results after high-fidelity simulation.

Conclusions: Seeing, doing and reflecting constituted the main sources of learning. Students identified the stimulating and debilitating aspects of learning which could help in the design of simulation sessions and promote their incorporation into nursing curricula. Finally, 'the flowering of the plant' represents the learning outcomes developed in a controlled and safe environment.

Relevance to clinical practice: The results of this meta-ethnography provide keys to promote change in teaching planning in relation to acute and critical care.

KEYWORDS
care, high-fidelity simulation training, nursing student, qualitative research

1 | INTRODUCTION

The integration of theoretical and practical knowledge must be accounted for in the education of nursing students; however, sometimes a gap exists between them. Among the causes are the diversity and heterogeneity of learning opportunities and the short duration of clinical stays in real clinical settings. Simulation could help reduce this gap by exposing students to clinical situations before experiencing actual practice (Brien et al., 2017). Furthermore, simulation can be a useful tool to assess the clinical skills and critical thinking of nursing students (Pierazzo et al., 2017). Simulation, specifically high-fidelity simulation, is a practical teaching method that has been increasingly introduced in nursing curricula to prepare students for the real clinical environment (Brien et al., 2017; Fey et al., 2014; Lee et al., 2015; Mackey et al., 2014).

Simulation is defined as the practice that mimics reality (Jeffries et al., 2015). In nursing, simulation enables students to learn cognitive, affective and psychomotor skills in a harmless and non-threatening environment using realistic equipment that imitates real clinical environments (Cant & Cooper, 2010). Simulation-based trainings are classified into three types according to their degree of similarity to reality: low-, medium- and high-fidelity simulation. High-fidelity simulations enable experiential and interactive learning using life-like mannequins with realistic physiological and pharmacological responses. This education methodology enables students to make, detect and correct medical errors without negative consequences (Nagle et al., 2009).

In the acute and critical care clinical environment, essential learning opportunities are not always possible due to short practice placements, sporadic cases and rapid decision-making in emergency situations (Abelsson & Bisholt, 2017; Pront & McNeill, 2019). Due to these limitations, high-fidelity simulation in acute and critical care should be strengthened so that students can gain experience in acute and critical care in a realistic environment and without posing a risk to patients (Pront & McNeill, 2019). This type of simulation also allows students, generally in their final years, to integrate practical skills, communication, teamwork and critical thinking before performing them in real practice (Kapucu, 2017). According to Benner's (1984) model, simulation-based learning experiences may contradict the understanding that knowledge can only be acquired through real experience. Although highly accurate, simulations may not fully capture the subtle realities of the 'real' experience. Regardless, Benner (1984) argues that learning experiences with high-fidelity simulation can contribute to 'refine' knowledge and facilitate transitions through different learning stages.

What does this paper contribute to the wider global clinical community?

- Lack of prior theoretical knowledge, unreliable environments and limited time for simulation sessions are factors that affect education. Thus, nursing education should include simulations adapted to the students' stage of competence from the beginning of the program, as well as structured debriefings, as these sessions enable reflective knowledge transfer.
- Previous experiences and preparation, a reliable and risk-free environment, and random role assignment during high-fidelity simulations help students learn beyond the acquisition of techniques and how to care for and manage their emotions.
- Students highlighted difficulties in associating simulations to real contexts, thus indicating the need for collaboration between the teacher and the clinical tutor.

Although the use of high-fidelity simulation has increased in nursing curricula, most of the published literature focuses on the benefits but there is little evidence of students' perspective on simulation, the learning process and environmental influences (Brien et al., 2017; Burbach et al., 2016). A meta-ethnography enables the grouping and synthesis of results from multiple studies, thereby generating interpretive findings that provide a more comprehensive view of nursing students' experiences with high-fidelity simulation in acute and critical care (Bondas et al., 2017). Further research is required to fully integrate simulation-based learning into acute and critical care nursing education and address the demands of today's nursing environment (Cant & Cooper, 2017).

The transition from a nursing student to a practising nurse is a complex process that can be exacerbated by contextual characteristics such as the COVID-19 pandemic. Many novice nurses reported a distressful transition to the clinical setting during the pandemic and felt they lacked proper training to address care demands (García-Martín et al., 2021; Naylor et al., 2021). These factors highlight the importance of high-fidelity simulation training for strengthening competencies, knowledge and skills related to acute and critical care. It can facilitate a good transition of newly qualified professionals into the clinical setting and promote a more comprehensive care. This meta-ethnography aims to synthesise the experience of nursing students in their final years regarding high-fidelity simulation in acute and critical care.

1.1 | Theoretical perspective

Benner (1984) studied the integration of practice and theory and reached the conclusion that there is implicit knowledge of clinical practice. She highlighted the use of simulation to help develop knowledge that is acquired through practice (Benner, 1984; Karen, 2018). To study nursing practice, Benner (1984) adapted the Dreyfus and Dreyfus (1980) model of skills acquisition. Originally investigated in chess players, air force pilots and army tank operators, the instrument is divided into five levels of skill acquisition and development: novice, advanced beginner, competent, proficient and expert. The application to nursing education has led teachers to realise the learning needs of students. This entails meaningful educational opportunities where teachers can guide students in realistic conditions (Escobar-Castellanos & Jara Concha, 2019; Karen, 2018). For Benner (2004), nursing students should be within the first two levels: novice would refer to first-year students, who have not had experience in real clinical settings; and advanced beginner refers to nursing students whose practice is close to that of a beginning staff nurse in their final year of nursing education.

For preparing nursing students for professional practice, Benner's model is complemented with the Experiential Learning Theory formulated by Kolb (1984) which has been suggested to be essential for preparation of nursing students for professional practice (Poore et al., 2014). This theory addresses individual learning styles and presents a cyclical process that allows students to acquire knowledge during each phase of the learning cycle. The process of knowledge creation materialises through experience transformation using high-fidelity simulation (Kolb, 1984). Reflective observation occurs during or after debriefing sessions, allowing students to make sense of the concrete experience. Then, students use logic and ideas to understand situations and problems in the abstract conceptualisation phase. Finally, in the active experimentation phase, students test what they have learned by applying the knowledge to new situations (Morse, 2012).

