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## School voor Educatieve Studies

Educatieve master in de  
gezondheidswetenschappen

### Masterthesis

*Simulation-based learning in nursing education: an umbrella review*

**Moniek van Raak**

Scriptie ingediend tot het behalen van de graad van Educatieve master in de gezondheidswetenschappen

### PROMOTOR :

Prof. dr. Jochen BERGS

De transnationale Universiteit Limburg is een uniek samenwerkingsverband van twee universiteiten in twee landen: de Universiteit Hasselt en Maastricht University.



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## Abstract

**Introduction:** Simulation-based education has been demonstrated to be a great pedagogical strategy to acquire numerous nursing skills. The literature on simulation-based learning (SBL) has grown noticeably and reviews are becoming more plentiful.

**Aim:** The present study aims to give a structural overview of the literature concerning simulation-based learning in nursing programs.

**Method:** An umbrella review was conducted to identify and review evidence on the use, impact, and implementation of simulation-based education in nursing education.

**Results:** The search in CINAHL, ERIC, MEDLINE, Science Direct and Web of Science identified 398 papers, of which 349 were scanned for in- and exclusion criteria. After assessment for eligibility, 87 studies were included in this review. These studies were collated into three themes: (a) type of simulators (b) the impact of simulation-based learning, and (c) pre- and debriefing. High-fidelity manikins and standardized patients are the most reported types of simulators used in nursing education. Integrating simulation-based learning into nursing curricula leaves a complex job for nurse educators. This umbrella review shows positive outcomes of simulation-based learning for the cognitive, affective, and psychomotor domains of learning. Most reviewed outcomes are: knowledge, critical thinking, communication skill, confidence, satisfaction, and psychomotor skills. The simulation program consist of three phases: (1) prebriefing, (2) the simulation, and (3) a debriefing. The latter is emerging as the most noteworthy component of simulation, in which most learning outcomes are achieved. However, this topic is still underreported in the literature. There is also a gap in knowledge regarding the time and frequency of simulation-based activities.

**Conclusion:** Simulation-based learning can enhance learning outcomes in the cognitive, affective, and psychomotor domain. High-fidelity manikins and standardized patients are the most used types of simulators. Additionally to the simulation, also the debriefing is an important part of the learning process.

## Introduction

Simulation-based learning (SBL) has been part of nursing clinical education and practice for over 40 years and has been rapidly expanding over the past two decades (1-3). Nursing is a profession in which students need to acquire numerous skills and psychomotor skills (4, 5). On top of that, students are expected to gain knowledge and critical thinking, enabling them to make clinical judgements about care and complex situations (4). Simulation-based learning has been demonstrated to be a great pedagogical strategy to acquire these qualities and has been adopted by many nursing education institutions (6, 7). It is an active learning strategy that engages students throughout the whole activity and interaction and enables them to acquire the essential skills in an environment closely resembling reality (1).

The recent growth in the use of simulation-based learning is mainly due to an increase in student numbers, decreased training opportunities and contact hours, infrequent clinical events, increased attention to patient safety, emphasis on healthcare outcomes and accountability and shortage of clinical placement opportunities (1-4, 8-11). Also recent advances in teaching technology have contributed to the growing interest (8). For nursing students, it is essential to learn how to apply knowledge, gained in the classroom, in the clinical context (12). Simulation-based education provides this opportunity to the students (9) and enables them to practice and acquire the requisite skills and knowledge (10, 13) and can thereby bridge the gap between theory and practice (6).

The literature on simulation-based learning has grown noticeably in the last ten years. However, researchers agree about the need for investigation involving simulated-based learning to advance the science of nursing education (14). Levels of evidence of the overall effectiveness of simulation-based education in healthcare are diverse and the educational outcomes are still equivocal. The

identification of existing studies and the extraction and comparison of findings can produce a complete summary, providing stronger evidence than results from a single study alone (15).

Therefore, the present study aims to give a structural overview of the literature concerning simulation-based learning in nursing programs. An umbrella review was conducted to identify and review evidence on the use, impact, and implementation of simulation-based education in nursing education.

## Methods

In the last ten years a vast amount of studies on simulation-based learning has been published and also reviews are becoming more plentiful. The excessive amount of studies of simulation education published in the last five years are too numerous to review individually and a wider overview is strategic (15). Therefore, a logical next step is the conduct of reviews of existing reviews, leading to a summary of the evidence of multiple research syntheses. This review of reviews is referred to as an umbrella review. They allow a rapid review of the evidence, provide an overall examination of the body of information that is available, and present a comparison and contrast of the results of published reviews. The methodology of an umbrella review has been clearly described by Aromataris *et al.* (2015) and this review has been conducted using the guidance of their protocol.

### Research questions

1. What types of simulators are used in nursing education and what is their effectiveness?
2. What is the impact of simulation-based learning on nursing students' learning outcomes?
3. How is simulation-based learning implemented in nursing curricula?

### Inclusion criteria

For this umbrella review, studies with participants who were students at all levels of nursing education programs, were included. This study looked at simulation-based learning and took interest in the following learner outcomes: cognitive, affective, and psychomotor. The learner outcomes encompassed those of nursing students across all academic and practice settings all over the world. Typically, an umbrella review only includes existing systematic reviews and meta-analyses (16). However, simulation is a relatively young science and there only have been three umbrella reviews on simulation-based learning so far (14). Therefore, this umbrella review does not limit itself to systematic reviews and meta-analysis, but includes the whole taxonomy of reviews.

### Literature Search Strategy

A search was conducted in multiple databases to identify recent relevant review studies and meta-analysis. The search process for this umbrella review included the following search terms and combinations of terms: simulation training, high fidelity simulation training, patient simulation, nursing, nursing education, and nursing education research. The following electronic databases were searched: CINAHL, ERIC, MEDLINE, Science Direct and Web of Science.

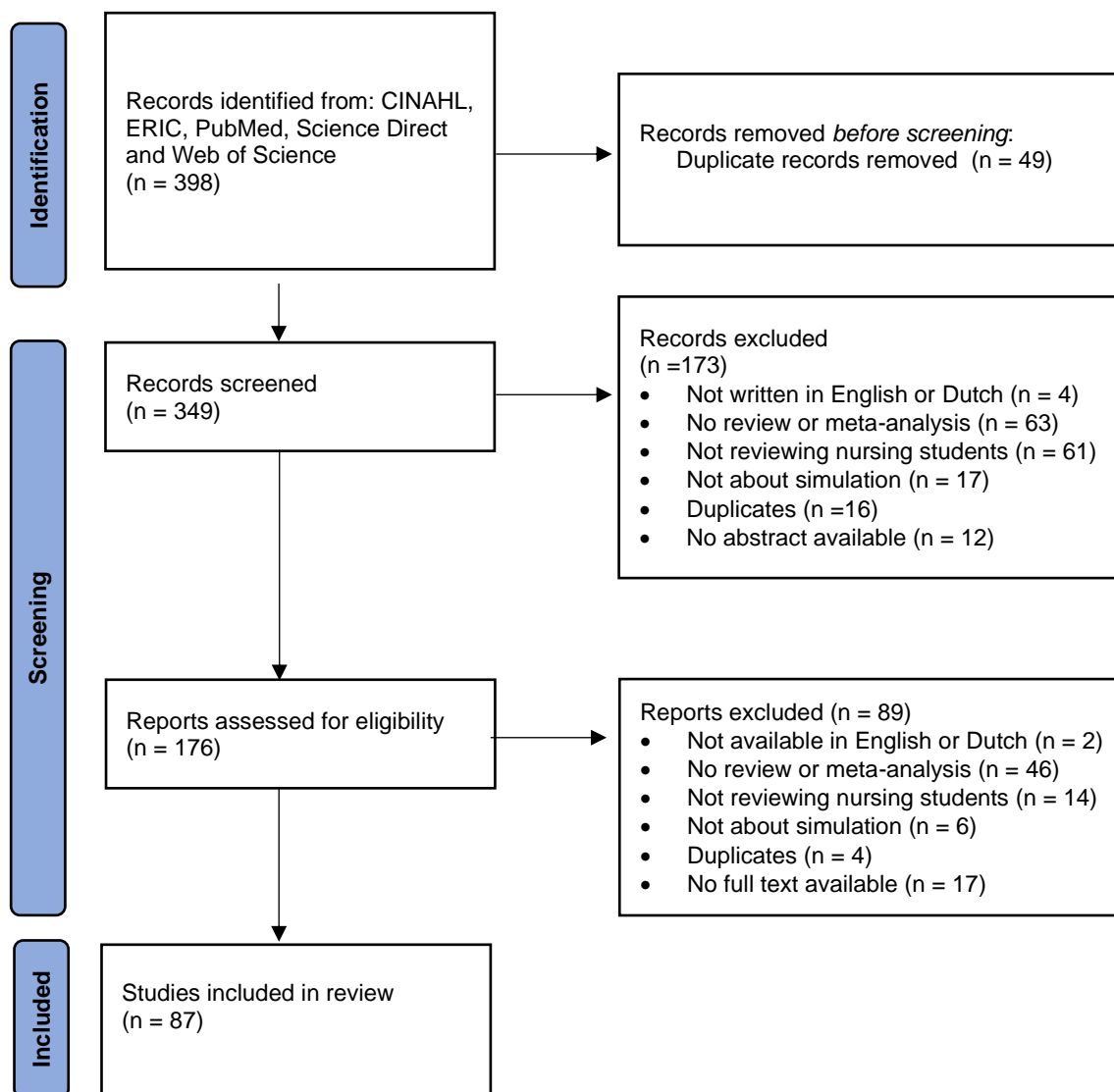
### Assessment of methodological quality

To assess reviews and meta-analyses that are eligible for inclusion in an umbrella review, there are several tools and checklists available (16). All reviews were scanned for the ten criteria on the checklist of Aromataris *et al.* (2015). However, since there are gaps in published research methodology and the objective of this study is to provide an all-encompassing summary of simulation outcomes, most reviews that met the eligibility criteria were included.

