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Review Article

Educational Characteristics of Virtual Simulation in Nursing: An Integrative Review

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simulation training;
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interactive learning;
engagement;
virtual reality;
nursing;
participatory learning;
simulation

Abstract

Background: Virtual simulation might be effective for enhancing nursing students' learning. We conducted an integrative review to identify the educational characteristics of virtual simulation in nursing education.

Method: We used Whittemore and Knaf's (2005) integrative review method. We searched for studies in PubMed, Medline, and CINAHL, and 40 studies met the inclusion criteria.

Result: We identified the general and virtual-specific characteristics of virtual simulation. The educational effects of virtual simulation were achieved through integration of virtual and general simulation strategies to promote learner engagement.

Conclusion: Virtual simulation might be an effective educational strategy for increasing learner engagement. To promote learner achievement, we recommend designing virtual simulations using the characteristics we identified.

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Effective teaching and learning involve learner participation, structured educational mechanisms, and formative and summative evaluations (Henrie, Halverson, & Graham, 2015; Koh, 2008; Mariani, Cantrell, Meakim, Prieto, & Dreifuerst, 2013). The current educational focus is on learner-oriented paradigms, which are based on the theories

of constructivism and active and experiential learning. The use of virtual simulation in education evolved along with this orientation, which positions learner engagement as the key factor influencing successful education. Virtual simulation has been used in various disciplines, including the medical field (Lopreiato & Sawyer, 2015; Moglia et al., 2016), system engineering (Barjis et al., 2012), military (Lele, 2013), and geography (Chen, Lin, Hu, He, & Zhang,

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2013) and appears effective in improving learners' educational achievements.

Simulation methods were introduced into nursing education to assist clinical practice training. These methods appear largely effective, specifically in the areas of learning motivation,

Key Points

- Through this integrative review, we identified the general and virtual-specific characteristics of virtual nursing simulations.
- The general simulation characteristics include the theoretical framework, teaching method, feedback, debriefing, purpose of simulation, scenario, and outcome; these serve as the scaffolding of the virtual simulation. The virtual-specific characteristics include instructor competency, mode of representation, participant role, interaction, type of platform, virtual framework, and virtual ethics.
- In virtual nursing simulation, learners participate in a cycle of engagement and experience, which helps drive them toward greater learning achievement.

self-learning ability, communication ability, problem-solving, and nursing skills (Warren, Luctkar-Flude, Godfrey, & Lukewich, 2016). Particularly, simulation education strategies using high-fidelity simulators and standardized patients (SPs) have a demonstrable impact on enhancing learners' performance skills and metacognitions. However, the high cost of manikins and SPs, and the time-consuming and labor-intensive nature of simulation, has prompted faculty to find alternative simulation strategies, such as virtual simulation (Shaikh et al., 2017).

Besides reducing costs and easing implementation, virtual simulation was introduced to enhance student learning experiences (Freina & Ott, 2015) and has since been used in various care contexts. Virtual reality simulation is defined as simulation using virtual reality, which according to (Bell 2008, p2) is defined as "a synchronous, persistent network of people, represented as avatars, facilitated by networked computers."

The early stages of virtual simulation were plagued by difficulties with the implementation technology; nowadays, however, virtual reality technology can closely reproduce real-world scenarios. Indeed, current technology enables the creation of virtual reality with excellent expression, clarity, and a sense of reality. Virtual reality is widely used in various fields such as computer graphics, displays, and industrial applications, as well as the entertainment industry, including broadcasting, film, and games (Park, Choi, Lee, & Sung, 2012; Rooney & Hennessy, 2013).

Many learners with experience of immersive media report feeling like they actually existed in the virtual space

when using the media. Researchers currently assume that the use of virtual simulation not only affords a safe medical environment but also a more realistic situation, as it removes temporal and spatial limitations (Gupta, Anand, Brough, Schwartz, & Kavetsky, 2008). Furthermore, by using virtual simulation, faculty are able to provide remote education or improve education in locations lacking in resources, such as underserved areas. Simulation using virtual reality is currently being applied in teaching materials mostly in Europe and the United States, and the results of systematic reviews have been positive (Abboudi et al., 2014; Moglia et al., 2016; Potkonjak et al., 2016). Overall, numerous studies (e.g., Potkonjak et al., 2016; Ryall, Judd, & Gordon, 2016) on the use of virtual reality have been conducted; however, studies on the use of virtual simulation in nursing education have not been carefully reviewed or validated (Freina & Ott, 2015).

