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REVIEW PAPER

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Learning theories and tools for the assessment of core nursing competencies in simulation: A theoretical review

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Abstract

Aim: To identify the theories used to explain learning in simulation and to examine how these theories guided the assessment of learning outcomes related to core competencies in undergraduate nursing students.

Background: Nurse educators face the challenge of making explicit the outcomes of competency-based education, especially when competencies are conceptualized as holistic and context dependent.

Design: Theoretical review.

Data Sources: Research papers (N = 182) published between 1999–2015 describing simulation in nursing education.

Review Methods: Two members of the research team extracted data from the papers, including theories used to explain how simulation could engender learning and tools used to assess simulation outcomes. Contingency tables were created to examine the associations between theories, outcomes and tools.

Results: Some papers (N = 79) did not provide an explicit theory. The 103 remaining papers identified one or more learning or teaching theories; the most frequent were the National League for Nursing/Jeffries Simulation Framework, Kolb's theory of experiential learning and Bandura's social cognitive theory and concept of self-efficacy. Students' perceptions of simulation, knowledge and self-confidence were the most frequently assessed, mainly via scales designed for the study where they were used. Core competencies were mostly assessed with an observational approach.

Conclusion: This review highlighted the fact that few studies examined the use of simulation in nursing education through learning theories and via assessment of core competencies. It also identified observational tools used to assess competencies in action, as holistic and context-dependent constructs.

KEYWORDS
assessment, competency-based education, learning theories, literature review, nursing education, simulation, undergraduate nursing students

1 | INTRODUCTION

Competency-based education (CBE) is characterized by learner-centeredness and active learning, but is mainly oriented to learning outcomes attainment (Frank et al., 2010; Goudreau et al., 2009). To determine if learners achieve standards of competence, CBE requires a robust and multifaceted approach to define and assess student learning outcomes and to provides trainees with feedback about their competency development (Holmboe, Sherbino, Long, Swing, & Frank, 2010). Nurse educators who adopt CBE must use tools that will make students' learning outcomes explicit. Furthermore, it is recommended that assessment tools should include criteria that reflect learners' attainment of the milestones that make up the trajectory to competence (Holmboe et al., 2010). However, this remains challenging when competencies are conceptualized as holistic and context-dependent combinations of knowledge, skills and attitudes, as opposed to task-specific behaviours (Cowan, Norman, & Coopamah, 2005).

1.1 | Background

Morcke, Dornan, and Eika (2013) argued that the evolution of CBE can be traced back to psychology in the 1940s, but that strong endorsement of CBE by the medical community started in the new millennium and was propelled by the Flexner centenary report on the future of medical education (Cooke, Irby, & O'Brien, 2010). A central requirement of CBE is to define learning outcomes of education – competencies – and to set clear expectations for learners. A competency can be defined as a complex knowing of how to act based on the effective mobilization and combination of a variety of internal and external resources in a family of situations (Tardif, 2006). In nursing, different sets of core competencies have been defined. The Quality and Safety Education for Nurses' competencies (Cronenwett et al., 2007) were adapted from the Institute of Medicine's (Greiner & Knebel, 2003) five core competencies for all health professionals and include patient-centred care, teamwork and collaboration, evidence-based practice, quality improvement, safety and informatics. The Competency Outcomes and Performance Assessment Model (Lenburg, Abdur-Rahman, Spencer, Boyer, & Klein, 2011) described another set of core nursing competencies: assessment and intervention, communication, critical thinking, teaching, human caring relationships, management, leadership and knowledge integration.

The way CBE is enacted is prone to variations, but active learning remains one of its main features. Active learning involves engaging students in meaningful learning activities and in reflection about what they are doing (Bonwell & Eison, 1991; Prince, 2004). Examples of active learning strategies include problem-based learning, classroom response systems, games and case studies. Simulation is also an active learning strategy, for which interest has grown tremendously in nursing education. Simulation has been described as "a technique – not a technology – to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner" (Gaba, 2004, p. i2).

Why is this review needed?

- Nurse educators face the challenge of making explicit the outcomes of competency-based education, especially when competencies are conceptualized as holistic and context dependent.
- Simulation is an active learning strategy coherent with competency-based education; hence, it is crucial to understand how it can contribute to the development of core nursing competencies. Accordingly, there is a need to determine which learning theories are currently guiding simulation research.
- Tools to assess students' competencies in simulation treat knowledge, skills and attitudes as separate constructs, which makes it difficult to assess how students mobilize and combine those resources in action.

What are the key findings?

- Most papers either did not cite a learning theory or cited an instructional design framework for simulation. The most frequently cited learning theories were Kolb's experiential learning and Bandura's social cognitive theory.
- Students' perceptions and satisfaction, knowledge, procedural skills and attitudes were the most frequently assessed outcomes of simulation, mostly with tools designed for the study where they were used.
- Few tools assessed core competencies as learning outcomes of simulation. Those that did relied on observation of students' actions in simulation.

How should the findings be used to influence policy/practice/research/education?

- Further research is needed to enhance our understanding of how simulation engenders learning.
- Since it appears possible to assess core competencies by observing students' actions in simulation, future research should aim at developing and testing new tools that correspond to a holistic perspective of core competencies in nursing. These tools should provide criteria to assess students' level of development.