## Results

### Search outcome

The search identified a total of 398 papers. After filtering for duplicates, 349 abstracts were scanned for in- and exclusion criteria. The identification and selection of studies for inclusion in this review are detailed in the PRISMA Flow Diagram in Figure 1.



**Figure 1** PRISMA Flow Diagram

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71

### Characteristics of included reviews

A total of 87 reviews were included; 35 were described as systematic reviews, four of which included a meta-analysis and 26 as integrative reviews, of which one also comprised a meta-analysis. An additional of four meta-analysis satisfied the eligibility criteria and were included in this review. Other designs included, were: state-of-the-art review, scoping review, umbrella review, focused review, summary review, theoretical review and a methodological review. Table A1, in the appendix, describes and summarizes the various studies, their design, aims, and outcomes.

### Simulation topics

The included reviews cover a diverse collection of topics. The 87 studies were collated into three simulation-based themes. The specific themes were: (a) types of simulators and their effectiveness, (b) the impact of simulation-based learning on students' performance, and (c) pre- and debriefing. A discussion of each simulation-based learning theme provides an overview of the current state of simulation science.

### Types of simulators and their effectiveness

In nursing education, different types of simulators are being used, including: manikins, either with low-, mid- or high-fidelity, standardized patients, and virtual learning (17). High-fidelity manikins

and standardized patients are the most reported types of simulators used in nursing education (4, 18, 19). Table 1 shows the effect of simulation-based learning on students' learners outcomes as seen in the meta-analysis included in this review. The overall and individual effects show positive results for most outcomes, with only no effect seen in satisfaction, self-confidence, and self-efficacy in the study of La Cerra *et al.* (2019) and critical thinking and learning satisfaction in the study of Oh *et al.* (2015). However, these affective outcomes are mostly self-reported and therefore regarded as less objective and more prone to biases.

When planning a simulated activity, one should not only consider the effectiveness of the simulator, but the choice of type of simulation should also be adopted and take into account the theoretical content being taught and the complexity of the scenario that is to be developed (6).

Table 1 Effect of simulators on students' learners' outcomes

Author	Type of simulation	Participants	Effect size
<b>Franklin and Lee (2014)</b>	Simulation-based training	Novice nurses	<ul style="list-style-type: none"> <li>Self-efficacy: <math>d=0.27</math>, 95%CI [0.10-0.44]</li> </ul>
<b>Kim et al. (2016)</b>	Low-, medium-, and high-fidelity mannikin, hybrid simulation, and standardized patients	Pre-licensure nursing students, licensed nurses, and nurse practitioners	<ul style="list-style-type: none"> <li>Overall effect: <math>d=0.70</math>, 95%CI [0.58-0.83]</li> </ul>
<b>La Cerra et al. (2019)</b>	High-fidelity patient simulation	Undergraduate and postgraduate nursing students	<ul style="list-style-type: none"> <li>Knowledge: <math>d=0.49</math>, 95%CI [0.17-0.81]</li> <li>Performance: <math>d=0.50</math>, 95%CI [0.19-0.81]</li> <li>Satisfaction: <math>d=0.38</math>, 95%CI [-0.01-0.77]</li> <li>Self-confidence: <math>d=0.21</math>, 95%CI [-0.02-0.43]</li> <li>Self-efficacy: <math>d=0.05</math>, 95%CI [-0.45-0.55]</li> </ul>
<b>Oh et al. (2015)</b>	Standardized patients	Undergraduate and graduate nursing students	<ul style="list-style-type: none"> <li>Knowledge: <math>d=0.38</math>, 95%CI [0.00-0.76]</li> <li>Critical thinking: <math>d=-0.07</math>, 95%CI [-0.48-0.35]</li> <li>Communication skill: <math>d=1.86</math>, 95%CI [1.54-2.18]</li> <li>Psychomotor skill: <math>d=1.06</math>, 95%CI [0.67-1.46]</li> <li>Self-efficacy: <math>d=0.61</math>, 95%CI [0.37-0.86]</li> <li>Learning motivation: <math>d=0.77</math>, 95%CI [0.43-1.10]</li> <li>Learning satisfaction: <math>d=0.12</math>, 95%CI [-0.17-0.41]</li> </ul>
<b>Shin et al. (2015)</b>	Low- and high-fidelity manikins and standardized patients	Graduate students, nurse practitioners, nurses	<ul style="list-style-type: none"> <li>Overall effect: <math>d=0.71</math>, 95%CI [0.47-0.95]</li> <li>Affective domain: <math>d=0.83</math>, 95%CI [0.55-1.11]</li> <li>Cognitive domain: <math>d=0.37</math>, 95%CI [0.04-0.70]</li> <li>Psychomotor domain: <math>d=0.94</math>, 95%CI [0.65-1.22]</li> </ul>

## Manikins

Manikins are mainly used as simulators for developing technical skills (5, 11, 15, 17). Low- and medium-fidelity simulators are advised to be used for skills training, whereas high-fidelity simulators could be used for more complex situations that demand clinical reasoning (5, 6).

The use of manikins results in an increase in learning outcomes, as healthcare behaviour, self-efficacy, confidence and independence, communication, clinical judgement, interprofessional collaborative care, civic engagement, as well as improvement in technical performance, error reduction, and patient safety (5, 8, 17, 20-24). The meta-analysis of Kim *et al.* (2016) shows that, overall, the effect sizes of high-fidelity simulation (0.86) and medium-fidelity simulation (1.03) are larger than the effect size of low-fidelity simulation (0.35) and would therefore offer benefits (19). However, these results need to be interpreted with caution. The degree of fidelity required of a simulation is in function of the learning task and context, and hence can vary widely for different areas and educational outcomes (19).

Furthermore, another advantage of high-fidelity simulation is that it is seen as a safe learning environment, which lowers anxiety and allows knowledge transfer to the clinical environment (15, 23, 25-28). However, Handeland *et al.* (2020) report that experiencing manikins as a doll makes it difficult for some students to practice communication (20).

Table 2 Effect size according to level of simulation fidelity

Outcome	Type of fidelity	Effect size [95%CI]
<b>Overall effect</b>	HFS	0.86 [0.67-1.05]
	MFS	1.03 [0.18-1.88]
	LFS	0.35 [0.18-0.52]
<b>Cognitive</b>	HFS	0.50 [0.36-0.64]
	MFS	0.06 [-0.55-0.68]
	LFS	0.47 [-0.11-1.05]
<b>Affective</b>	HFS	0.80 [0.54-1.07]
	MFS	0.01 [-0.61-0.62]
	LFS	0.39 [0.06-0.71]
<b>Psychomotor</b>	HFS	1.03 [0.77-1.30]
	MFS	1.76 [1.41-2.11]
	LFS	0.38 [-0.05-0.82]

HFS = high-fidelity simulation, MFS = medium-fidelity simulation, LFS = low-fidelity simulation

## Standardized patients

Standardized patients (SPs) are used in simulations involving a variety of topics and are therefore versatile to provide diverse learning opportunities, of which communication training is the most common topic (29). The use of standardized patients offers the opportunity for teaching and evaluating high-level cognitive functions, such as application, synthesis, and evaluation of nursing knowledge (30). As visualized in table 1, the meta-analysis from Oh *et al.* (2015) shows significant effects of standardized patients on knowledge acquisition, communication skill, self-efficacy, learning motivation, and clinical competence (7). Furthermore, the use of standardized patients can increase student confidence and satisfaction and reduce anxiety (3, 14, 19, 31-35).

However, more research is needed to determine if standardized patients are a favourable teaching method over other types of simulation experiences (3). It is also important to take into account that



standardized patients need training to ensure the fidelity of the SP and to guarantee standardization of the simulation scenario's (31).

### **Virtual learning**

Virtual environments are an alternative way to provide clinical experience to students (14, 36). Shin *et al.* (2019) found it to be an effective educational strategy for increasing learner engagement. It is the most suitable when it is based on the use of learners' own experience to identify and solve problems in a given context (36). Studies by Coyne *et al.* (2018) report that simulation video and virtual patients can increase students knowledge and skill, and enhances the flexibility and autonomy associated with the learning of clinical skills (37-40). It improves knowledge transfer and students' satisfaction, when compared to didactic teaching. The use of simulation videos provides opportunities for students to visualize the activity, allows them to engage at their own pace and level of comprehension, and allows repeated practice in a safe environment (37, 38, 40).

This is in line with the research of dos Santos *et al.* (2017), who review the use of simulated games in a virtual environment. These serious games support the development of motor skills and encourage clinical reasoning and decision taking (41). Nasiri *et al.* (2019), as well, found game-like simulation to have a significant positive effect on learning outcomes (42). Another advantage is the possibility to standardise the learning experience across a curriculum and can be adjusted according to the curriculum requirements (37). Simulated activities are most effective when they are well integrated with the curriculum (43).