In short, Benner's (1984) model helps to determine the necessary content and skills to be addressed at each stage through simulations, whereas Kolb's (1984) experiential learning theory helps to determine how the simulation can achieve learning objectives.

2 | METHODS

2.1 | Design

The following question guided this meta-ethnography: What are the learning experiences of nursing students in their final years regarding high-fidelity simulation in acute and critical care?

To address this question, this study followed the seven steps of synthesis described by Noblit and Hare (1988): (1) getting started, (2) deciding what is relevant to the initial interest, (3) reading the studies, (4) determining how the studies are related, (5) translating the studies into one another, (6) synthesising translations, and (7) expressing the synthesis. Meta-ethnography is a grounded, comparative and interpretative methodology for qualitative evidence synthesis (France et al., 2014). It consists of a meta-synthesis where the goal is to create a new and integrative interpretation of all qualitative articles examined, contributing much more than each individual investigation result, while remaining faithful to each study interpretation (Mahtani Chugani et al., 2006).

This review was written in accordance with the Meta-ethnography Reporting Guidance (eMERGe) (France et al., 2019) with the aim of improving the quality and increasing the transparency and comprehensiveness of the meta-ethnography (Supplementary File 1).

2.2 | Search strategy

The second step involves identifying and selecting the appropriate primary studies. For that, a comprehensive systematic search strategy was carried out with PubMed, Scopus, CINAHL, Web of Science and PsycINFO databases in January 2020 (Supplementary File 2) and updated in December 2020. The search strategy was developed by the SFB and agreed to by the rest of the authors, according to the phenomenon of interest (high-fidelity simulations), the purpose of the study or evaluation (learning experiences), the sample (nursing students) and the type of research (qualitative research). For each query, search terms and medical subject headings were included and combined using the Boolean operators OR and AND. Truncations were also employed to ensure a broad search.

Original qualitative or mixed-method articles, from which the qualitative results could be extracted, addressing the learning experience of nursing students in their final years regarding high-fidelity simulations in acute and critical care were included in this review. Grey literature, discussion or review papers, and papers not in English, Portuguese or Spanish were excluded.

2.3 | Search outcomes

Database searches yielded 401 records. Supplementary searches did not provide any additional records. Following the removal of 139 duplicate results, 95 articles were selected after evaluation of the title and abstract of 262 articles. The final sample of 10 articles resulted from a full reading of the 95 articles. Exclusion criteria are detailed in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (Moher et al., 2010) (Figure 1). The updated search, conducted by SFB and MJMF, did not provide additional primary articles that met the inclusion criteria.

The second author was responsible for the first screening of records. Screening evolution was reported to all authors during weekly team sessions, where reservations were expressed and discussed. The second screening consisted of a full-reading of the articles and was conducted by the first and second authors, including constant communication with all the authors, to share and discuss discordant situations.

The 10 selected articles were evaluated using the Clinical Appraisal Skills Program (CASP) (2018) tool. Primary articles were considered to have sufficient quality to be included in the synthesis (Table 1). No study was excluded after quality assessment, for this meta-ethnography is not focused on eliminating articles due to their methodological weakness, but rather to verify the richness and strengths of their findings.

The CASP assessment was performed by LPG, although all authors participated in meetings held throughout the process to reach consensus.

2.4 | Data abstraction and synthesis

The analysis followed the seven steps described by Noblit and Hare (1988). Initial data extraction involved rereading of the included articles and development of a table describing the study aim, sample, method, simulation type, care type, data collection methods and key findings to provide context (Table 2).

Step 3 consisted of the authors immersing themselves in the data and noting the interpretive metaphors and/or core concepts in the studies, which were recorded in Microsoft Word tables. Tables included constructs, a brief description of each construct and the line-by-line code. The meaning units and codes were discussed in the research group and intra- and inter-study comparisons were conducted to identify similarities and contrasts. Through a systematic and sequential comparison of concepts based on the characteristic of recorded studies (Table 2), new concepts were created and existing concepts were adopted (step 4). All authors participated in these two steps. In step 5, the findings from the studies were incorporated into one another by analogue translations (concepts in one study can incorporate those of another) to form new third-order concepts (meta-ethnography through authors' interpretations) (Schütz, 1962). The analysis process was iterative and involved moving back and forth in the data, comparing and contrasting the findings from the individual studies, and translating them into one another. The new understandings were added to the reciprocal synthesis, building on four themes and a metaphor (step 6).

The Confidence in the Evidence from Reviews of Qualitative (CERQual) research approach was used to show the degree of confidence in the review findings (Lewin et al., 2015) (Table 3).

All authors participated in these steps and in the confidence assessment of the review findings, agreeing on the themes and the overarching metaphor.