Following the call for more valid and reliable tools to measure the outcomes of simulation (Kardong-Edgren, Adamson, & Fitzgerald, 2010; Tanner, 2011), there has been considerable efforts in developing such instruments. However, recent literature reviews (Adamson, Kardong-Edgren, & Willhaus, 2013; Foronda et al. 2013; Kardong-Edgren et al., 2010) showed that these tools often measure knowledge, skills and attitudes as separate constructs. As such, it is difficult for nurse educators to assess how students mobilize and combine those resources in their encounters with simulated patients.

Furthermore, a systematic review of 120 simulation studies by Kaakinen and Arwood (2009) revealed that 94 studies discussed simulation as a teaching strategy and only 16 studies referenced a learning theory to explain how and why simulation was used. As the authors explained, this suggests that simulation is executed from a teaching paradigm rather than a learning paradigm. If simulation is posited as an active learning strategy congruent with CBE, it is important to understand the process of learning in simulation to explain why it is used and how to assess the learning outcomes it is expected to engender. Besides, detailing how a conceptual or theoretical framework guided the development of a simulation study was included as a criterion by which the quality of simulation-based research articles should be assessed (Fey, Gloe, & Mariani, 2015).

2 | THE REVIEW

2.1 | Aim

The aim of this review was to identify the theories used to explain learning in simulation and to examine how these theories guided the assessment of learning outcomes in simulation research. We aimed to examine how core competencies were assessed in undergraduate nursing students participating in simulation.

2.2 | Design

Active learning strategies, including simulation, are complex interventions, as they comprise various interacting components, involve great outcome variability and require high skill levels for delivery (Craig et al., 2008). To apprehend this complexity, it is important to attend to the results of the interventions and to the mechanisms by which they produce their effects. In this review, we focused on theories used by authors to explain how simulation could engender learning outcomes and tools used to assess those outcomes. The research questions were as follows: What are the theories used to explain learning in simulation? What would be the learning outcomes of simulation per those theories and do they correspond to learning outcomes assessed in simulation studies? Which tools are used to assess learning outcomes in simulation and are they compatible with a holistic and context-dependent vision of competencies?

To answer these questions, we designed a theoretical review (Campbell et al., 2014; Paré, Trudel, Jaana, & Kitsiou, 2015). Theoretical reviews are explanatory by nature; their primary aim is to identify and map theories that have become influential – or overlooked – in a field of research to form new and more abstract theoretical understandings of the relationships between different concepts or constructs. Through structured approaches, theoretical reviews organize prior research and examine patterns and similitudes to facilitate the development of new theories (Paré et al., 2015).

To design this theoretical review, we followed guidelines for systematic reviews (Moher, Liberati, Tetzlaff, & Altman, 2009) to the greatest possible extent. As discussed by Campbell et al. (2014), reviewing theories using methods from systematic reviews presents some methodological challenges. In our case, the most prominent issues were quality appraisal and synthesis. We did not perform quality appraisal, as the purpose of the review was to provide a comprehensive picture of the theories, outcomes and tools used in the field of simulation research, rather than appraise the effectiveness of simulation. For synthesis, we organized the literature with an iteratively developed coding framework and analysed the frequency of codes. The appraisal of the appropriateness of the relationships between theories, outcomes and assessment tools was inductive and based on investigators' knowledge of the field.

2.3 | Search Methods

Two independent librarians defined an extensive search strategy to retrieve research papers describing simulation in nursing education. Keywords related to CBE, assessment, measurement and instrumentation in research were included. The strategy was developed to include core nursing competencies, as defined by Greiner and Knebel (2003), Cronenwett et al. (2007) and Lenburg et al. (2011). These included: (1) leadership; (2) clinical reasoning, clinical judgement or critical thinking; (3) collaboration or teamwork; (4) informatics; (5) learning to learn; (6) evidence-based practice; (7) interpersonal skills or caring relationships and (8) clinical competence, clinical assessment or clinical intervention. The keywords were subject to a Delphi process with 14 educators and researchers involved in CBE, who requested the addition of (9) cultural competence and (10) ethical competence. The search strategies are available as supplementary material (see Appendices S1 and S2).

The search was performed twice, in June 2014 (1999–2014) and July 2015 (2014–2015). Inclusion criteria included: (1) use of role playing, standardized patients, or low- to high-fidelity mannequins; (2) undergraduate nursing students; (3) English or French; and (4) description of a research methodology. Exclusion criteria included: (1) secondary analysis; literature review or meta-analysis; (2) no focus on a form of simulation; (3) simulation used solely as a data collection method; (4) no student outcomes; (5) focus only on specific parts of a simulation, such as debriefing; and (6) psychometric studies. We excluded studies using anatomical models, computer-assisted instruction, games, task trainers and virtual reality, since they were less representative of real experiences that students might encounter in their practice.