Virtual reality was initially applied to aid nursing students with the acquisition of basic nursing skills (Liaw, Chan, Chen, Hooi, & Siau, 2014). Virtual reality has also been applied to complex nursing situations such as emergency and disaster management (Farra, Miller, Timm, & Schafer, 2013; Freina & Ott, 2015) and acute (LaFond et al., 2015), chronic (Tschannen, Aebersold, Sauter, & Funnell, 2013), and home visiting care (Levett-Jones, Bowen, & Morris, 2015). Although a number of virtual simulation programs have arisen in the nursing field, their level of implementation has not yet been adequately evaluated. Specifically, there is a lack of analyses of the educational characteristics of virtual simulation, which would help us achieve a broader view.

Methods

Aim/Design

The purpose of this integrative review is to describe the educational characteristics of virtual simulation in nursing education. Specifically, we used the five stages of integrative review by Whittemore and Knaf (2005) and focused on nursing studies published over the past six years.

Review Process

The first of the five stages of Whittemore and Knaf's (2005) integrative review approach entails clarifying the purpose of the research through problem recognition. The second stage involves a literature search to identify suitable data on the topic of interest and select standards. The third stage entails selecting suitable studies through a qualitative evaluation of the initial research data. The fourth stage focuses on integration of the meaning of the data—that is, extracted data are compared and grouped into categories based on their similarities. The categories

are then compared, analyzed, and synthesized. The fifth and final stages involve presenting the concept or characteristics of related topics in a diagrammatic form or table. We outlined the specific process of each stage in the following sections.

Problem Identification

Our review was guided by the following question: what are the educational characteristics of virtual simulation in the nursing field?

Data Collection

All data were collected from January 10, 2017 to March 20, 2017. According to [Whittemore and Knafelz \(2005\)](#), there is no standard method of data collection for integrative literature reviews; instead, the specific criteria should be devised in consideration of the review topic. In this review, the inclusion criteria were as follows: (1) a research paper published in an academic journal between January 1, 2011 and December 30, 2016, and (2) research conducted in a nursing environment or in the nursing field. The exclusion criteria were as follows: (1) a review, systemic review, integrative review, or meta-analysis; (2) a paper presented at an academic conference or an unpublished thesis; and (3) research on virtual simulation that does

not match the previously stated definition of virtual simulation as “a synchronous, persistent network of people, represented as avatars, facilitated by networked computers” ([Bell, 2008, p.2](#)).

We used the following search string for PubMed and Medline: ((“virtual” (Title/Abstract)) AND (“nursing” (Text word)) AND (“English” (language)) AND (“patient simulation” [MESH]) AND (“user computer interface” [MESH])). For CINAHL, we used the following search string: ((“virtual” (Title/Abstract)) AND (“nursing” (Text word)) AND (“English” (language)) AND (“patient simulation” [CINAHL HEADINGS]) AND (“computer user training” [CINAHL HEADINGS])).

A total of 261 studies were initially identified, from which we excluded 108 duplicates. Subsequently, we excluded systemic reviews, integrative reviews, and meta-analyses by checking the titles and abstracts. We checked the full text of the remaining 147 articles and excluded a further 90 studies because they were overview articles on contemporary issues or studies on the use of haptic devices in practice, or did not adhere to the previously stated definition of virtual simulation. Eighteen studies were manually identified through searching the reference lists. Through this entire process, we selected a total of 59 studies ([Figure 1](#)).