However, it is still unclear if virtual simulation leads to improved retention of knowledge over time (39). Furthermore, students perceptions are mixed and it is known to be time consuming and expensive (14, 38, 39). It is also reported that, within virtual simulation, technical issues are a common problem, which causes anxiety, frustration, and dissatisfaction in students (39, 40). Additionally, evidence suggest that e-based learning alone does not exceed face-to-face patient simulation but can be used as a complementary teaching method in teaching of theoretical knowledge (40, 44).

### **The impact of simulation-based learning on student performance**

The impact of simulation-based learning on student performance seems to be the most widely researched topic. It can aid nursing students in learning clinical and non-clinical skills. Outcomes of simulation, based on Bloom's taxonomy, encompass the cognitive, affective, and psychomotor domains of learning (45). Furthermore, it is known to be a resource to bridge the gap between theory and practice (5, 6, 11, 21, 26, 43, 46-49).

#### **The cognitive domain**

A large number of review studies reported that simulation-based learning improved students' knowledge (4-7, 11, 12, 14, 15, 17, 22, 26, 28, 30, 33, 34, 38-40, 44, 46, 48-65). This is supported by the evidence in table 1, where all studies show a positive effect size of simulation-based learning on the knowledge domain. Other skills in the cognitive domain that were reported to improve were: critical thinking (2, 4-6, 12, 14, 15, 18, 21, 26, 43, 46, 47, 49, 54, 61, 64), clinical reasoning (5, 6, 18, 26, 37, 41, 43, 46, 59), clinical judgement (14, 15, 18, 46, 48, 49, 54, 58, 59), problem solving (7, 14, 21, 43, 46, 54, 66), and communication skills (5, 7, 14, 20, 21, 23, 26, 31-33, 37, 43, 46, 50, 51, 54, 57-59, 63, 66-70).

Little is known about the impact of simulation-based learning over the long term and studies show mixed results (8). Although, Connell *et al.* (2016) report that high-fidelity simulation provides knowledge retention over time (71), Laschinger *et al.* (2008) note that knowledge decreases significantly within 4 to 8 months (53) and Cantrell *et al.* (2017) say repetitive practice is required for skill retention (14). More research is necessary to test the best exposure time and schedule for simulation-based learning.

#### **The affective domain**

In the affective domain results for self-efficacy, confidence, competence, learning satisfaction, and learning motivation are found. Self-efficacy is the belief that one has the skills required to achieve a

goal (15) and is shown to statistically improve through simulation (72). This finding in the meta-analysis of Franklin and Lee (2014) is supported by others (6, 14, 18, 54, 72-74). Other simulation evaluation measures as, confidence, competence, and satisfaction are regarded as less objective measures that are subject to response biases. Nonetheless, confidence (3, 5, 6, 8, 9, 12, 14, 15, 18, 20, 23, 24, 26-28, 33-35, 39, 43, 44, 46, 48-50, 53, 56-58, 61, 63, 65, 69, 73, 75-77), competence (9, 15, 46, 48, 49, 65), satisfaction (3-5, 12, 24-27, 32, 33, 53, 54, 56-58, 60, 65), and motivation (14, 47, 54, 57) are reported to be improved in several studies. Additionally, studies report a reduction of anxiety and stress (5, 8, 18, 26, 28, 32, 35, 57, 58, 63, 77) and an improvement in teamwork (27, 46, 50, 56, 57, 59, 67, 70, 78).

However, not all studies show positive results. Table 1 shows that La Cerra *et al.* (2019) report no superior effect of high-fidelity patient simulation on satisfaction, self-confidence, and self-efficacy to any other teaching method (lectures, no intervention or low-fidelity manikins) (52).

### **The psychomotor domain**

Twenty-eight studies reported the use of simulation-based learning for psychomotor skills acquisition. Table 2 presents findings of Kim *et al.* (2016) that show that the use of high-fidelity simulators or standardized patients are better for the development of affective (effect size 0.80 and 0.73, respectively) and cognitive domain (effect size 0.50 and 0.32, respectively), whereas the acquisition of psychomotor skills was improved with the use of simulators of average fidelity (effect size 1.76) (19). The finding that simulation-based learning experience facilitate the development of psychomotor skills is supported by several other studies (6, 8, 14, 15, 17, 22, 26-28, 34, 37-41, 43, 44, 46, 48, 50, 52-56, 58, 59, 62, 71, 79, 80). However, as Cant and Cooper (2017) note in their review, more high-quality research is necessary to enable definitive conclusions on the benefits of simulation-based learning on psychomotor skills (15).

### **Additional outcomes**

On top of the cognitive, affective, and psychomotor domain, simulation can be used to develop other competencies. Learners develop a greater awareness of patient safety while using simulation (11, 14, 46, 58, 81). The study of Bordignon and Monteiro (2019) shows that simulation can be used to train nursing students on violence in the work environment in order to offer resources to manage situations of violence (82). Furthermore, three studies show that medication administration error rates decrease after a simulation-based educational intervention (14, 26, 81). Simulation-based learning can also enhance the development of empathy (26, 35, 57), improve leadership (46, 50, 59, 66), time management skills (69), and engagement (74, 83), and can support cultural competent nursing care (21).

### **Pre- and debriefing**

The simulation program is described to consist of three phases: (1) a prebriefing, where the facilitator explains how the simulation session will be conducted, discusses intended objectives and assigns students' roles; (2) followed by the simulation or scenario, where students have experiential or observational experience with real cases, and (3) ending with a group discussion or a debriefing, in which retrospective assessment and discussion of students' performance take place (11, 12). Acquiring foundational knowledge in advance, applying it during the scenario, and engaging in debriefing promote a deep reflection that supports knowledge development (84). It is reported that most learning outcomes of simulation-based learning are achieved in debriefing (85) and therefore debriefing is emerging as the most noteworthy phase of the simulation program (6, 14, 37, 43, 50, 86),

#### **Prebriefing**

Prebriefing is the phase occurring immediately prior to the scenario and prepares the participant for the simulation activity by clarifying the process and creating relevance to learning objectives (25, 87). Clear learning objectives are effective in guiding all aspects of the simulation and can assist in focussing student learning (18). Prebriefing helps learners to connect theory to practice prior to participating in a scenario (14). Furthermore, it increases the engagement level of the student, aids in learning of the participant, improves self-confidence, and may initiate clinical thinking that will enhance the development of clinical judgment (18, 25, 73, 84, 87). Additionally, it lowers anxiety

levels of the student (18, 84). Instructors hold the primary role in preparation, with preparing the setting, scenario, and expectations (73). It is beneficial for students to have clear understandable guidelines and expectations before participating in simulation. Presimulation activities, guided by the learning objectives, prepare the learner with required foundational knowledge to fully immerse in the simulation experience (84). Although, there is not enough research to determine if one method of preparation is associated with superior learning outcomes to another, there is a consensus that inclusion of alternate methods of presimulation preparation and/or prebriefing leads to better learner outcomes than either traditional approaches or no preparation at all (84).

### **Debriefing**

Debriefing is the closing of the simulation activity from discussion on positive points and points to be improved (50). Debriefing places a great emphasis and reflection on the students' experiences, perceptions, decision-making, critical thinking, clinical reasoning, and clinical competency. It enhances students' clinical judgement and problem-solving abilities, aids in building confidence, satisfaction, and knowledge and provides more opportunities for students to reflect on their knowledge, to link with their actions, feelings, and thoughts, and relate the exercise to real-life experiences (6, 13, 14, 17, 18, 26, 45, 50, 73, 85, 88-90).

Debriefing can be conducted through several methods, such as, feedback, blogging or journaling, group discussions, with or without using audio or video resources, whether or not led by a facilitator (6, 85, 88, 91). Dufrene and Young (2014) note that facilitated debriefing is the most recommended and widely practiced method following simulation (88). Structured debriefing has a more positive effect on learners' critical thinking or clinical judgement and video assisted debriefing has shown to be significant in improving learners' satisfaction, learning experience, performance, clinical thinking, clinical reasoning ability, confidence, and knowledge (27, 85, 92). There can be three facilitators for debriefing: instructors, peers, and learners themselves (91). The facilitators have the responsibility to lead guided reflective discussion about the students' performance (73), as unstructured debriefing loses direction (86). Therefore, it is not surprising that students feel that discussion sessions without faculty assistance are not helpful at all (73) and Laschinger *et al.* (2008) emphasize the presence of a clinical instructor to avoid the possibility of negative learning (53). However, there is no evidence in the literature that it is the only effective method (88).

There is no consensus regarding the time of debriefing. It can occur during or after the simulation. Some studies reporting within-event debriefing is more effective than post-event debriefing, but there have also been contradictive results reported. However, within-event debriefing is less widely used than post-event debriefing (91), and students prefer to participate in debriefing immediately following the simulation (88). Noteworthy is that Alanazi *et al.* (2017) report that debriefing time is essential and is estimated at 15 minutes per objective or twice the time of the simulation activity (8). The optimal length of debriefing varies by the simulation courses' objectives, type of debriefing, and simulation experiences. Simulation that are too long often contribute to fatigue and information overload (85).

### **Feedback**

Effective feedback provides learning direction, helps learners to reach their goals and increases reflective thinking (36, 43). Evans and Harder (2013) note that students value direct feedback as they are motivated to be successful (89). This is supported by the finding of MacKinnon *et al.* (2017) and Cant and Cooper (2010) who report that feedback that is immediate and specific is the most helpful and the most important factor influencing learning (12, 43). It allows students to self-assess their skills and monitor their progress towards skill acquisition and maintenance. Feedback can be achieved by a variety of means, including student observer and instructor feedback and from a reflective review of video records (12). According to Brewer (2011), feedback through open-ended questions is one of the most beneficial aspects of simulation training (73). Additionally, MacLean *et al.* (2017) report that the formative feedback of standardized patients at the end of a scenario is a unique learning opportunity for students. It gives them a different perspective to compare and improve their self-evaluation (32).