2.4 | Search outcome

As depicted in Figure 1, the first database search yielded 8,023 articles (CINAHL: 2,510; Education Source: 1,919; Embase, 2,636; ERIC: 74; MEDLINE: 744; and PsycInfo: 149). Two independent members of the research team screened the titles and abstract of the non-duplicate records (N = 5,954) and assigned inclusion or exclusion codes. Inter-rater agreement yielded a Kappa of 0.86 (95% CI 0.84–0.88). The screening process left 659 full-text articles to be assessed for eligibility. Full texts were retrieved and split in two equal sets.

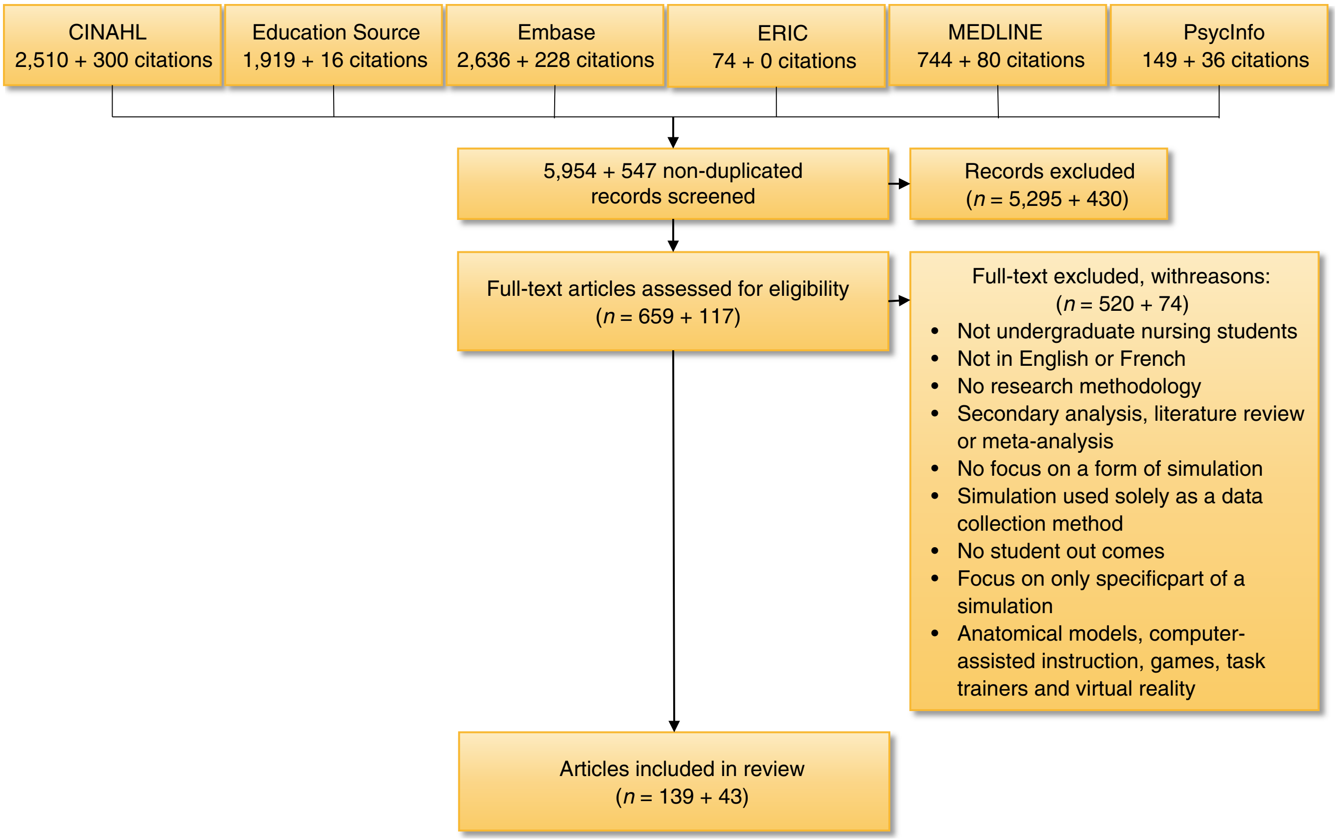

FIGURE 1 Literature flow diagram [Colour figure can be viewed at wileyonlinelibrary.com]

Two researchers each read one set and 520 articles were excluded per inclusion and exclusion criteria. When either investigator doubted whether to include an article, another investigator examined the article and consensus was reached. Ultimately, 143 studies identified in the first database search were included.

The second database search yielded 660 articles (CINAHL: 300; Education Source: 16; Embase, 228; ERIC: 0; MEDLINE: 80; and PsycInfo: 36). Of these, 547 were identified as non-duplicate records. Given the high inter-rater agreement for the articles from the first database search, a single researcher identified potentially relevant studies from the second database search. Following the screening process, 430 of these articles were excluded, leaving 117 full-text articles to be assessed for eligibility. Of these, 74 were excluded. Ultimately, 43 studies identified in the second database search were included in the review. In the end, 182 articles were included and are listed as supplementary material (see Appendix S3).

2.5 | Quality appraisal

None undertaken.