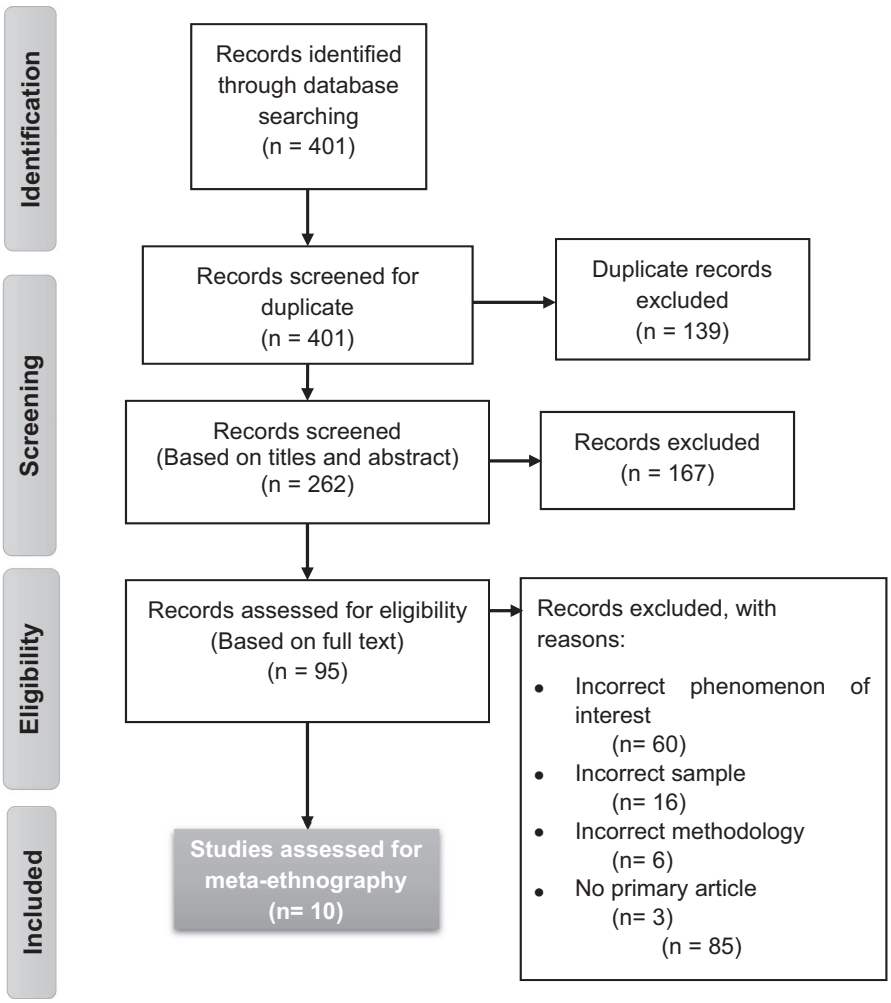

FIGURE 1 PRISMA flow diagram (Moher et al., 2010)

TABLE 1 Quality assessment of included studies

Articles	Questions									
	1	2	3	4	5	6	7	8	9	10
Abelsson and Bisholt (2017)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Badir et al. (2015)	✓	✓	✓	✓	✓	–	✓	✓	✓	✓
Burbach et al. (2016)	✓	✓	✓	✓	✓	×	✓	✓	✓	✓
Hober and Bonnel (2014)	✓	✓	✓	✓	✓	–	✓	✓	✓	✓
Hustad et al. (2019)	✓	✓	✓	✓	✓	–	✓	✓	✓	✓
Kapucu (2017)	✓	✓	✓	×	✓	✓	✓	–	✓	✓
Lawrence et al. (2018)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mackey et al. (2014)	✓	✓	✓	✓	✓	×	✓	✓	✓	✓
Nash and Harvey (2017)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nyström et al. (2014)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: ✓Yes—Unclear ×No; Critical appraisal questions: (1) Was there a clear statement of the aims of the research? (2) Is the qualitative methodology appropriate? (3) Was the research design appropriate to address the aims of the research? (4) Was the recruitment strategy appropriate? (5) Were the data collected in a way that addressed the research issue? (6) Has the relationship between researcher and participants been adequately considered? (7) Have ethical issues been taken into consideration? (8) Was the data analysis sufficiently rigorous? (9) Is there a clear statement of findings? (10) How valuable is the research?

3 | RESULTS

3.1 | Characteristics of the studies

The sample consisted of 10 primary qualitative articles on the experience of nursing students in high-fidelity simulations in critical care (Figure 1). These studies originated in Sweden, Turkey, United States, Norway, Singapore and Australia. A total of 293 third- and fourth-year nursing students with previous experience in real clinical settings were included. The studies reported the experiences of students in using high-fidelity simulation as a strategy for learning critical care in intensive care, emergency room and post-surgical resuscitation settings. The predominant design was qualitative, descriptive, exploratory or observational, and the data were collected through observation, individual interviews and focus groups (Table 2).

3.2 | Synthesis results

The lines-of-argument synthesis emerged from the analogous translations (Figure 2). The metaphor 'Cultivating learning *in vitro*', and four themes related to the metaphor that capture the learning experience of nursing students through high-fidelity simulations in acute and critical care were created. The essence of the findings was grasped using this metaphorical phrase, allowing improvement in the phenomenon of comprehensive understanding (Sandelowski & Barroso, 2006). Observation, active participation in simulations and subsequent reflections were the roots that nourished nursing students' learning. External elements such as previous experience and preparation, simulation sessions in a trust-based environment, random role assignment and realistic scenarios contributed to learning. Metaphorically, these elements symbolise the appropriate conditions for the growth and flowering of plants in the pipettes. The pipettes symbolise the student stage, where knowledge begins to germinate in a protected environment. However, lack of theoretical knowledge, fidelity, connection and time, and difficulties in transfer into practice, weakened learning and represented inappropriate conditions for plant growth. The flourishing of learning shows the results of the theoretical–practical education of students in a safe and controlled environment which is highly similar to reality (Figure 2). Table 4 summarises the participation of each article in the different topics and subtopics.

The CERQual tool showed that the results had mostly a moderate level of confidence, so it is probable that the results of the metaethnography are a reasonable representation of the phenomenon of interest (Table 3). Next, each of the topics is explained in detail and supported by reports from the nursing students.

3.3 | Learning roots—Ways to learn during high-fidelity simulation

Seeing, doing and reflecting comprise the methods of learning through which the nurses acquired the competencies, skills and theoretical-practical knowledge for acute and critical care situations. These elements are symbolised by the roots, through which the plant acquires the necessary water and nutrients.

During the observation phase, the students examined and analysed the simulation of their peers without taking part as a nurse or patient. Because it involved passive participation, students reported feeling comfortable and with a decreased stress level, which helped them to focus on learning. They reported that with this role they were able to have a broader view of the nursing process and setting (Abelsson & Bisholt, 2017; Hober & Bonnel, 2014; Mackey et al., 2014; Nyström et al., 2014).