## Discussion

Simulation-based learning has been part of nursing education and practice for over 40 years and has been well accepted by students. The students learn how to apply knowledge, gained in the classroom, in the clinical context and simulation-based learning can thereby bridge the gap between theory and practice. High-fidelity manikins and standardized patients are the most reported types of simulators. However, when designing a simulation course, the level of fidelity may differ according to learning environments. High- and medium-fidelity simulators show a larger overall effect than low-fidelity simulators, however the choice of simulation should also take into account the theoretical content being taught: a simple technique requires a simple model depending on the learner's level. Each type of simulator has its benefits and its disadvantages. Manikins are mainly used as simulators for developing technical skills, but can be difficult or even feel unnatural for students to practice communication, since students perceive the manikins as a doll. Other barriers nurse educators face when using high-fidelity manikins include the time required to become familiar with the technology, to write and run realistic scenarios, and educators being rarely trained to use them. However, there are enablers which may increase the use, including training through simulation workshops, conferences, observation, hands-on practice, and mentor feedback. There is great importance of having a full-time simulation coordinator, with responsibility for teaching faculty members on how to use technology and incorporate simulation into their courses (4). Faculties should assess the cost/benefit relation in the purchase of simulators, when planning and structuring of simulation centres at teaching institutions. These measures should be aligned with investments in people in the organization with the goal of utilizing all resources and optimizing policies (6).

Standardized patients are versatile and can be used in a variety of topics, of which communication is the most common. They offer the opportunity for teaching and evaluating high-level cognitive functions. In order to ensure the fidelity of the standardized patient and guarantee standardization of the simulation scenario, the SPs should be trained. Furthermore, to achieve cultural competence in learning objectives, an SP program should recruit, develop, and maintain a diverse SP population. Simulation-based learning programs must carefully screen their applicants for the confidentiality of learners, peers, and individual performance. Also, here the importance of having a designated SP coordinator is stated. It reduces the faculty and staff workload to manage and train standardized patients (93). The goal of SP training is to imbue the standardized patients with the characteristics, mannerisms, and history of a real patient so that the portrayal is consistent and accurate (94). This provides consistency and delivers high-quality simulation to all healthcare students for the dynamic healthcare environment. Additionally, regular, systematic evaluation of the standardized patients will contribute to improved SP performance, learner outcomes, and programmatic success (93).

Virtual environments are an alternative way to provide clinical experience to students. They increase learner engagement, knowledge, and skills. Furthermore, virtual environments provide a safe environment in which students can practice repeatedly and allow students to engage at their own pace and level of comprehension. Other benefits are the possibility to standardize the learning experience across a curriculum and the experience can be adjusted according to the curriculum requirements. However, it is still unclear if virtual environments lead to improved retention of knowledge over time. Furthermore, students' perceptions are mixed, it is time consuming and expensive, and technical issues are a common problem. Evidence suggest that e-based learning alone does not exceed face-to-face patient simulation but can be an auxiliary tool. Additional research is recommended to determine if the benefits outweigh the costs (14). Also in teaching with virtual environments, instructor competency has a strong impact on educational effectiveness of learners and therefore should be carefully considered when using virtual simulation as a new educational environment (36).

Thus, simulators have a tremendous potential, however teacher preparation and the pedagogical framework that guides their use are just as important as their fidelity (17). The facilitation of simulation-based learning is complex and requires a mastery of a variety of techniques. Educators need extensive knowledge, behaviours, and skills acquired from both nursing and education. They

need to be able to manage group dynamics, create an authentic context within an artificial environment, be able to solve technical problems, utilize diverse resources, and integrate this into the existing curricula. Furthermore, they need to bring the theory to life, maintain an emotionally safe learning environment, and act as a professional role model (14, 95).

Despite this complex job for nurse educators, simulation-based learning seems profitable, since most studies present a positive outcome on students' performance. This review shows positive outcomes of simulation-based learning for the cognitive, affective, and psychomotor domains of learning. Most reviewed positive outcomes are: knowledge, critical thinking, communication skill, confidence, satisfaction, and psychomotor skills. Additionally, a reduction in anxiety and has been reported. Some students perceive a moderate to high level of stress, but see this as part of the overall process and appreciate simulation as a valuable learning experience and prefer simulation-based learning rather than theoretical lessons (47, 90).

When considering integrating simulation-based learning into a curriculum, research leaves some gaps to fill. At the moment, little is known about the impact of simulation-based learning over the long term. It is important to understand how skills and knowledge are sustained after the simulation practice. Studies show that knowledge decreases over time and, for skill retention, repetitive practice is seen as one of the key features of simulation that best facilitates learning. However, there is lack of knowledge regarding the adequate exposure time and no consensus about the frequency of simulation necessary to prevent skills decay. Most common study designs are the posttest, or pretest-posttest design, with little of them having a long-term follow-up. More rigor research, with stronger studies designs, is needed. Alanazi *et al.* (2017) offer an alternative study design, which includes three groups: (1) an experimental group with simulation training, (2) an experimental group with traditional training, and (3) a control group without training. However, this is hard to execute since the latter groups may be disadvantaged (8). Here is also proposed to add a long term follow-up over the course of the students' education.

A good simulation design is important and "*integrates the mastery of required knowledge, psychomotor skills, clinical reasoning, and reflective thinking skills within authentic scenarios that are either commonly encountered and/or have significant impact, with learning outcomes that can be measured against professional standards for practice* (18)". Therefore, the last topic addressed in this review is pre- and debriefing. The simulation program consists of three phases: (1) prebriefing, (2) the simulation, and (3) a debriefing. The prebriefing is used to clarify the process and create relevance to the learning objectives. It increases the engagement levels of the students and lowers anxiety levels. The debriefing phase is the closing of the simulation and emphasizes the reflection on the students' experiences. Debriefing can be conducted through several methods, but is most recommended to be facilitated by an instructor. Having a tutor, with skills and knowledge in the process of debriefing, present, optimizes learning and provides moments for reflection, which can lead to more critical and reflective thinking. It is emerging as the most noteworthy component of simulation. Furthermore, effective feedback provides learning direction and helps learners to reach their goals and increase the reflective thinking. Although the importance of prebriefing, and especially, debriefing is stated in the literature, these are not commonly reported and have been understudied to date (18).

## **Limitations**

Limitations of this study are recognized. An umbrella review is based on results from existing reviews and therefore has to accept the quality and accurateness of these studies. The quality was assessed using the checklist of Aromataris *et al.* (2015). However, since there are gaps in published research methodology and the objective of this study was to provide an all-encompassing summary of simulation outcomes, also some weaker study designs may have been included. Authors report that study design of some studies threatens the internal and external validity of the studies. Most reviews include three common study designs: the posttest design, the one group pretest-posttest design, and the non-equivalent control group pretest/posttest design (8, 34). The internal validity is threatened by the student-selection factor, meaning that the selection of students is based on

accessibility and convenience rather than randomization (8). Additionally, terminology is inconsistent across most studies with variance in description of manikins or simulation typology, levels of fidelity, and design elements. Due to this diversity in terminology, it is difficult to generalize findings across disciplines, institutions, and teaching methods (14, 25). Therefore, authors may have combined various heterogeneous studies with different settings, interventions or outcome measures. Furthermore, valid and reliable measurement tools are lacking in simulation and the use of proxy measures such as confidence, perception, and competence has been criticized (25).

## Conclusion

This umbrella review provides an overview of the current research in simulation-based learning in nursing education. The most common used types of simulators are high-fidelity manikins and standardized patients. Simulation experiences contribute to students' learning in a variety of ways: it can improve students' knowledge and enhance affective outcomes and psychomotor skills. However, the facilitation of simulation-based learning is complex and requires a mastery of a variety of techniques for educators. Moreover, to date there is a gap in knowledge regarding adequate exposure time or the frequency of simulation-based activities. Additionally, debriefing is reported to be the most noteworthy component of simulation, in which most learning outcomes are achieved, but has also been understudied to date.