2.6 | Data abstraction

Two researchers extracted data from the 182 selected articles per the following categories: year, country, design, purpose, sample, form of simulation, theory about how simulation could engender learning outcomes, outcomes, assessment tools and instruments and results. Two investigators worked independently to inductively code the content of the grids and detail the categories presented above. Comparison of the investigators' coding for 20% of the studies revealed that it was identical.

2.7 | Analysis and synthesis

Data were summarized as frequencies and percentages for categorical variables and means and standard deviations for continuous variables. Contingency tables were created with the following combinations of variables: theories and outcomes, outcomes and tools and theories and tools. Based on these tables, we identified the outcomes and tools most frequently associated with the prevalent theories. Outcomes were classified into categories, which were arrived at by regrouping similar codes that were inductively generated from the content analysis. As in a previous review by Adamson et al. (2013), our classification was influenced by Kirkpatrick and Kirkpatrick's (2006) model for evaluating training programme, but we also took into account Tardif's (2006) definition of competency. We reviewed the original texts of the prevalent theories and summarized their depiction of the learning process and possible learning outcomes. We compared the association between learning theories and outcomes in the studies to how they were described in the original texts. The results were presented to the entire research team in an audit. Questions asked by the team allowed refinement of the findings.

3 | RESULTS

The following section includes: (1) characteristics of the studies; (2) prevalent theories; (3) the outcomes studied and the tools used to assess them; and (4) associations between theories, outcomes and tools in exemplar studies. It should be noted that the counts for the studies sometimes exceeded the number of studies under review, because some cited two or more theories, outcomes or tools/instruments.

3.1 | Characteristics of the Studies

Based on first authors' affiliations, most studies (*N* = 131, 70.1%) were conducted in North America, with 116 conducted in the USA (63.7%) and 10 in Canada (5.5%). The remaining studies were conducted in Europe (*N* = 21, 11.5%) Asia (*N* = 18, 9.9%), Oceania (*N* = 11, 6.0%) and the Middle East (*N* = 6, 3.3%). The first study included in this review was published in 1999. The number of studies published annually from 1999 to 2007 (*M* = 1.7) increased in 2008–2009 (*M* = 13.0) and peaked in 2010–2014 (*M* = 25.0). Although the results appeared to show a decrease in this number in 2015 (*N* = 17), they should not be interpreted as such, as the review did not include studies published during the final 5 months of 2015.

Most studies (*N* = 127, 69.8%) used mannequins exclusively, most of which were of high fidelity (*N* = 74, 40.7%). A smaller number of studies included role-play (*N* = 16, 8.8%) or standardized patients (*N* = 12, 6.6%) exclusively. Fourteen studies (7.7%) used two types of simulation, either mannequins and standardized patients (*N* = 10, 5.5%), mannequins and role-play (*N* = 3, 1.6%), or standardized patients and role-play (*N* = 1, 0.05%). Of note, 13 (7.1%) and 28 (15.4%) studies did not define simulation type and mannequin fidelity respectively.

3.2 | Theories

As explained above, theories are to be understood as hypotheses about how simulation engenders learning outcomes. Almost half of the studies (*N* = 79, 43.4%) did not cite an explicit theory. Instead, the rationale for simulation included the standardization of learning experiences, exposure to rare clinical events, the possibility of error without risk to patients, the possibility for pausing or repeating simulations and realism and authenticity. Authors also described simulation as an active or interactive instructional strategy with opportunities for immediate feedback. Simulation was considered a means for bridging the theory-practice gap or a solution to the clinical placement shortage and nursing staff overload. Other arguments were drawn from previous studies examining simulation effectiveness in various learning outcomes. The remaining papers (*N* = 103, 56.6%) explicitly identified one or more theory as depicted in Table 1. The most frequently cited was an instructional design framework, the National League for Nursing (NLN)/Jeffries Simulation Framework (Jeffries, 2012; *N* = 35, 19.2%). Then, two learning theories were the most frequent: Kolb's (1984) experiential learning theory and Learning Style Inventory (Kolb & Hay, 1999; *N* = 20, 11.0%), followed by Bandura's (1986) social cognitive theory and concept of self-efficacy (1977; *N* = 18, 9.9%).