TABLE 2 Characteristics of included studies

Authors (year), Location	Methods	Aim	Sample
Abelsson and Bisholt (2017), Sweden	Observational study inspired by an ethnographic approach	To describe how nursing students learn acute care of patients through simulation exercises, based on observation and debriefing	41 third-year nursing students (32 females and 9 males)
Badir et al. (2015), Turkey	Qualitative study	To understand students' perceptions of the use of simulation in nursing courses	32 senior nursing students (29 females and 3 males)
Burbach et al. (2016), USA	Qualitative descriptive design	To identify influences on performance from the student perspective and understand the contextual barriers inherent in simulation before using simulation for high-stakes testing	29 senior nursing students
Hober and Bonnel (2014), USA	Descriptive and qualitative	To examine the perceptions of nursing students who played roles in high-fidelity patient simulation, with focus on the observer role	40 senior nursing students
Hustad et al. (2019), Norway	Qualitative descriptive design	To explore nursing students' experiences of simulation-based training and how the students perceived the transfer of learning to clinical practice	32 s- and third-year nursing students (27 females and 5 males)
Kapucu (2017), Turkey	Qualitative study	To determine nursing students' opinions related to experiencing a thorax trauma scenario in a lifelike high-quality simulation environment	7 third-year nursing students (7 females)
Lawrence et al. (2018), USA	Qualitative study	To explore the experiences and perceptions of nursing students who had participated in a peer teaching initiative in high-fidelity simulation	8 senior nursing students and 7 first-year nursing students
Mackey et al. (2014), Singapore	Exploratory qualitative research	To identify whether the knowledge and skill of a student playing the role of standardised patients in simulated clinical learning and assessment scenarios was enhanced through playing that role	15 senior undergraduate nursing students (third and fourth-year students)
Nash and Harvey (2017), Australia	Descriptive qualitative research	To undertake an initial exploration of the transfer of simulation learning to the practice context from the perspective of undergraduate nursing students	25 final year undergraduate nursing students
Nyström et al. (2014), Sweden	Descriptive qualitative research	To describe bachelor nursing students' experiences of being video-recorded during an examination with a simulated patient in emergency care	44 undergraduate nursing students (42 females and 2 males)

Abbreviation: USA, United States of America.

Simulation and care type	Data collection method	Key findings
High-fidelity simulation in acute care scenarios	Observations and interviews	Nursing students created space for reflection when needed. There was a positive learning situation when suitable patient scenarios were presented. Observations and discussions with peers gave the students opportunities to identify their own need for knowledge, while also identifying existing knowledge. Reflections could confirm or reject their preparedness for clinical practice. The importance of working in a structured manner in acute care situations became apparent. However, negative feedback to peers was avoided, which led to a loss of learning opportunity
High-fidelity simulation in an intensive care course	Focus groups	Simulation is a method that promotes deep learning by helping students transfer theory to practice. Preparation, debriefing, and repetition are 3 key factors for a simulated learning environment. The repetition of the simulations decreased the anxiety of the students. The structure and context of the simulation can determine learning
• High-fidelity simulation • Acute care	Individual interviews	Student performance during simulation was influenced by anxiety, uncertainty, technological limitations, and experience with the patient condition. Students had few previous simulation-based learning experiences that may have influenced performance
High-fidelity patient simulation, in medical-surgical complications simulations	Observations and interviews	Three themes emerged from the data including conceptualising the learning experience, capturing the big picture, and connecting with the team. The students reported that being randomly assigned to the observer role was a meaningful experience. Although observers described a difference in ''seeing and doing'' simulation from when they were in more traditional roles, they described the value of this role in using clinical judgment and learning safe quality patient care strategies
High-fidelity simulation sessions with acute simulation scenarios	Focus group interviews	Three major themes emerged from the focus group interviews; first, the simulation-based training promoted self-confidence; second, understanding from simulation-based training improved clinical skills and judgements in clinical practice; and third, simulation-based training emphasised the importance of communication and team collaboration
Chest trauma scenario in a lifelike high-quality simulation environment	Open-ended interviews	Students stated that they experienced excitement and anxiety during the simulation and that they felt the learning environment was very realistic, as if they were treating a real patient. Students found training with simulation to be useful for improving their skills and efficient than only providing treatment to a mannequin
High-fidelity simulation in acute medical-surgical scenarios	Focus groups	The 4th year students who pretended to be 'peer teachers' highlighted the reinforcement of prior knowledge and the advantage of practicing skills in a safe environment. They highlighted feeling more comfortable with their skills and more focused on critical thinking and clinical judgment (this could be due to their previous experiences as simulation students). Anxiety decreased and comfort increased when interacting with colleagues
High-fidelity simulation (standardised patients) in acute care scenarios	Focus groups	Four main themes were identified seeing the nurse through the eyes of the patient, using observation skills, using reflection and evaluation. Being in the standardised patients role provided students with the opportunity to apply the clinical skills of observation, reflection and evaluation to gain new insights into their own practice, particularly their communication skills
High-fidelity simulation in emergency department scenarios	Semi-structured focus group discussions	The students considered that the simulations were a learning opportunity, however, they emphasised the complexity of transferring this learning to the real environment, due to the difference between the simulation environment and the real environment. A design consistent with actual clinical settings is essential
High-fidelity simulation (simulated patient in an emergency care situation)	Open-ended interviews	A latent content analysis resulted in three themes: (i) visualisation might cause nervousness at first; (ii) visualisation promotes dialogue and acknowledgement; and (iii) visualisation promotes increased self-knowledge and professional growth

TABLE 3 Confidence in the evidence from reviews of qualitative research (CERQual) evidence profile