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## Appendix

Table A3 Evidence table

Study	Review design	Aim/purpose	Study sample/inclusion period	Outcomes
<b>Adib-Hajbaghery and Sharifi (2017)</b>	Systematic review	To gain insight into the existing scientific evidence on the effect of simulation on critical thinking in nursing education	N = 16 studies (1975-2015)	<ul style="list-style-type: none"> <li>Eight of 16 studies report that simulation training positively affected the critical thinking skills</li> <li>The other eight studies reported ineffectiveness</li> <li>There is a large heterogeneity between studies regarding instruments and methods used</li> </ul>
<b>Alanazi et al. (2017)</b>	Systematic review	To review the best available evidence (level and quality) for the use of simulation training to improve clinical skills, knowledge, and self-confidence among healthcare students	N = 30 studies (2000-2016)	<ul style="list-style-type: none"> <li>The use of simulation in student education significantly improves knowledge, skills, and self-confidence</li> </ul>
<b>Al-Ghareeb and Cooper (2016)</b>	Integrative review	To identify, critically appraise and synthesize the existing evidence on the barriers and enablers to using high-fidelity human patient simulator manikins (HPSMs) in undergraduate nursing education.	N = 21 studies (2000-2015)	<ul style="list-style-type: none"> <li>Barriers identified in HPSMs education include: lack of time, fear of technology, workload issues</li> <li>Enablers identified, include: faculty training, administrative support and a dedicated simulation coordinator</li> </ul>
<b>Almeida et al. (2018)</b>	Integrative review	To identify and reflect on evidence regarding the use of simulation in nursing education.	N = 160 articles (January 2008 – March 2014)	<ul style="list-style-type: none"> <li>Positive aspects related to the use of simulation, include support for the teaching process and increased self-efficacy and self-confidence</li> <li>Appropriate tools are needed to measure the true impact of the strategy on the teaching of nursing care and the training needed to use simulation as a teaching strategy</li> </ul>
<b>Alt-Gehrman (2019)</b>	Literature review	To describe what research has been conducted on transfer of knowledge using high-fidelity patient simulation (HFPS) and determine what further research is needed.	N = 16 articles	<ul style="list-style-type: none"> <li>Themes that emerged included competence, confidence, safety, timing, method and delivery. Study results varied, with only some showing transfer.</li> <li>More research is needed to determine how HFPS influences knowledge transfer to the clinical setting.</li> </ul>

<b>Berry et al. (2009)</b>	Literature review	To describe the development of a high-fidelity simulation for community nursing education	Unknown	<ul style="list-style-type: none"> <li>Simulation can provide opportunities for learning that may not be readily available in community settings</li> </ul>
<b>Blodgett et al. (2016)</b>	Literature review	To analyze the scientific quality of articles related to SMPS and to provide recommendations for future research about the use of SMPS in undergraduate nursing education.	N = 12 studies (January 1 2005 – October 31 2015)	<ul style="list-style-type: none"> <li>Evidence about its effectiveness as a strategy to learn how to care for multiple patients simultaneously is lacking</li> </ul>
<b>Bordignon and Monteiro (2019)</b>	Integrative review	To evaluate the applicability and results of the use of simulation in nursing students and professionals' training on violence at work.	N = 9 studies (up to 2017)	<ul style="list-style-type: none"> <li>Simulation is a resource capable of helping nursing students and professionals to deal with cases of workplace violence, preventing it to occur or reducing damage.</li> </ul>
<b>Bortolato-Major et al. (2018)</b>	Scoping review	To identify the contributions of simulation for undergraduate students of Nursing	N = 41 articles (2012-2016)	<ul style="list-style-type: none"> <li>Simulation improves learning/knowledge and develops of psychomotor skills</li> <li>Simulation increases confidence/safety/efficacy and improves communication skills</li> <li>Simulation aids the development of critical thinking and reflective skills, improves the attitude and integrates theory and practice</li> </ul>
<b>Brewer (2011)</b>	Integrative review	To explore techniques used successfully for human simulation exercises in nursing education	N = 37 studies (2005-2010)	<ul style="list-style-type: none"> <li>Human patient simulation can be used successfully as an instructional method in nursing education</li> </ul>
<b>Camp and Legge (2018)</b>	Integrative review	To examine what is currently known about clinical remediation using simulation and how simulation contributes to clinical competency	N = 24 articles	<ul style="list-style-type: none"> <li>simulation is an effective pedagogy for development of clinical competency skills, such as critical thinking and clinical reasoning, but there is a significant deficit of literature on the use of simulation as a tool for clinical remediation of undergraduate nursing students.</li> </ul>
<b>Cant and Cooper (2010)</b>	Systematic review	To report the quantitative evidence for medium to high fidelity simulation using manikins in nursing, in comparison to other educational strategies	N = 12 studies (1999-2009)	<ul style="list-style-type: none"> <li>Medium and/or high fidelity simulation using manikins is an effective teaching and learning method when best practice guidelines are adhered to.</li> <li>Simulation may have some advantage over other teaching methods, depending on the context, topic and method.</li> </ul>

<b>Cant and Cooper (2017)</b>	state-of-the-art review and meta-analysis	To review the effectiveness of medium to high fidelity simulation as an education mode in pre-licensure/pre-registration nurse education	N = 72 studies (2010-2015)	<ul style="list-style-type: none"> <li>• Medium to high fidelity simulation is reported to benefit student learning and give high student satisfaction</li> <li>• Simulation programs provide a multi-modal way of learning</li> <li>• Simulation programs significantly improve clinical knowledge from baseline</li> </ul>
<b>Cant and Cooper (2017)</b>	Umbrella review	To conduct a systematic review to appraise and review evidence on the impact of simulation-based education for undergraduate/pre-licensure nursing students, using existing reviews of literature.	N = 25 studies (2010-2015)	<ul style="list-style-type: none"> <li>• The reviews measured 14 different main outcome variables. Many agreed on the key learning outcome of knowledge acquisition, although no quantitative effect were derived.</li> <li>• Three of four high-quality reviews found that simulation supported psychomotor development</li> <li>• Simulation statistically improved self-efficacy</li> <li>• Simulation education is reported with strong student satisfaction and improved confidence and/or critical thinking</li> </ul>
<b>Cantrell et al. (2017)</b>	Umbrella review	To present the findings of an umbrella review and to examine the state-of-the-science in SBLE	N = 97 reviews (1990 - 2016)	<ul style="list-style-type: none"> <li>• There are four themes in the current literature: (a) specific clinical practice area or learner, (b) learner outcomes/identified skill acquisition, (c) elements of simulation design and (d) simulation as pedagogy</li> <li>• There is a need for objective evidence obtained through the use of reliable and valid measurement tools used by trained and objective raters</li> </ul>
<b>Cantrell et al. (2017)</b>	Integrative review	To critically integrate the literature related to the stress that nursing students experience regarding high-fidelity simulation (HFS).	N = 17 articles (2010 - 2015)	<ul style="list-style-type: none"> <li>• Students report either moderate or high stress associated with simulation, but they rated the HFS experience as a valuable learning tool</li> <li>• More high-quality studies are needed to investigate techniques that can be implemented to decrease the negative effects of simulation stress on nursing students</li> </ul>
<b>Chlalup et al. (2019)</b>	Integrative review	To analyze the publications on clinical simulation practices for education in Nursing in Intensive Care	N = 29 articles (2008 - 2017)	<ul style="list-style-type: none"> <li>• Variables after simulation use, such as confidence, communication skills, efficiency in the identification of clinical worsening of patients, development of technical skills, teamwork and clinical decision-making, presented a significant improvement, demonstrating that this tool is effective in qualifying care for critical patients.</li> </ul>
<b>Connell et al. (2016)</b>	Systematic review	To identify: (i) the evidence supporting educational effectiveness in the recognition and management of the deteriorating patient and (ii) outcome measures used to evaluate educational effectiveness.	N = 23 studies (2002 - 2014)	<ul style="list-style-type: none"> <li>• Educational interventions designed to improve the recognition and management of patient deterioration can improve learner outcomes when they incorporate medium to high-fidelity simulation.</li> <li>• Outcome measures should include knowledge and skill developments but there are important benefits in understanding patient outcomes</li> </ul>
<b>Coyne et al. (2018)</b>	Integrative review	To inform future educational strategies by synthesising research	N = 10 articles	<ul style="list-style-type: none"> <li>• Blended learning allows for different student learning styles, repeated viewing, and enables links between theory and practice</li> </ul>

		related to blended learning resources using simulation videos to teach clinical skills for health students		<ul style="list-style-type: none"> <li>The video presentation needs to be realistic and culturally appropriate and this requires both time and resources to create.</li> <li>Blended learning not only increases students' knowledge and skills, but is often preferred by students due to its flexibility</li> </ul>
<b>De Oliveira et al. (2014)</b>	Integrative review	To understand how simulation has been used in nursing education	N = 54 studies (2008 - 2012)	<ul style="list-style-type: none"> <li>Different types of simulators are used in nursing education for the development of various competences</li> <li>Simulation goes beyond the simple use of the simulator and involves strategies, techniques, processes, and tools</li> </ul>
<b>Doolen et al. (2016)</b>	Focused review	To provide an overview of existing high-fidelity simulation reviews in undergraduate nursing education	N = 7 (January 1, 2009 - June 30, 2015)	<ul style="list-style-type: none"> <li>There is a need for methodologically sound research that translates simulation outcomes to future performance and practice</li> <li>There are a multitude of challenges in simulation research including a lack of funding, a lack of simulation training for faculty and staff, and a lack of support for faculty conducting simulation research</li> <li>Limitations of prior studies include weak designs, mixed samples, and a lack of valid and reliable evaluation tools.</li> </ul>
<b>Dos Santos et al. (2017)</b>	Integrative review	To identify the evolution in the use of serious games in virtual environments for health teaching and learning in the literature	N = 13 articles	<ul style="list-style-type: none"> <li>Serious games have been developed through the elaboration of software and specific interactivity tools, mainly focused on skills development, using internet components and the use of peripherals of the computers in the teaching-learning strategies to encourage clinical reasoning and decision making.</li> </ul>
<b>Dufrene and Young (2014)</b>	Literature review	To identify articles and studies examining simulation and debriefing methods.	N = 13 studies	<ul style="list-style-type: none"> <li>improvement is noted in learners regardless of the debriefing process used.</li> </ul>
<b>Evans and Harder (2013)</b>	Systematic review	To critically analyze the merits of using a simulation framework and a clinical judgment rubric as tools to create an effective formative remedial strategy to support student learning	N = 32 articles and 4 books (2000 - 2012)	<ul style="list-style-type: none"> <li>Educators can purposefully leverage the simulation framework and clinical judgment rubric in formative remedial sessions with a goal for student success in clinical practice.</li> </ul>
<b>Evans and Taubert (2019)</b>	Summary review	To summarize the current literature and evidence for simulation and high-fidelity simulation in palliative and end-of-life care settings, and discuss potential uses of technologies including virtual and augmented reality in future training	Unknown	<ul style="list-style-type: none"> <li>There has been less emphasis on training with manikins and even less on using computer simulation and virtual reality environments to recreate challenging end-of-life care scenarios</li> </ul>