TABLE 1 Theories cited in the studies

Theory	Citations *n* (%)
NLN/Jeffries Simulation Framework (Jeffries & Rizzolo, 2007)	35 (19.2)
Experiential learning theory, Learning Style Inventory (Kolb, 1984; Kolb & Hay, 1999)	20 (11.0)
Self-efficacy, social cognitive theory (Bandura, 1977, 1986)	18 (9.9)
Clinical judgment model (Tanner, 2006)	6 (3.3)
Situated learning (Lave & Wenger, 1991)	6 (3.3)
Constructivism	4 (2.2)
Novice-to-expert model (Benner, 1984)	4 (2.2)
Taxonomy of learning domains and mastery learning (Bloom, 1956, 1968)	3 (1.6)
Deliberate practice (Ericsson, Krampe, & Tesch-Römer, 1993)	3 (1.6)
Crisis resource management principles (Gaba, Fish, & Howard, 1994)	3 (1.6)
Adult learning principles (Knowles, Holton, & Swanson, 1998)	2 (1.1)
Assessment of clinical competence (Miller, 1990)	2 (1.1)
Cognitive apprenticeship model (Collins, Brown, & Newman, 1989)	2 (1.1)
Dewey's (1997) *Experience and Education*	2 (1.1)
Transformative learning (Mezirow, 1991)	2 (1.1)
Cognitive learning theory (as depicted in Billings & Halstead, 1998)	1 (0.05)
Complexity integration nursing theory (Van Sell & Kalofissudis, 2002)	1 (0.05)
Engagement theory of student learning (Kuh, Kinzie, Schuh, & Whitt, 2005)	1 (0.05)
Four-phase teaching model for simulation (Joyce & Weil, 1996)	1 (0.05)
Freire's critical pedagogy (as depicted in Roberts, 2000)	1 (0.05)
Multiple intelligence learning (Gardner, 2006)	1 (0.05)
Schema of cognitive and ethical development (Perry, 1970)	1 (0.05)
Self-directed learning (as depicted in Merriam, Caffarella, & Baumgartner, 2007)	1 (0.05)
Seven principles of good practice (Chickering & Gamson, 1987)	1 (0.05)
Three-P (presage-process-product) model of learning (Biggs, 1993)	1 (0.05)
Transfer or learning (Simons, 1999)	1 (0.05)

3.3 | Outcomes and assessment tools

As shown in Table 2, we classified the outcomes most frequently assessed in the reviewed studies into six categories: (1) perception and satisfaction; (2) knowledge, procedural skills and attitudes; (3) self-confidence and self-efficacy; (4) core competencies; (5) performance; (6) learning transfer (i.e. whether or how simulation prepared students for clinical placement or practice); and (7) other. To assess these outcomes, researchers used a variety of tools and most were designed specifically for the study (DFS) where they were used. A total of 87 studies (47.8%) used one or a combination of DFS tools, which included Likert-type scale measures of students' perceptions, questions to test students' knowledge, open-ended questions and rating scale of students' performance, among others. In the studies reviewed, we identified 87 tools that were developed and had undergone some form of validity or reliability testing, but that were used in only one or two studies in the sample. The remaining tools were used in at least three studies and are presented in Table 3.

In our categorization of outcomes, performance differed from procedural skill in that it consisted of a series of global, comprehensive actions, which were not deconstructed in multiple procedural steps. It also differs from core competencies in that performance refers to the demonstration of multiple competencies and skills. For these outcomes, the accuracy of measurements obtained via performance of assessment skills (such as blood pressure) was evaluated in four studies (2.2%). Other data to measure performance included those supplied by simulators used in cardiopulmonary resuscitation training, which records the depth and rate of cardiac compressions or volume and rate of insufflation (*N* = 4, 2.2%).

TABLE 2 Outcomes assessed in simulation studies

Category of outcome	Outcome	Studies *n* (%)
Perception and satisfaction	Perception of simulation	56 (30.8)
	Satisfaction with simulation	44 (24.2)
	Perception of learning	31 (17.0)
Knowledge, procedural skills, and attitudes	Knowledge	53 (29.1)
	Procedural skills	33 (18.1)
	Attitudes	12 (6.6)
Self-confidence and self-efficacy	Self-confidence	50 (27.5)
	Self-efficacy	18 (9.9)
Core competencies	Communication	20 (11.0)
	Critical thinking	13 (7.1)
	Teamwork and collaboration	12 (6.5)
	Clinical judgement	11 (6.0)
	Caring	4 (2.2)
	Safety	4 (2.2)
	Quality and Safety Education for Nurses competencies	2 (1.1)
	Patient-centred care	1 (0.5)
Performance		33 (18.1)
Learning transfer		13 (7.1)
Other	Anxiety	5 (2.7)
	Grades on course exams	4 (2.2)

Some studies assessed global constructs that could be linked to the sets of core competencies described in the introduction. Communication, clinical competence and the set of core competencies in the Quality and Safety Education for Nurses framework (Cronenwett et al., 2007) were assessed mainly via DFS tools. Critical thinking was assessed mainly via the California Critical Thinking Dispositions Inventory (Facione, Facione, & Sanchez, 1994) or DFS tools. Clinical judgement was exclusively assessed using the Lasater Clinical Judgment Rubric (Lasater, 2007). Teamwork and collaboration were assessed via DFS tools or a variety of validated instruments including the Mayo High Performance Teamwork Scale (Malec et al., 2007), which was used in two studies (1.1%). Caring was assessed qualitatively via observation or interviews in two studies and with different instruments in two other studies.

Among the tools that were used in one or two studies, we identified two that measure students' performance in a series of behaviour related to core nursing competencies. The Clinical Simulation Evaluation Tool (Radhakrishnan, Roche, & Cunningham, 2007) measures students' performance in safety and communication, assessment, diagnosis, interventions, evaluations, reflection and critical thinking. The Creighton Simulation Evaluation Instrument (Todd, Manz, Hawkins, Parsons, & Hercinger, 2008) includes five sections: safety, assessment, communication, critical thinking and technical skills.

Beside these tools, individual and focus group interviews were used to collect data concerning students' perception and satisfaction in 31 individual studies (17.0%). Most papers did not include a copy of their interview guides; it was difficult to compare the questions asked in the interviews, but they generally addressed students' experience and preference or their perception of learning in simulation.