Summary of review findings		Studies contributing to the review findings	Methodological limitations	Coherence
Learning roots—Ways to learn during high-fidelity simulation	Seeing	Abelsson and Bisholt (2017), Hober and Bonnel (2014), Mackey et al. (2014), Nyström et al. (2014)	Moderate concerns regarding methodological limitations since in 3 of the 4 articles there was a lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)
	Doing	Badir et al. (2015), Hustad et al. (2019), Lawrence et al. (2018)	Moderate concerns regarding methodological limitations since in 2 articles there was a lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)
	Reflecting	Abelsson and Bisholt (2017), Badir et al. (2015). Hober and Bonnel (2014), Hustad et al. (2019)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)
Learning stimulants – Elementsthatfavour learning	Previous preparation and experiences	Abelsson and Bisholt (2017), Badir et al. (2015)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)
	Trusting environment	Abelsson and Bisholt (2017)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)
	Random roles	Abelsson and Bisholt (2017), Badir et al. (2015), Nash and Harvey (2017)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)
	Realistic scenario	Badir et al. (2015). Burbach et al. (2016), Kapucu (2017), Lawrence et al. (2018)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa, and an article did not clearly explain the limitations or justify the sample	Very minor concerns regarding coherence (data very consistent within and across studies)
Learning impairments—Elements that hinder learning	Lack of theoretical knowledge	Abelsson and Bisholt (2017). Burbach et al. (2016), Kapucu (2017)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)
	Lack of fidelity and connection	Badir et al. (2015). Burbach et al. (2016)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)
	Limited time	Kapucu (2017)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Minor concerns regarding coherence
	Difficulties in transfer to practice	Nash and Harvey (2017)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Minor concerns regarding coherence

Relevance	Adequacy of data	Overall CERQual assessment of confidence	Explanation of decision
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Minor concerns about adequacy of data. There were rich data to support the finding across many studies	Moderate confidence	Minor concerns about adequacy of data; very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Minor concerns about adequacy of data. There were rich data to support the finding across many studies	Moderate confidence	Minor concerns about adequacy of data; very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Minor concerns about adequacy of data. There were rich data to support the finding across many studies	Moderate confidence	Minor concerns about adequacy of data; very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Moderate concerns about adequacy of data as the quantity of data was limited	Moderate confidence	Very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations and adequacy of data
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Serious concerns regarding adequacy as the quantity of data was limited, with only one study	Moderate confidence	Serious concerns about adequacy of data; very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Minor concerns about adequacy of data. There were rich data to support the finding across many studies	Moderate confidence	Minor concerns about adequacy of data; very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Minor concerns about adequacy of data. There were rich data to support the finding across many studies	Moderate confidence	Minor concerns about adequacy of data; very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Minor concerns about adequacy of data. There were rich data to support the finding across many studies	Moderate confidence	Minor concerns about adequacy of data; very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Moderate concerns about adequacy of data as the quantity of data was limited	Moderate confidence	Very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations and adequacy of data
Moderate concerns regarding relevance (only one study)	Serious concerns regarding adequacy as the quantity of data was limited, with only one study	Low confidence	Serious concerns about adequacy of data; Moderate concerns about methodological limitations and relevance; minor concerns about coherence
Moderate concerns regarding relevance (only one study)	Serious concerns regarding adequacy as the quantity of data was limited, with only one study	Low confidence	Serious concerns about adequacy of data; Moderate concerns about methodological limitations and relevance; minor concerns about coherence

(Continues)

TABLE 3 (Continued)

Summary of review findings		Studies contributing to the review findings	Methodological limitations	Coherence
Learning flourishing—Results after high-fidelity simulation	Theoretical	Abelsson and Bisholt (2017), Badir et al. (2015), Burbach et al. (2016), Hober and Bonnel (2014), Hustad et al. (2019), Nash and Harvey (2017)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)
	Practical	Abelsson and Bisholt (2017), Badir et al. (2015), Hustad et al. (2019), Kapucu (2017)	Moderate concerns regarding methodological limitations since lack of clarity regarding the influence of the researcher in the investigation, and vice versa	Very minor concerns regarding coherence (data very consistent within and across studies)

Note: Definitions of levels of confidence from the CERQual evaluation (Lewin et al., 2015): *High confidence*: It is highly likely that the review finding is a reasonable representation of the phenomenon of interest. *Moderate confidence*: It is likely that the review finding is a reasonable representation of the phenomenon of interest. *Low confidence*: It is possible that the review finding is a reasonable representation of the phenomenon of interest. *Very low confidence*: It is not clear whether the review finding is a reasonable representation of the phenomenon of interest.

Maintaining an observer role allowed them to be better prepared for their performance in the acute and critical care simulation. It also favoured reflection, learning through detection of errors, and improvements in their performance, specifically in communicating with patients (Abelsson & Bisholt, 2017; Hober & Bonnel, 2014; Mackey et al., 2014; Nyström et al., 2014).

> It was really good. You learned a lot by watching and judging yourself. The best examination I've ever had, to be filmed and see yourself, better understanding. (Nyström et al., 2014)

On the other hand, most indicated that their clinical skills and the transfer of theoretical knowledge to practice improved when they played the role of nurse during the simulation and the clinical case scenarios were similar to reality (Badir et al., 2015; Hustad et al., 2019). Other roles such as leaders enhanced the feeling of professional duty and their involvement in the simulation activity (Hustad et al., 2019). In addition, if they shared the practice with students of another educational level, learning was reciprocal and favoured an environment of trust and comfort to develop the simulation (Lawrence et al., 2018).

> The step from theory in books and tasks to hospital reality is overwhelming. Simulation made that step easier to take. (Hustad et al., 2019)

The debriefing sessions made it possible to view the simulations, which encouraged group reflection regarding improvement aspects, theory and ideas of what was observed. During these sessions, the students became aware of the theoretical knowledge they lacked and the errors made during the simulation. The comments and suggestions made by the teachers were key to strengthening knowledge and self-confidence (Abelsson & Bisholt, 2017; Badir et al., 2015; Hober & Bonnel, 2014; Hustad et al., 2019).

> The way the teachers communicated with us … They pointed out some mistakes and suggested improvements … They did it in a friendly way, so you didn't feel stupid … The teachers were very pedagogic, and that resulted in a great learning outcome. It was fantastic for me. (Hustad et al., 2019)

3.4 | Learning stimulants—Elements that favour learning

Previous experiences and preparation, a reliable environment, the different and random roles during the simulations, and the realistic, controlled, and risk-free setting were highlighted by the participants as aspects that improved learning.