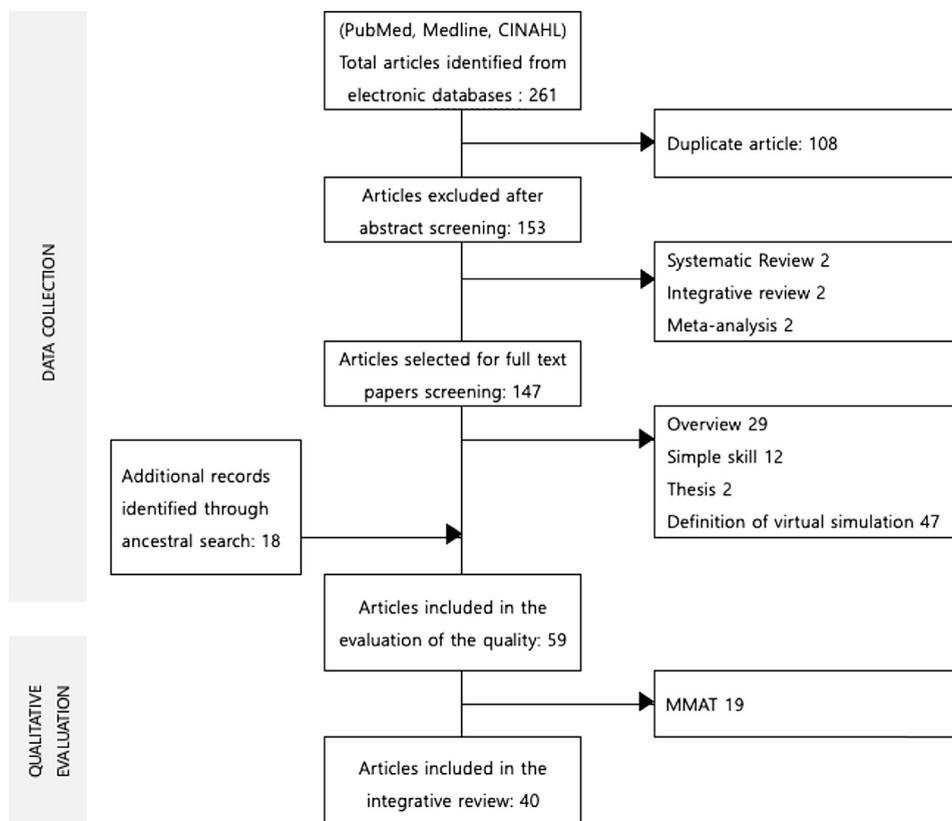


Figure 1 Research process. *Note.* MMAT, Mixed Methods Appraisal Tool.

Qualitative Evaluation of Data

Whittemore and Knaf (2005) recommend that, for studies that do not have the same research design, one should apply the inclusion and exclusion criteria in a sampling frame based on rational evidence, given that there would be no standard for analyzing and evaluating the quality of the studies. However, we performed a qualitative evaluation of the 59 studies using the Mixed Methods Appraisal Tool (MMAT; Pace et al., 2012), which allows a researcher to reasonably evaluate the quality of various study designs (qualitative, quantitative, and mixed methods) included in a systematic review. The MMAT has been confirmed to be an effective and reliable tool (Souto et al., 2015). We evaluated the quality of the studies according to their research design. We also verified the inter-rater reliability of the MMAT in this study. We excluded all methodological studies that did not specify the effects of the virtual simulation on learning outcomes and those with MMAT scores below 50%. Overall, 40 studies were deemed to be of sufficient quality and were thus included in the review (Figure 1, Appendix A).

Data Analysis

Four researchers individually analyzed the contents of the 40 studies, extracting the major elements of these contents. Subsequently, they discussed the extracted elements and derived the educational characteristics of virtual simulation in nursing. We then constructed a matrix with the identified elements, and the 40 studies were recoded using this matrix.

We then conducted word clouding using Word Cloud Generator (Jason Davies), followed by concept mapping, to achieve conceptual clustering. Three hundred sixty-five keywords found in the 40 studies were entered into the generator, after which 82 words (some of which are in the title of this review) were excluded. Finally, text segments were created using the remaining 283 keywords. We performed concept mapping using the major concepts from the texts of the included studies and drew a concept

map to identify the diversity and congruity of these concepts. The results of the content analysis and conceptual clustering were then analyzed to synthesize the extracted elements into an integrative model.

Data Presentation

The concepts and characteristics (both the general and virtual-specific characteristics) of virtual simulation derived through the integrative review were presented in a table. We also visually presented the conceptual relations between elements and keywords in a diagrammatic form to aid understanding of the main characteristics.

Results

Among the 40 studies on virtual simulation (Table 1), 75.0% (30 studies) focused on virtual simulation with nursing college students; the remainder focused on virtual simulation with registered nurses. The most frequent research design was mixed methods. Many of the studies explored scenarios in adult nursing, followed by pediatric and community nursing. Virtual simulation was applied to the teaching of basic nursing skills, nursing care related to emergency situations, conferences, and pharmacology classes.

Through the integrative analysis, we extracted 14 educational characteristics of virtual simulation, including seven general simulation characteristics and seven virtual-specific characteristics. The general characteristics were theoretical framework, teaching method, simulation feedback, debriefing method, purpose of simulation, scenario, and outcome. The virtual-specific characteristics, on the other hand, were instructor competency, mode of representation, participant role, interaction, type of platform, virtual framework, and virtual ethics. We initially extracted 15 educational characteristics; however, we ultimately decided to exclude audio-video system (AVS) because it was a technical element rather than an educational characteristic.

Table 1 General Characteristics of Included Studies (n = 40)

Category	Contents	N	%	
Research subject	Registered nurse	10	25.0	
	Nursing student	30	75.0	
Research design	Qualitative	4	10.0	
	Quantitative	RCTs	3	7.5
		Nonrandomized	11	27.5
		descriptive	4	10.0
	Mixed method	18	45.0	
Nursing taxonomy	Pediatric nursing	6	15.0	
	Maternal nursing	2	5.0	
	Adult nursing	12	30.0	
	Psychiatric nursing	3	7.5	
	Community nursing	9	22.5	
	Nursing management	2	5.0	
	Other	6	15.0	

Table 2 General Simulation Characteristics of Nursing Studies on Virtual Simulation (n = 40)