3.4 | Associations between theories, outcomes and tools

In studies where the NLN/Jeffries Simulation Framework was used as the principal framework (*N* = 35), the most frequent outcomes were students' self-confidence (*N* = 21), satisfaction (*N* = 20) and perception of simulation (*N* = 17). Although other tools/instruments were sometimes used to assess these outcomes, the SCLS, EPQ and SDS were used most frequently (see Table 3). Students' knowledge was assessed via DFS tools in a smaller number of studies (*N* = 10). An example of use of the NLN/Jeffries Simulation Framework was found in Butler, Veltre, and Brady's (2009) pilot study comparing the implementation of low- and high-fidelity simulation in paediatric education. The researchers designed simulations for the educational practices presented in the framework and measured students' perception of and satisfaction with the simulations with the three NLN instruments.

In the studies that cited Kolb's theory of experiential learning or learning styles (*N* = 20), the most frequent outcomes were students'

TABLE 3 Assessment Tools Cited in Three Studies or More

Tool	Description	Studies *n* (%)	Category of outcome
Student Satisfaction and Self-Confidence in Learning Scale (SCLS, Jeffries & Rizzolo, 2007)	Measures students' satisfaction with instructional methods, learning materials, and instructors (five items), and their self- confidence in learning (eight items) Five-point scale (strongly disagree to strongly agree). Scores range from 13 to 65 points	24 (13.2)	Perception and satisfaction Self-confidence and self-efficacy
Simulation Design Scale (SDS, Jeffries & Rizzolo, 2007)	Measures students perception of the five simulation design features of the NLN/Jeffries Simulation Framework (objectives and information, support, problem-solving, feedback/guided reflection and fidelity) Twenty items, five-point scale, each item is evaluated for the presence (strongly disagree to strongly agree) and importance (not important to very important). Scores ranges from 20–100 points for presence and for importance	14 (7.7)	Perception and satisfaction
Lasater Clinical Judgment Rubric (Lasater, 2007)	Assess the development of students' clinical judgement as per the four phases of Tanner's (2006) Clinical Judgment Model (noticing, interpreting, responding, reflecting). Each phase has two to four dimensions, for a total of 11 dimensions Performance descriptors for the dimensions at each of the four levels of development (beginning, 1 point; developing, 2 points; accomplished, 3 points; exemplary, 4 points). Scores range from 11 to 44 points	11 (6.0)	Core competency (clinical judgement)
Educational Practices Questionnaire (EPQ, Jeffries & Rizzolo, 2007)	Measures students' perceptions of four of the educational practices included in the NLN/Jeffries Simulation Framework: active learning, collaboration, high expectations and diverse learning. Other educational practices (feedback, student–faculty interaction and time on task) are not included Sixteen items, 5-point scale, each item is evaluated for presence (strongly disagree to strongly agree) and importance (not important to very important). Scores range from 16 to 80 points for presence and for importance	10 (5.5)	Perception and satisfaction
State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983)	Measures individual's trait (20 items) and state (20 items) anxiety Four-point scale (almost never to almost always), scores range from 20 to 80 points	6 (3.3)	Other (anxiety)
California Critical Thinking Disposition Inventory (Facione et al., 1994)	Measures individual's disposition to value and utilize seven critical thinking attributes-of-mind: inquisitiveness, systematicity, analyticity, truth-seeking, open-mindedness, critical thinking self-confidence and maturity Seventy-five items, 6-point Likert scale (strongly agree to strongly disagree), scores range from 70 to 420 points	4 (2.2)	Core competency (critical thinking)
Simulation Effectiveness Tool (Elfrink Cordi, Leighton, Ryan-Wenger, Doyle, & Ravert, 2012)	Measures students' perception of the effectiveness of simulation on two subscales: learning (eight items) and confidence (five items) Three-point scale (do not agree to strongly agree), scores range from 0 to 26 points	4 (2.2)	Perception and satisfaction Self-confidence and self-efficacy
Satisfaction with Simulation Experience Scale (Levett-Jones et al., 2011)	Measures students' satisfaction with debriefing and reflection (nine items), clinical reasoning (five items) and clinical learning (four items) Five-point scale (strongly disagree to strongly agree), scores range from 18 to 90 points	3 (1.6)	Perception and satisfaction

knowledge (*N* = 6) and student satisfaction (*N* = 6), both measured mainly via DFS tools. In one exemplar study, Kameg, Englert, Howard, and Perozzi (2013) sought to determine whether simulation enhanced students' theoretical knowledge and retention of knowledge related to the content of three simulation scenarios. The theory was used to explain how students' engagement in a simulated experience could result in knowledge acquisition. The simulation scenarios and the debriefing questions were developed to support problem-solving, decision-making and reflection, which are associated with enhanced learning in Kolb's theory (1984). Of note, Kolb and Hay's (1999) Learning Style Inventory was the most frequently used tool in studies assessing students' learning styles (*N* = 2/6).