Nursing students reported that previous simulations or experiences in the clinical learning environment provided them with greater confidence and skills, knowledge and abilities to carry out the acute and critical care simulation. In particular, they were able to become familiar with the equipment and instruments related to this care (Abelsson & Bisholt, 2017; Badir et al., 2015). High-fidelity simulation also promoted the perception of risks in patients and the need to take precautions to ensure their safety (Badir et al., 2015).

> There is someone there depending on you; you feel responsible. (Badir et al., 2015)

When the simulation sessions were developed with groups of students who knew each other, they were more open to participate and

Relevance	Adequacy of data	Overall CERQual assessment of confidence	Explanation of decision
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Minor concerns about adequacy of data. There were rich data to support the finding across many studies	Moderate confidence	Minor concerns about adequacy of data; very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations
Very minor concerns regarding relevance (All studies included third- and fourth-year nursing students, high-fidelity simulations, and they were developed in acute care scenarios)	Minor concerns about adequacy of data. There were rich data to support the finding across many studies	Moderate confidence	Minor concerns about adequacy of data; very minor concerns about coherence and relevance; and moderate concerns regarding methodological limitations

the sessions were smoother. In addition, the fact that critical care practice was performed on a mannequin helped students practice skills such as evaluation, decision-making and nursing interventions without risks to a real patient (Burbach et al., 2016; Kapucu, 2017; Lawrence et al., 2018).

Finally, the random assignment of roles during the simulations forced the students to prepare for the entirety of the sessions, which led to a more complete view of the case and the scenario. In addition, the performance of active or passive roles also provided them with another approach to the situation and stimulated reflection on those aspects (Abelsson & Bisholt, 2017; Badir et al., 2015; Nash & Harvey, 2017).

> If the role of the patient's relative is richer and more active, we can learn better to handle patients' relatives' stress. (Badir et al., 2015)

3.5 | Learning impairments—Elements that hinder learning

The students identified lack of theoretical knowledge, fidelity, and connection, limited time, and difficulties in transferring learning to practice as obstacles to acute and critical care learning.

Insufficient theoretical knowledge made it difficult for students to evaluate comprehensively the patient and to detect serious symptoms. This generated feelings of nervousness, fear and disorientation during the simulation (Abelsson & Bisholt, 2017; Burbach et al., 2016; Kapucu, 2017). Furthermore, this was exacerbated when the performance time during the high-fidelity simulation was reduced (Kapucu, 2017).

> I felt so confused because everything was so new for me. I was a little lost when I faced the patient. (Kapucu, 2017)

Some students reported that despite participating in a high-fidelity simulation, the scenario did not reflect reality and that performing acute and critical care with a mannequin hindered the relational aspect with the patient (Badir et al., 2015; Burbach et al., 2016). As a student mentioned:

> I rely on the monitor … which is not normal and … in a typical setting, I would be looking at the patient. But that patient hasn't changed. If it was a real person, I would be looking at them and then looking back at the monitor to see correlations. (Burbach et al., 2016)

Specifically, students in the Nash and Harvey (2017) study identified a gap between simulations and clinical practice, as there was sometimes a lack of opportunities to apply what was learned during simulations. On the other hand, the continuous change of location of real clinical environments confused them and made it difficult for them to transfer what was learned during the high-fidelity simulation (Nash & Harvey, 2017).

3.6 | Learning flourishing—Results after high-fidelity simulation

The acute and critical care simulations contributed to strengthen the theoretical and practical learning of the students. High-fidelity simulations were considered a useful method to test their

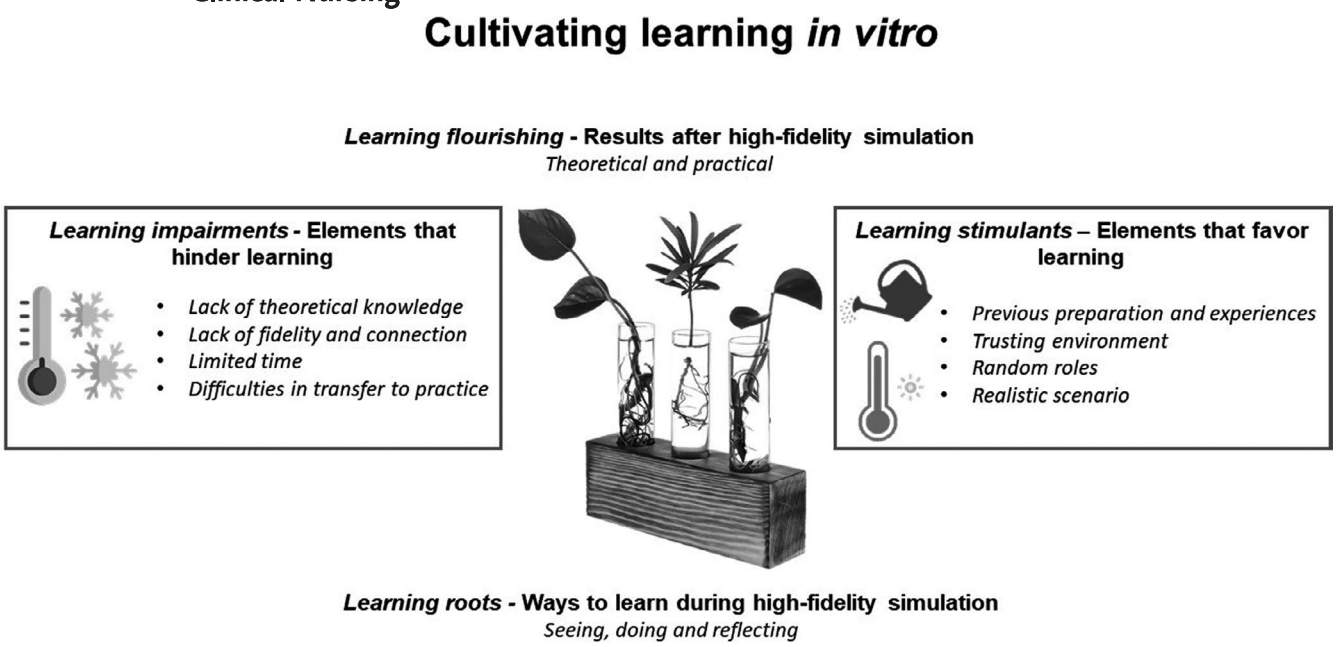

FIGURE 2 'Cultivating learning *in vitro*' metaphor

prior knowledge and to consolidate new knowledge. Regarding acute and critical care, the students verbalised that the feeling of professional duty and practical nursing skills were developed. Specifically, they highlighted the care and monitoring of patients, the use of tools and technology of these services, and decision-making as learning outcomes (Abelsson & Bishtol, 2017; Badir et al., 2015; Burbach et al., 2016; Hober & Bonnel, 2014; Hustad et al., 2019).