<b>Fisher and King (2013)</b>	Integrative review	To synthesize studies that explored simulation as preparation of nursing students for recognition and response to the deteriorating patient	N = 18 studies (2004 – 2012)	<ul style="list-style-type: none"> <li>• Simulation exposes students to a broader range of experiences whilst in a safe environment with transference of skills to clinical practice occurring</li> <li>• Confidence, clinical judgement, knowledge and competence, all vital in the care of a deteriorating patient, were enhanced</li> <li>• Evidence of simulation used specifically to prepare nursing students to recognize and respond to the deteriorating patient appeared limited</li> </ul>
<b>Foronda et al. (2020)</b>	Systematic review	To identify how virtual simulation impacts nursing student learning outcomes.	N = 80 (1996 – 2018)	<ul style="list-style-type: none"> <li>• Virtual simulation is an effective pedagogy</li> <li>• Future studies should use more robust research designs, prioritize curricular integration of virtual simulation, and determine best practices in virtual simulation methodology</li> </ul>
<b>Foster et al. (2019)</b>	Integrative review	To synthesize literature on how simulation is used to teach teamwork skills to prelicensure nursing students	N = 21 studies	<ul style="list-style-type: none"> <li>• While simulation appears to be an appropriate methodology to teach teamwork skills to prelicensure nursing students, it is evident that some of those skills are not being taught using the TeamSTEPPS framework</li> </ul>
<b>Franklin and Lee (2014)</b>	Meta-analysis	To provide an overall estimate of the effect of simulation on self-efficacy for novice nurses	N = 43 (up to January 15, 2014)	<ul style="list-style-type: none"> <li>• Simulation is effective at increasing self-efficacy among novice nurses, compared with traditional control groups</li> </ul>
<b>Hall (2017)</b>	Literature review	To review and report on the literature that is available on mental health simulation in particular relating to the outcomes	N = 45 studies	<ul style="list-style-type: none"> <li>• High fidelity simulation has the outcomes of knowledge gains, improved communication skills, increased confidence, increased satisfaction, decreased anxiety, increased critical thinking and clinical reasoning, increased psychomotor skills and empathy</li> </ul>
<b>Handeland et al. (2020)</b>	Systematic review and thematic meta-synthesis	To summarise and synthesise findings from qualitative primary research studies of nursing students' experiences from educational activities using manikins to gain a deeper understanding of the role these manikins play in the students' learning	N = 28 articles (from 2008)	<ul style="list-style-type: none"> <li>• A manikin can give students a realistic experience of what it means to behave like nurses. This realism lets students practice and acquire relational, communicative, and collaborative nursing skills</li> <li>• Using a manikin can facilitate the development of students' professional identity.</li> </ul>
<b>Hart and Chilcote (2016)</b>	Literature review	To identify the benefits and barriers of using SPs as a simulation modality	From 2006	<ul style="list-style-type: none"> <li>• Based on identified barriers, an innovative, interdisciplinary course to prepare theatre students to portray patients for simulations is proposed. This proposed course could potentially eliminate identified barriers and increase use of SPs</li> </ul>

<b>Jang et al. (2019)</b>	Literature review	To synthesize literature on simulation scenarios related to adult health nursing according to the learning objectives	N = 26 articles	<ul style="list-style-type: none"> <li>When developing a standardized simulation scenario for students, it is necessary to consider the various learning objectives of adult health nursing, and to evaluate various areas extensively</li> </ul>
<b>Jeppesen et al. (2017)</b>	Systematic literature review	To explore the literature on the connection between teaching strategies and nursing students' learning to clarify which teaching strategies provide optimal learning experiences and outcomes	N = 45 studies (January 2000 – November 2016)	<ul style="list-style-type: none"> <li>Teaching in skills lab and simulation laboratories provides a positive learning environment and motivates student nurses to learn. It develops critical thinking and the student nurses' ability to take part in problem-based nursing</li> </ul>
<b>Kaplonyi et al. (2017)</b>	Systematic review	To critically analyse the existing research, investigating whether SP-based communication skills training improves learner–patient communication, how communication skill improvement is measured, and who measures these improvements.	N = 60 studies	<ul style="list-style-type: none"> <li>SP-based education is widely accepted as a valuable and effective means of teaching communication skills but there is limited evidence of how this translates to patient outcomes and no indication of economic benefit for this type of training over another method</li> </ul>
<b>Kardong-Edgren et al. (2010)</b>	Review	To discuss the importance of learning domains in evaluation, to review current challenges in designing simulation evaluation instruments, and to provide a review of currently published instruments for simulation evaluation	Unknown	<ul style="list-style-type: none"> <li>There are several instruments for evaluating HPS, however they need to be used and reused to provide valid data for reliability and validity</li> </ul>
<b>Kim et al. (2016)</b>	Meta-analysis	To determine the effect size of simulation-based educational interventions in nursing and compare effect sizes according to the fidelity level of the simulators through a meta-analysis	N = 40 studies	<ul style="list-style-type: none"> <li>Simulation-based nursing education is effective in various learning domains, with a pooled random-effects standardized mean difference of 0.70</li> <li>Effect sizes are larger for high-fidelity simulation (0.86), medium-fidelity simulation (1.03), and standardized patients (0.86) than they are for low-fidelity and hybrid simulations</li> </ul>
<b>Kim and Yoo (2020)</b>	Literature review	To examine how debriefings have been conducted in healthcare simulations	N = 22 studies	<ul style="list-style-type: none"> <li>Peer-led debriefing might be more appropriate for experienced healthcare professionals than unlicensed students due to a gap in knowledge and problem-solving skills between them</li> <li>Tele-debriefing is feasible in some studies</li> </ul>



				<ul style="list-style-type: none"> <li>• A substantial number of debriefings closely aligns to the standards for high-quality debriefing.</li> </ul>
<b>Kunst et al. (2018)</b>	Scoping review	To synthesize a framework of best practice in simulation applied to Australian simulation education	N = 44 articles	<ul style="list-style-type: none"> <li>• Inconsistency in the methods used to evaluate simulation activities creates challenges in pooling results to provide definitive answers about the benefits of simulation in undergraduate nurse education.</li> <li>• Improved clarity and rigor in evaluation is needed to guide the appropriate use of simulation in the undergraduate nursing curricula</li> </ul>
<b>Kunst et al. (2016)</b>	Integrative review	To investigate the effect of high-fidelity manikin simulation in the development of knowledge and confidence in mental health care in undergraduate nurse education	N = 9 articles (2000 - 2016)	<ul style="list-style-type: none"> <li>• Simulation was found to increase learner confidence, satisfaction with learning, and self-efficacy in knowledge and communication in mental health care scenarios through the opportunity to rehearse complex care situations</li> </ul>
<b>La Cerra et al. (2019)</b>	Systematic review and meta-analysis	To analyse the effectiveness of high-fidelity patient simulation (HFPS) based on life-threatening clinical condition scenarios on undergraduate and postgraduate nursing students' learning outcomes.	N = 33 studies (up to July 2017)	<ul style="list-style-type: none"> <li>• Compared with other teaching methods, HFPS revealed higher effects sizes on nursing students' knowledge and performance</li> </ul>
<b>Labrague et al. (2018)</b>	Integrative review	To appraise and synthesize evidence examining the effects of interprofessional simulation on nursing students' outcomes	N = 30 articles (from 2010 onwards)	<ul style="list-style-type: none"> <li>• There are five essential themes: interprofessional communication, appreciation of interprofessional team roles, interprofessional teamwork or collaboration, self-confidence or self-efficacy, and positive attitudes or readiness toward interprofessional learning</li> </ul>
<b>Labrague et al. (2019)</b>	Systematic review	To critically appraise existing scientific articles that cover the influence of utilizing HFS on the effects of nursing students' anxiety and self-confidence during undergraduate nursing education	N = 35 articles	<ul style="list-style-type: none"> <li>• High fidelity simulation is found to be effective in the enhancement of nursing student self-confidence and the reduction of their anxiety when caring for patients and/or employing nursing skills</li> </ul>
<b>Lapkin et al. (2010)</b>	Systematic review	To identify the best available evidence for the effectiveness of Human Patient Simulation Manikins in teaching of clinical reasoning skills to undergraduate nursing students	N = 8 studies (1999 - 2009)	<ul style="list-style-type: none"> <li>• The use of HPSMs improves knowledge acquisition and critical thinking and enhances students' satisfaction with the learning</li> </ul>