Studies (*N* = 18) that cited Bandura (1977, 1986) mainly measured self-efficacy (*n* = 13). However, self-confidence and satisfaction were assessed in six of these studies. No tool was used most frequently for either outcome and the only trend was in the use of DFS tools. Studies using Bandura's (1977, 1986) work included Goldenberg, Andrusyszyn, and Iwasiw (2005) and Sinclair and Ferguson (2009). In both studies, simulation was described as an instructional strategy that could promote students' self-efficacy via access to four information sources: performance mastery, vicarious learning experience, social persuasion and psychological state. These studies examined the effect of simulation on students' self-efficacy.

4 | DISCUSSION

Most studies did not include an explicit theory of learning or were framed in an instructional design framework. Studies that included an explicit learning theory most frequently cited Kolb's theory of experiential learning (1984) and Kolb and Hay's (1999) Learning Style Inventory and Bandura's self-efficacy (1977) and social cognitive theory (1986). While other theories were also identified (Table 1), they appeared less frequently and seem to have had less impact on the field of simulation research for undergraduate nursing education. This was an interesting finding considering that, according to Aliakbari, Parvin, Heidari, and Haghani (2015), a great variety of behaviourist, cognitivist and constructivist learning theories have influenced nursing education at a broader level.

Although closer to a teaching theory, the NLN/Jeffries Simulation Framework was the most prevalent, with citation in 35 studies (18.6%). This instructional design framework was conceived as a guide to the design, implementation and evaluation of simulation-based teaching activities in nursing education. It consists of five components: (1) facilitator; (2) participant; (3) educational practice (active learning, feedback, student–faculty interaction, collaboration, high expectations, diverse learning and time on task); (4) simulation design characteristics (objectives, fidelity, authenticity, problem-solving, student support, debriefing); and (5) expected student outcomes (knowledge, skills performance, learner satisfaction, critical thinking, self-confidence). As described by Jeffries, Rodgers, and Adamson (2015), it builds on a set of eclectic approaches, principles and techniques from a variety of theoretical perspectives, including learner-centred, constructivist and sociocultural perspectives of learning. Simulation is described as an opportunity for learning by communicating and remembering information (information processing), experiencing activities that promote cognitive network development (experiential growth) and embedding learning in participative and realistic tasks via which learners participate as a community (sociocultural). Because it is an instructional design framework, it is more situated in the teaching paradigm and it does not explicitly describe learning in simulation. Instantiation of this include the EPQ and the SDS, which assess the presence of educational practices and simulation design features, but do not consider their contribution to learning. To our understanding, some learning mechanisms were defined in the framework's educational practices and design characteristics, features of which appeared to overlap at times (e.g. problem-solving is considered both a design characteristic and a feature of active learning, which was one of the educational practices included in the framework). While these features are believed to contribute to learning, it is important to examine if and how they do so in the context of simulation. This is not to say that the framework is not valuable; it offers much-needed guidance for simulation design and implementation in nursing education. However, further research is required to enhance understanding of learning related to the framework's components, to guide simulation practices.

The prevalent learning theories proposed by Kolb (1984), Kolb and Hay (1999) and Bandura (1977, 1986) provide a theoretical understanding of the potential learning mechanisms of simulation. Kolb's (1984) theory of experiential learning emphasized the role of experience in learning, which is conceived as an adaptive process of transforming experiences to create knowledge. The individual grasps an experience, via either concrete experience or abstract conceptualization and transforms it into knowledge with reflective observation or active experimentation. Therefore, studies citing Kolb's experiential learning theory often associated simulation with concrete experience and/or active experimentation. The reflective observations and abstract conceptualizations that precede or follow simulation (e.g. in debriefing) allow for new conceptualizations, which are reinvested in the future. Kolb and Hay (1999) developed an inventory of four learning styles (accommodating, assimilating, converging and diverging), based on individuals' preferences in grasping experiences and transforming them into learning. Accordingly, simulation is considered a strategy that allows learning and aligns with different learning styles. However, studies by Ravert (2008) and Shinnick, Woo, and Evangelista (2012) failed to show that students' learning styles were affecting learning outcomes of simulation. Nevertheless, in a secondary analysis of Shinnick et al.'s (2012) data, Shinnick and Woo (2015) showed higher effect sizes of simulation for assimilating, diverging and balanced students than for accommodating and converging students.

Bandura (1995, p. 2) was most often cited through his concept of self-efficacy, which is defined as "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations". Self-efficacy is a performance attainment outcome that is based on the goals that people set for themselves and their persistence in achieving them. In a simulation context, self-efficacy is considered a valuable learning outcome. It is worth mentioning that self-efficacy scales are often task-specific and of those identified in the review, the following were used with minor modifications, each in two different studies: the English version of the General Self-Efficacy Scale (Schwarzer & Jerusalem, 1995), the Baccalaureate Nursing Student Teaching-Learning Self-Efficacy Questionnaire (Goldenberg et al., 2005) and the Self-Efficacy for Nursing Skills Evaluation Tool (McArthur Ravert, 2004). In addition to the concept of self-efficacy, Bandura's (1986) social cognitive theory posits that individuals learn by observing and extracting information from others' behaviour and this learning is reinvested to guide later action. There are four components to observational learning: attention, retention through symbolic coding operations or skill practice, reproduction and motivation. The concept of reciprocal determinism is central to this theory, which describes the influence of individuals, their behaviour and environment. Individuals possess intention, which is demonstrated through goal setting, motivation to change and perception of self- efficacy. Through the lens of Bandura's social cognitive theory, simulation entails all four components of observational learning. As such, it provides an occasion for students to self- regulate their behaviour and learn. Presentation of video recordings of expert performance in the simulation of role modelling is another example of how this theory influenced simulation educators.