On a practical level, some students reported that the realistic situations created during the high-fidelity simulations prepared them to face acute and critical care situations in the real environment (Hustad et al., 2019; Kapucu, 2017). They also contributed to enhancing skills in managing emotions, teamwork and inter- and intra-professional communication (Abelsson & Bishtol, 2017; Badir et al., 2015; Hustad et al., 2019; Kapucu, 2017).

> A patient got acute respiratory problems, so I assessed the patient using the decision-making tools we learned to use during the simulation sessions, and then I contacted the nurse and the doctor. I've learned not just to stand there in panic. I felt confident, I know what to do. Without the simulation-based training, I would not dare to act in this situation. (Hustad et al., 2019)

4 | DISCUSSION

The aim of this meta-ethnography was to obtain knowledge of the learning experiences of nursing students in their final years in high-fidelity simulations of acute and critical care scenarios. From a reciprocal synthesis of the 10 included articles, the metaphor 'Cultivating learning *in vitro*' emerged (Figure 2). This metaphor symbolises the learning process of these students in a very realistic but controlled environment. Seeing, doing and reflecting constituted the main sources of learning, akin to the roots of learning. Learning stimulants, such as previous preparation and experiences, a reliable environment, the performance of different and random roles in the simulations, and a realistic and risk-free environment contributed to student learning. However, this learning was sometimes hampered by a lack of prior theoretical knowledge, unreliable environments, limited time for simulation sessions and difficulties in applying what was learned to clinical practice. The growth of the plant represents learning that has developed in a controlled and safe environment, and results are symbolised by the flourishing of learning.

The literature tends to agree that nursing education should position newly undergraduate nurses at least at the advanced beginner level, or second level, and possibly at the proficient or third level (Rhodes & Curran, 2005). According to Benner (1984), academic training in nursing education should include methodologies that promote practical and theoretical development and allow the transfer of this knowledge to the real environment. Specifically, Benner (1984) recommended that teachers should teach in concrete situations rather than rely on abstract knowledge, avoid the separation between practice and classroom training, move from critical thinking to clinical reasoning and help in the formation of a professional identity. Although Kolb advocated for taking the learning needs and preferences of each student into consideration (Kaakinen & Arwood, 2009), adapting simulations to each learning style may be a laborious task that requires a lot of time and effort. According to Kolb (1984), the nursing profession attracts divergent students, so high-fidelity simulations in acute and critical care should be designed with divergent styles and ideally in a complex way.

TABLE 4 Themes and subthemes distribution

	Themes												
	Subcategories												
	Learning roots—Ways to learn during high-fidelity simulation			Learning stimulants—Elements that favour learning				Learning impairments—Elements that hinder learning				Learning flourishing—Results after high-fidelity simulation	
Articles	Seeing	Doing	Reflecting	Previous preparation and experiences	Trusting environment	Random roles	Realistic scenario	Lack of theoretical knowledge	Lack of fidelity and connection	Limited time	Difficulties in transfer to practice	Theoretical	Practical
Abelsson and Bisholt (2017)	●		●	●	●	●		●				●	●
Badir et al. (2015)		●	●	●		●	●		●			●	●
Burbach et al. (2016)							●	●	●			●	
Hober and Bonnel (2014)	●		●									●	
Hustad et al. (2019)		●	●									●	●
Kapucu (2017)							●	●		●			●
Lawerence et al. (2018)		●					●						
Mackey et al. (2014)	●												
Nash and Harvey (2017)						●					●	●	
Nyström et al. (2014)	●												

Note: Symbols: ● Yes.

Debriefing sessions are key to learning as they facilitate reflection and conceptualisation and allow students to adapt and reconstruct their cognitive frameworks. In this scenario, high-fidelity simulation debriefs would help students creating meaning. These sessions should also include spaces for students to express their emotions, thus promoting a more objective reflection. Moreover, the sharing of ideas tends to foster discussion which can generate a set of principles for further exploration. Student self-assessments could also help clarify their perceptions on developing nursing skills (Kaakinen & Arwood, 2009).

Clinical simulation is a good method to incorporate these aspects and integrate practical knowledge into teaching. In our findings, high-fidelity simulations in critical and acute care were considered a useful tool because they helped students to test their prior knowledge and consolidate new knowledge and to develop and train nursing skills and competencies (Abelsson & Bisholt, 2017; Badir et al., 2015; Burbach et al., 2016; Hober & Bonnel, 2014; Hustad et al., 2019, Kapucu, 2017).

Specifically, Pront and McNeill (2019) identified that, for nursing students, high-fidelity simulations in acute and critical care were more beneficial than those of other types of care since it allowed them to develop a wide variety of nursing skills. The students mostly described an increase in confidence when starting clinical practice after having participated in simulations (Casida & Shpakoff, 2012; Reilly & Spratt, 2007). This is mainly because they were able to develop skills in a safe and controlled environment and to rehearse with acute situations that are not usually seen on a daily basis in clinical practice (Moule et al., 2008). They also benefitted from error-based learning and through suggestions made by teachers (Hall & Tori, 2017; Neill & Wotton, 2011; Tosterud et al., 2014).