<b>Laschinger et al. (2008)</b>	Systematic review	To identify the best available evidence on the effectiveness of using simulated learning experiences in pre-licensure health profession education	N = 23 (1995 – 2006)	<ul style="list-style-type: none"> <li>• There is high learner satisfaction with using simulators to learn clinical skills</li> <li>• Human patient simulators which are used for teaching higher level skills are useful</li> <li>• There are short-term gains in knowledge and skill performance, however performance of skills over time after initial training decline</li> </ul>
<b>Lee et al. (2020)</b>	Systematic review and meta-analysis	To identify the debriefing methods that are most effective in improving learning outcomes	N = 18 studies (January 1995 – December 2016)	<ul style="list-style-type: none"> <li>• The overall effect size of the learning outcomes, according to the type of debriefing method, was 0.31.</li> <li>• The results regarding debriefing methods were statistically non-significant in the learning outcomes (95% CI [-0.33-0.96], Z =0.95, p=0.34)</li> <li>• Structured debriefing helps to improve learning</li> </ul>
<b>Lee and Oh (2015)</b>	Meta-analysis	To evaluate the effects of high-fidelity human simulation (HFHS) on cognitive, affective, and psychomotor outcomes of learning	N = 26 trails	<ul style="list-style-type: none"> <li>• The use of HFHS tended to have beneficial effects on cognitive and psychomotor domains of learning</li> </ul>
<b>Lee et al. (2018)</b>	Integrative review	To assess the curriculum development process of simulation-based educational interventions in nursing in Korea	N = 125 papers	<ul style="list-style-type: none"> <li>• Educators and researchers should pay more attention to the educational strategies to integrate simulation into nursing education</li> <li>• This study could contribute to guiding educators and researchers to develop a simulation-based curriculum and improve the quality of nursing education research</li> </ul>
<b>Lucas and Edwards (2017)</b>	Literature review	To identify evidence available and explore the effectiveness of high-fidelity simulation education on the development of Crisis Resource Management Skills	N = 31 articles	<ul style="list-style-type: none"> <li>• Results are mixed, with 22 studies showing improvement in at least one CRM skill</li> <li>• Some studies show statistically significant improvement in some areas and no improvement or non statistically significant improvement in others</li> </ul>
<b>MacKinnon et al. (2017)</b>	Systematic review	To identify the appropriateness and meaningfulness of maternal-child simulation-based learning for undergraduate nursing students and nursing educators in educational settings to inform curriculum decision-making	N = 22 articles	<ul style="list-style-type: none"> <li>• Students feel that simulation prepares them for practice through building their self-confidence</li> <li>• The presence or absence of resources impacts the capacity of educators to integrate simulation activities throughout curricula</li> </ul>
<b>MacLean et al. (2017)</b>	Integrative review	To analyse how SPs are used in nursing education to develop communication skills, to evaluate the evidence that is available to support the efficacy of using SPs for	N = 19 studies (2006 – 2019)	<ul style="list-style-type: none"> <li>• The use of SPs to teach nurse-patient communication skills targets more challenging clinical interactions</li> <li>• Engaging SPs in both CST program facilitation and course evaluation provides nurse educators with a strong foundation to develop further pedagogical and research capacity</li> </ul>

		training nurses in communication skills and to review the SP recruitment and training procedure		<ul style="list-style-type: none"> <li>Expanding the utilisation of SPs to augment nurses' communication skills and ability to engage with patients in a broader range of clinical contexts with increased methodological rigor is recommended.</li> </ul>
<b>Marion-Martins and Pinho (2020)</b>	Systematic review and meta-analysis	To conduct a systematic review of studies describing the effects of interprofessional education (IPE) on collaborative competence using simulated-based training of undergraduate healthcare students	N = 11 studies	<ul style="list-style-type: none"> <li>Quantitative analysis reveals a positive impact and the effectiveness of interprofessional simulation</li> </ul>
<b>May et al. (2009)</b>	Literature review	To determine whether the educational use of SPs has an effect on the knowledge, skills, and behaviour of learners in the health professions	N = 69 articles (1996 – 2005)	<ul style="list-style-type: none"> <li>Most studies reported that the educational use of SPs was valuable</li> </ul>
<b>McDonald et al. (2018)</b>	Integrative review	To examine the current evidence on the effectiveness of digital technologies or e-based learning for enhancing the skills and knowledge of nursing students in nursing assessment.	N = 20 articles (2006 – 2016)	<ul style="list-style-type: none"> <li>E-based learning alone does not exceed face-to-face patient simulation</li> <li>E-based learning and traditional teaching methods used in conjunction with each other create a superior learning style</li> </ul>
<b>McGuire and Lorenz (2018)</b>	Integrative review	To examine studies evaluating learner stress in simulated settings as measured by cortisol	N = 17 publications (2009 – 2016)	<ul style="list-style-type: none"> <li>Cortisol is a valid measure of stress in simulation</li> <li>Evidence is inconclusive on whether elevated stress during simulation promotes performance</li> </ul>
<b>Miller and Jensen (2014)</b>	Integrative review	To explore the use of avatars and virtual worlds in education, synthesize the articles and findings and present implications for nurse educators.	N = 18 projects	<ul style="list-style-type: none"> <li>Avatars allow students to practice in a safe environment, enhancing learning</li> </ul>
<b>Mok et al. (2016)</b>	Systematic review	To evaluate the effectiveness of using HFPS in teaching clinical reasoning skills to undergraduate nursing students and a comparison with other teaching methods	N = 11 studies	<ul style="list-style-type: none"> <li>There is a lack of support for the hypothesis that the use of HFPS is more effective than other teaching methods in teaching clinical reasoning skills to undergraduate nursing students.</li> </ul>
<b>Murdoch et al. (2014)</b>	Systematic review	To identify best practice recommendations to enhance collaborative healthcare using interprofessional simulation	N = 17 studies	<ul style="list-style-type: none"> <li>The following simulation techniques are recommended: high-fidelity human patient simulators, role play, and didactic lecture and audience response didactic lecture, both followed by role play with a standardized patient.</li> </ul>

		education innovations for learners in pre-licensure nursing programs		<ul style="list-style-type: none"> <li>Instructor modelling was related to achievement of interprofessional competencies when compared to no modelling.</li> </ul>
<b>Nasiri et al. (2019)</b>	Systematic review	To explore and describe the educational games developed for students in the area of perioperative nursing and examine the quality of the evidence to determine whether the findings are valuable, relevant, and applicable	N = 10 studies	<ul style="list-style-type: none"> <li>It seems that the investigated games are insufficient to promote the nursing students' learning outcomes in different domains</li> </ul>
<b>Negrão et al. (2014)</b>	Systematic review	To identify the best scientific evidence on the gains perceived by the Nursing students in relation to high-fidelity simulation practice	N = 9 papers (2005 – 2011)	<ul style="list-style-type: none"> <li>High-fidelity simulation is valued by students for increasing their cognitive and psychomotor perception of the clinical reality that awaits them and raises a lot of apprehension</li> </ul>
<b>Negri et al. (2017)</b>	Integrative review	To identify in the literature the gains health students and professionals perceive when using clinical simulation with dramatization resources	N = 53 studies	<ul style="list-style-type: none"> <li>The use of dramatization in the clinical simulation leads to gains in satisfaction, self-confidence, knowledge, empathy, realism, reduced level of anxiety, comfort, communication, motivation, capacity for reflection and critical thinking and teamwork</li> </ul>
<b>Norman (2012)</b>	Systematic review	To review the literature that identified simulation outcomes measurement in nursing education	N = 17 studies (2000 – 2010)	<ul style="list-style-type: none"> <li>Simulation is useful in creating a learning environment which contributes to knowledge, skills, safety, and confidence</li> </ul>
<b>Øgård-Repål et al. (2018)</b>	Integrative review	To evaluate the available evidence supporting the efficacy of using simulation with standardized patients to prepare nursing students for mental health clinical practice	N = 6 studies	<ul style="list-style-type: none"> <li>Simulation with standardized patients could decrease students' anxiety level, shatter pre-assumptions, and increase self-confidence and self-awareness before entering clinical practice in mental health</li> </ul>
<b>Oh et al. (2015)</b>	Meta-analysis	To evaluate the effect of simulation-based learning using standardized patients (SPs) on cognitive, affective, and psychomotor domain outcomes of learning in nursing students	N = 18 controlled trails	<ul style="list-style-type: none"> <li>Simulation-based learning using SPs appears to have beneficial effects on the cognitive, affective, and psychomotor domains of learning</li> <li>SPs show significant effects on knowledge acquisition (d = 0.38, p = .05, I2 = 42%), communication skill (d = 1.86, p &lt; .001, I2 = 15%), self-efficacy (d = 0.61, p &lt; .001, I2 = 6%), learning motivation (d = 0.77, p &lt; .001, I2=0%) and clinical competence (d=0.72, p &lt; .001, I2=0%)</li> <li>Treatment effects on critical thinking (p=.75) and learning satisfaction (p= .43) are not significant</li> </ul>