However, reflection is required to align the learning mechanisms proposed by Kolb and Bandura with outcomes in terms of core competencies. Most studies citing these theories assessed outcomes such as knowledge or self-efficacy, which represent finite elements that, from a holistic and context-dependent perspective, should be combined to form a greater whole, to contribute to nurses' competencies. Besides participants' perceptions and satisfaction, knowledge, procedural skills and attitudes were the most frequently observed outcomes in our sample. However, such outcomes represent resources that, according to Tardif (2006), are to be mobilized and combined to produce effective action. While knowledge, procedural skill and attitude assessment is still required, researchers and educators should be aware of the way it fragments core competencies and consider the need for comprehensive assessment approaches. Therefore, performance and core competency outcomes are a promising venue for comprehensive assessment in simulation, especially when tools designed to assess those outcomes provide developmental criteria that reflect the evolution of learners' competence.

Few studies in the review assessed core competencies or performance as learning outcomes in simulation. Furthermore, few validated tools were available to assess these outcomes. This reiterates the issue of assessing core competencies in nursing, particularly in the absence of clear, common definitions of these competencies and the benchmarks by which they are to be evaluated. However, this review identified tools available to assess competencies in action, which can already be used by researchers. Examples of these tools include, but are not limited to, the Lasater Clinical Judgment Rubric (Lasater, 2007), the Clinical Simulation Evaluation Tool (Radhakrishnan et al., 2007) and the Creighton Simulation Evaluation Instrument (Todd et al., 2008). These tools take an observational approach to assessing different dimensions of core competencies. Other tools also rely on the observation of learners' actions for specific clinical competencies such as communication, teamwork and collaboration. This suggests that observation of actions might be a promising venue to the development of tools to assess core competencies in nursing. Nonetheless, the Lasater Clinical Judgment Rubric (Lasater, 2007) was the only tool identified in this review that provided indicators of performance for different levels of competence.

During this review, we encountered a series of methodological challenges. There was a wide variation in the descriptions of simulation activities, which made it difficult to appreciate the characteristics of the studies. To address this issue, guidelines for the description of interventions (see Conn & Groves, 2011; Hoffmann et al., 2014), combined with guidelines for reporting simulation research (Cheng et al., 2016) could be useful. Another tool that can provide guidance is the Simulation Research Evaluation Rubric (Fey et al., 2015). Much like it is recommended for competency assessment (Holmboe et al., 2010), this tool provides indicators of different level of quality for elements that should be present in reports of simulation research. With respect to assessment tools, a surprisingly high number were used in only one study, without consideration of their validity or reliability. This poses a great challenge to nursing education researchers, who try to position their results in relation to the landscape of simulation outcomes and more generally, the credibility of nursing education research. This was also identified as a research priority in the systematic review conducted by Adamson (2015).

This review is limited by several factors. First, we did not consider the contextual aspects of studies. For instance, it was not possible to identify trends in the use of theories or assessment of outcomes per the types of simulation studied, since standardized patients and role-play were under-represented in our sample compared with mannequin-based simulation. The same goes for cultural variations considering that most studies have been conducted in the Western world. Second, some core competencies were not represented in our sample (e.g. evidence-based practice, quality improvement, leadership, management and knowledge integration). Our research strategy could explain this, as many types of simulation, such as computer-based simulation, were excluded. Third, we did not collect data regarding study results or evaluate methodological quality. Therefore, our results should be considered a portrait of research practice in the simulation field and by no means account for the effectiveness of this active learning strategy. Despite these limitations, the review was one of the first to examine the assessment of core competencies in simulation research and to review the alignment between theories and outcomes in a large number of papers.

5 | CONCLUSIONS AND RECOMMENDATIONS

This review showed that the mechanisms by which simulation produce its effects have been understudied in past simulation research. This emphasizes the need for studies of the learning processes involved in simulation and the way different characteristics of simulation foster or impede learning. Future studies should use and validate existing learning theories in the context of simulation to further understand the mechanism by which simulation contributes to core nursing competencies. Given the scarcity of tools to assess these competencies in action, from a holistic and context-dependent perspective, further work is needed to identify the milestones in the development of nursing competencies. These milestones could then serve as indicators or benchmarks to assess at which point students are in their path to competent nursing practice.

AUTHOR CONTRIBUTIONS

All authors have agreed on the final version and meet at least one of the following criteria [recommended by the ICMJE (http://www.icmje.org/recommendations/)]:

- substantial contributions to conception and design, acquisition of data or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

CONFLICT OF INTEREST

No conflict of interest has been declared by the authors.

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SUPPORTING INFORMATION

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