Our findings show that high-fidelity simulation could contribute to better management of emotions such as stress and anxiety (Abelsson & Bishtol, 2017; Badir et al., 2015; Hustad et al., 2019; Kapucu, 2017). Although being anxious or overly nervous can have a negative impact, a certain degree of optimal stress can help promote learning. For this reason, it is important to introduce simulation from the beginning of academic training to improve emotion management (Zhang et al., 2019).

However, some students found a significant gap between simulation and clinical practice since the controlled environment at times differed markedly from the real one, or because they subsequently lacked opportunities to apply what they learned in clinical practice (Nash & Harvey, 2017). According to Perkins and Salomon (1989), learning transfer to different situations can be developed in two ways: low- and high-road transfer. Low-road transfer occurs when stimulus conditions in the transfer context are sufficiently similar to those of a previous learning context and trigger well-developed semi-automatic responses. On the other hand, high-road transfer depends on a conscious abstraction of the learning context and a deliberate search for connections. In general, high-road transfer is not reflexive and requires mental effort (Perkins & Salomon, 1992) along with the presence of a metacognitive guide that we would identify as the teacher. According to this model, *hugging* refers to the promotion of reflective transfer under the guidance of the teacher, while *bridging* refers to the promotion of conscious abstraction, the search for connections between different experiences, and the identification of a series of general skills that can be applied in different contexts (Hajian, 2019; Johnston et al., 2017). In nursing, highly complex healthcare environments pose challenges for students in terms of making meaningful connections between simulations and the application of learned knowledge into real contexts (Nash & Harvey, 2017). Given this, two figures and the symbiosis between them stand out to address this problem. The teacher, or 'metacognitive guide', becomes relevant to create models for the integration of knowledge in future situations and to facilitate meaningful learning (Johnston et al., 2017). On the other hand, the clinical tutor is a role model that must provide clinical learning, supervise the student and promote the student's socialisation and intuition within real clinical practice (Andrews et al., 2006; Arieli, 2013; Serçekuş & Başkale, 2016).

4.1 | Relevance for clinical practice and research

This analysis shows the importance of high-fidelity simulation in acute and critical nursing care to improve student learning and transfer knowledge from the classroom to the real clinical environment. Our results are original for showing the elements that favour or hinder learning.

Learning derived from high-fidelity simulations transcends the acquisition of techniques. The simulation sessions help students learn how to care for and manage their emotions and to provide care in high-demand environments such as acute and critical care. For this reason, simulations should be present from the beginning of nursing training and incorporate debriefing sessions, which should not be underestimated in the design of the curriculum. It is in these sessions that the reflective transfer of knowledge occurs and where the teacher must create a safe and reliable environment that encourages learning and participation.

On the other hand, it is important to establish communication and collaborative ties between the faculties and clinical environments, where the clinical tutor and teaching tutor are the drivers that facilitate the transition of students to the real clinical environment. In line with the developed metaphor, these facilitators represent the transplantation process of the plant to nature, or the real environment.

To expand the knowledge of learning experiences through simulations, it would be interesting to delve into teachers' experiences. They play an important role in simulation, both in the design of the sessions and in their execution. This would allow a broader overview of the nursing student learning experience through simulation and foster the design and implementation of improvement proposals that strengthen learning.

4.2 | Strengths and limitations

By comparing results of previous studies and generating new ideas from them, meta-ethnography is a qualitative research method used in health research with the aim of presenting results applicable to

practice (Edwards & Kaimal, 2016). In this way, the results are combined in an interpretive way rather than merely an aggregation, with the objective of seeking intra- and inter-study perspectives (Mahtani Chugani et al., 2006).

To carry out this meta-ethnography, we used several quality tools: eMERGe, CASP, and CERQual. The eMERGe Reporting Guidance (France et al., 2019) was used to increase credibility of findings and make the results more useful and applicable to the educational environment, thereby improving their quality. The CASP checklist was used to assess the value of the studies through 10 questions, and this verified that the 10 articles selected for the analysis were of high quality. The tool to assess the confidence of the findings (CERQual) (Lewin et al., 2015) confirmed the confidence and applicability of the results. Another strength was an exhaustive bibliographic search with rigorous filters and quality control tools that allowed us to find results applicable to nursing education and to bridge the gap between theory and practice. Finally, the language expansion to English, Spanish and Portuguese can also be considered a strength.

In terms of limitations, the geographic contexts of the included studies only represented developed countries. Furthermore, the nursing degree is taught very differently in various areas of the world in terms of course duration, subjects and methodologies and there is variability in what is considered high-fidelity simulation, which could make it difficult to transfer the results to all learning environments. Further empirical research is needed to address these limitations.

5 | CONCLUSION

The metaphor 'Cultivating learning *in vitro*' represents the learning of nursing students in their final years in high-fidelity simulation in critical and acute care. The roots symbolise the three ways in which students learned through simulations. In addition, the students identified the stimulating and debilitating aspects of learning, which could help in the design of simulation sessions and promote their incorporation into nursing curricula. Finally, the flowering of the plant represents the learning outcomes after the high-fidelity simulations in acute and critical care.

The results of this meta-ethnography provide keys to promote change in teaching planning that can contribute to improving the training of nursing students in relation to acute and critical care.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHOR CONTRIBUTIONS

Conceptualisation, Sara Fernández-Basanta, Laura Picallo-García, and María-Jesús Movilla-Fernández; methodology, Sara Fernández-Basanta, Laura Picallo-García, and María-Jesús Movilla-Fernández; formal analysis, Sara Fernández-Basanta, Laura Picallo-García, and María-Jesús Movilla-Fernández; investigation, Sara Fernández-Basanta, Laura Picallo-García, and María-Jesús Movilla-Fernández; resources, Sara Fernández-Basanta and María-Jesús Movilla-Fernández; data curation, Sara Fernández-Basanta; writing—original draft preparation, Sara Fernández-Basanta; writing, review and editing, Sara Fernández-Basanta and María-Jesús Movilla-Fernández; visualisation, Sara Fernández-Basanta; supervision, Sara Fernández-Basanta and María-Jesús Movilla-Fernández. All authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

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