<b>Page-Cutrara (2014)</b>	Literature review	To comprehensively review the available nursing simulation literature about the phenomenon of prebriefing and critically evaluate its current role as a component of nursing simulation	N = 15 studies	<ul style="list-style-type: none"> <li>• Prebriefing may be beneficial in developing students' abilities to notice aspects of the clinical situation, anticipate patient needs, and focus on the application of existing knowledge to meet simulation objectives for forming essential skills such as clinical judgment and thinking</li> <li>• Prebriefing has the potential to enrich the learning experience from the beginning of the simulation process by the guided discovery of nursing care and thought processes</li> </ul>
<b>Ribeiro et al. (2018)</b>	Integrative review	To analyze the contribution of clinical simulation use as a teaching and training strategy of advanced nursing practices	N = 11 articles	<ul style="list-style-type: none"> <li>• Clinical simulation contributes to the teaching of advanced practice nursing, enhancing the clinical awareness and competency building for advanced clinical management, leadership and teamwork skills</li> </ul>
<b>Ricketts (2011)</b>	Literature review	To identify the current literature outlining the role of simulation for learning within undergraduate pre-registration nursing education and to consider its' evaluation as a teaching strategy from the learner's perspective	N = 6 studies	<ul style="list-style-type: none"> <li>• Simulated learning in a clinical skills laboratory is reported to increase student confidence and prepares students for real clinical setting, however, this acquisition of skill is often achieved at different rates by different students</li> <li>• Standardised approach to simulated learning in nursing education and the development of further holistic clinical scenarios which are linked to related theory and lectures, would offer measurable learning outcomes to meet professional and regulatory requirements</li> </ul>
<b>Rutherford-Hemming et al. (2016)</b>	Systematic review	To search, extract, appraise, and synthesize research related to the use of simulation in Nurse Practitioner education in order to answer the two following questions: 1) What research related to simulation in NP education has emerged in the literature?, and 2) Of the research studies that have emerged, what level of Kirkpatrick's Training Evaluation Model (1994) is evaluated?	N = 15 studies	<ul style="list-style-type: none"> <li>• There is a lack of empirical evidence in the literature to support using simulation in lieu of direct patient care clinical hours in NP education</li> <li>• There is a need to produce rigorous scientific studies in the future in order to provide quantitative support to allow simulation to be counted as clinical hours in NP programs</li> </ul>
<b>Rutherford-Hemming et al. (2019)</b>	Systematic review	To search, extract, appraise, and synthesize studies using standardized patients (SPs) in nursing academia to determine how this modality of simulation is being used.	N = 65 studies (January 2011 – September 2016)	<ul style="list-style-type: none"> <li>• There is a lack of rigorous research studies producing empirical evidence in simulations that have used SPs as a modality.</li> <li>• SPs are used twice as often in simulations with undergraduate students compared to graduate nursing students.</li> <li>• It is unclear how individuals are chosen to be SPs.</li> <li>• Most studies lack an objective documentation evaluating SP prior to the simulation</li> </ul>

<b>San (2015)</b>	Literature review	To identify the best practices in the utilization of simulation to enhance CC nursing care	N = 36 articles	<ul style="list-style-type: none"> <li>The use of simulation can support CC nursing care by providing a safe environment to conduct a cultural assessment, elicit students' attitudes toward cross-cultural situations, and improve communication, critical thinking, and nursing skills</li> <li>Gaps in research still exist regarding the effectiveness of clinical simulation to enhance CC nursing care</li> </ul>
<b>Shearer (2013)</b>	Integrative review	To evaluate existing evidence that nursing education using HFS improves patient safety outcomes, specifically skill performance, as influenced by simulation and design characteristics.	N = 20 studies (from 2007 onwards)	<ul style="list-style-type: none"> <li>Simulation-enhanced clinical experiences may decrease medication errors</li> <li>Knowledge and attitudes of safety may be improved with simulation, depending on the students' educational levels</li> <li>More comparative studies are needed to support theoretical models of simulation</li> </ul>
<b>Sherwood and Francis (2018)</b>	Systematic review and meta-analysis	To examine if increasing equipment fidelity improves learning outcomes	N = 16 trails	<ul style="list-style-type: none"> <li>Training on higher-fidelity mannequins was associated with improved performance immediately post-intervention when compared with training on lower-fidelity mannequins for knowledge (<math>p &lt; 0.00001</math>) and psychomotor outcomes (<math>p &lt; 0.00001</math>)</li> <li>During follow-up testing at intermediate (1–3 weeks) and long-term (1–6 months) data points, there was insufficient evidence to determine any advantage in the use of higher fidelity mannequins.</li> </ul>
<b>Shin et al. (2019)</b>	Integrative review	To identify the educational characteristics of virtual simulation in nursing education	N = 40 studies	<ul style="list-style-type: none"> <li>Virtual simulation might be an effective educational strategy for increasing learner engagement.</li> <li>The educational effects of virtual simulation were achieved through integration of virtual and general simulation strategies to promote learner engagement.</li> </ul>
<b>Shin et al. (2015)</b>	Meta-analysis	To identify the best available evidence about the effects of patient simulation in nursing education through a meta-analysis	N = 20 studies	<ul style="list-style-type: none"> <li>Significant post-intervention improvements were found in various domains for participants who received simulation education compared to the control groups</li> </ul>
<b>Shorey and Esperanza (2020)</b>	Systematic review	To examine the current evidence on the use of virtual worlds as a teaching tool and to ascertain the outcomes measured	N = 18 studies	<ul style="list-style-type: none"> <li>Advantages of virtual worlds include higher time-cost-effectiveness as compared to mannequin-based simulations and face-to-face lectures</li> <li>Two major disadvantages were technological issues and the lack of realism</li> <li>Virtual worlds are the most effective in improving cognitive outcomes such as theoretical knowledge</li> </ul>
<b>Skrable and Fitzsimons (2014)</b>	Literature review	To synthesize the research findings evaluating simulation specifically in associate degree nursing education	N = 12 articles (2010 – 2013)	<ul style="list-style-type: none"> <li>Exposure to HFPS increases standardized critical thinking test scores, although not significantly higher than other teaching modalities</li> <li>HFPS increases knowledge acquisition and skill performance</li> </ul>

				<ul style="list-style-type: none"> <li>• HFPS experiences increases student confidence levels</li> </ul>
<b>Smith et al. (2018)</b>	Systematic review	To present the findings on the use of simulation-based learning experiences (SBLEs) to teach communication skills to nursing students and clinicians who provide palliative and end-of-life care to patients and their families.	N = 30 articles	<ul style="list-style-type: none"> <li>• Simulation-based learning experience are being used to teach palliative and end-of-life communication skills to nursing students and clinicians</li> <li>• Lack of standardization, poor evaluation methods, and limited exposure to the entire interprofessional team makes it difficult to identify and disseminate validated best practices</li> </ul>
<b>Stokes-Parish et al. (2018)</b>	Systematic review	To explore the use of moulage in simulation practice today and its influence on participant engagement	N = 10 articles (2005 – 2015)	<ul style="list-style-type: none"> <li>• There is a widely held assumption that moulage is essential in simulation-based education for improved realism and subsequent learner engagement, however there is no clear evidence from the literature</li> </ul>
<b>Stunden et al. (2015)</b>	Systematic review	To present the best available evidence into strategies that help reduce first year nursing students' anxiety levels prior to undergoing OSCA and clinical placement	N = 8 articles	<ul style="list-style-type: none"> <li>• A simulation session prior to the OSCA increased students confidence and reduced their anxiety levels</li> <li>• Students who have been exposed to simulation scenarios before the OSCA are able to cope much better during the OSCA</li> </ul>
<b>Svellingen et al. (2020)</b>	Mixed study systematic review	To examine the use and effects of multiple simulations in nursing education	N = 27 studies	<ul style="list-style-type: none"> <li>• Multiple scenario-based simulation is a positive intervention that can be implemented in various courses during every academic year to promote nursing students' learning</li> </ul>
<b>Tyerman et al. (2019)</b>	Systematic review	To systematically examine the effectiveness of various presimulation preparation and briefing activities for health care professionals and students	N = 21 studies	<ul style="list-style-type: none"> <li>• Presimulation preparation and briefing had positive effects on satisfaction and learning outcomes such as knowledge and skill performance</li> <li>• Presimulation activities should be tailored to learner levels of clinical and simulation experience</li> </ul>
<b>Vandyk et al. (2018)</b>	Systematic review	To systematically search and review empirical literature on the use of psychiatry-focused simulation in undergraduate nursing education	N = 32 studies (January 2004 – October 2015)	<ul style="list-style-type: none"> <li>• Simulation is effective in reducing student anxiety and improving their knowledge, empathy, communication, and confidence</li> <li>• Summarized qualitative findings all support the benefit of simulation</li> </ul>
<b>Vincent et al. (2015)</b>	Integrative review and meta-analysis	To explore what researchers have established about the impact of high-fidelity simulation on improving the psychomotor clinical performance of undergraduate nursing students	N = 8 articles	<ul style="list-style-type: none"> <li>• A meta-analysis using Hedges' g to compute the effect size and direction of impact yielded a range of -0.26 to +3.39</li> <li>• A positive effect of HFS on psychomotor clinical performance was shown in seven of eight studies</li> </ul>

<b>Warren et al. (2016)</b>	Systematic review	To synthesize the best available evidence about the effectiveness of HFS within NP education programs worldwide	N = 10 studies (2007 - 2014)	<ul style="list-style-type: none"> <li>HFS increases students' knowledge and confidence, and students are more satisfied with simulation-based teaching in comparison to other methods</li> </ul>
<b>Weaver (2011)</b>	Integrative review	To analyze studies on the use of high-fidelity patient simulation (HFPS) in undergraduate nursing education	N = 24 articles	<ul style="list-style-type: none"> <li>HFPS benefits nursing students in terms of knowledge, value, and realism</li> </ul>
<b>Yuan et al. (2012)</b>	Systematic review	To determine the effects of high-fidelity simulation on knowledge and skills in nursing or medical education	N = 26 studies	<ul style="list-style-type: none"> <li>High-fidelity simulation enhances the scores on knowledge and skill exams but its contribution to objective structured clinical evaluation is mixed</li> </ul>
<b>Zhang et al. (2019)</b>	Systematic review	To evaluate the effectiveness of VAD on learners' reactions, learning, and behavior compared with verbal debriefing (if possible) and identified its effective elements	N = 23 studies (2002 - 2017)	<ul style="list-style-type: none"> <li>VAD improves learners' experience, attitude, and performance, but it does not show its advantage over verbal debriefing on knowledge acquisition</li> </ul>