Category	Contents	N	%
Theoretical framework	Mentioned	23	57.5
	Not mentioned	17	42.5
Teaching method	Didactic learning	1	2.5
	Active learning	35	87.5
Feedback	Not mentioned	4	10.0
	Scenario embedded feedback	6	15.0
	On-site feedback	13	32.5
	Post hoc feedback	11	27.5
Debriefing method	Not mentioned	10	25.0
	Structured	18	45.0
	Unstructured	3	7.5
Virtual simulation purpose	Not mentioned	19	47.5
	Education		
	Lecture	3	7.5
	Practicum	31	77.5
	Information sharing	4	10.0
Scenario	Evaluation	2	5.0
	Developed scenario	31	77.5
	Pre-existing scenario	2	5.0
	Modified scenario	2	5.0
	Not mentioned	5	12.5
Outcome*	1. Psychomotor	6	
	Clinical performance skill	6	7.1
	2. Cognitive	21	
	Knowledge	16	18.8
	Metacognition	5	5.9
	3. Affective	58	
	Self-confidence	5	5.9
	Learner satisfaction	30	35.3
	Self-efficacy	4	4.7
	Leadership	3	3.5
	Communication	8	9.4
	Teamwork (collaboration)	4	4.7
	Professionalism	1	1.2
	Competency	3	3.5
Subtotal	85	100	

* Duplicated response.

Table 2 shows the general characteristics of virtual simulation in nursing education. Half the studies (57.5%) mentioned using a theoretical framework. Active learning was the most frequently used teaching method. Thirty (75.0%) studies used feedback methods; more specifically, the most frequently used method was “feedback given right after simulation performance,” followed by “on-site feedback.” Of the studies that mentioned a debriefing method, a reflection diary was the most widely used; 19 studies (47.5%) did not describe debriefing in detail. A total of 31 studies (77.5%) used new scenarios for virtual simulation instead of existing ones. The included studies used a variety of indicators to evaluate if students were meeting the learning objectives of the virtual simulation, with a total of 85 outcome indicators being used across the 40 studies. These indicators were classified into cognitive, affective, and psychomotor domains according to the educational purpose classification system of Bloom (1956): 58 were

classified into the affective domain, 21 into the cognitive domain, and six into the psychomotor domain. Regarding the affective domain indicators, in 30 studies (35.3%), researchers investigated learning satisfaction as the outcome, whereas they investigated communication ability in eight studies (9.4%). As for the cognitive domain, 16 studies (18.8%) included knowledge as the outcome.

Table 3 presents the characteristics specific to virtual nursing simulation. Researchers mentioned instructor competency in relation to virtual simulation in only 22.5% of the studies. In half the studies, avatars were used to represent participants in the virtual reality, with 13 studies using avatars with voice-chatting functions and 12 studies using avatars with scripts. Two-way interaction between the computer interface and participant was used in over 90% of included studies, and various types of two-way interactions were used, including automatic computer responses, facilitator-led interaction, spontaneous responses by

Table 3 Virtual-Specific Characteristics in Nursing Studies on Virtual Simulation (n = 40)

Category	Contents	n	%
Instructor competency	Suggested	9	22.5
	Not mentioned	31	77.5
Learner representation	Screen representation	18	45.0
	Voice	1	
	Script	17	
	Avatar representation *	21	52.5
	Voice	13	
	Script	12	
Interaction	Not mentioned	1	2.5
	One-way interaction	3	7.5
	Two-way interaction	37	92.5
	Computer-automatic	19	
	Computer-AI	1	
	Computer-facilitator leading interaction	9	
Platform type	Participant-spontaneous	8	
	Developed platform	4	10.0
	Second Life®	14	35.0
	Unity 3D	2	5.0
	vSim	2	5.0
	CliniSpace	2	5.0
	Other	16	40.0
Participation role	Fixed	35	87.5
	Nonfixed	5	12.5
Framework of virtual	Yes	4	10.0
	No	36	90.0
Ethical Consideration	Virtual specific	2	5.0
	Ethical consideration(general)	36	90.0
	Ethical consideration none	2	5.0

* Duplicated response.

participants, and artificial intelligence (AI) responses. In 35% of the studies, researchers used the Second Life platform to develop the virtual simulation, followed by Unity 3D and vSim. Most learners participated in the virtual simulation by adopting the fixed role of nurse rather than using other roles. A theoretical framework was mentioned in only four studies.

Figure 2 shows the keywords introduced in the Word Cloud Generator. When the 365 keywords were entered in the generator, we identified the following as larger text segments: simulation, virtual, nursing, education, Second Life, students, nurses, technology, teaching, and so forth (Figure 2A). After excluding the words in the title of this review (such as virtual, simulation, nursing [nurse, student],

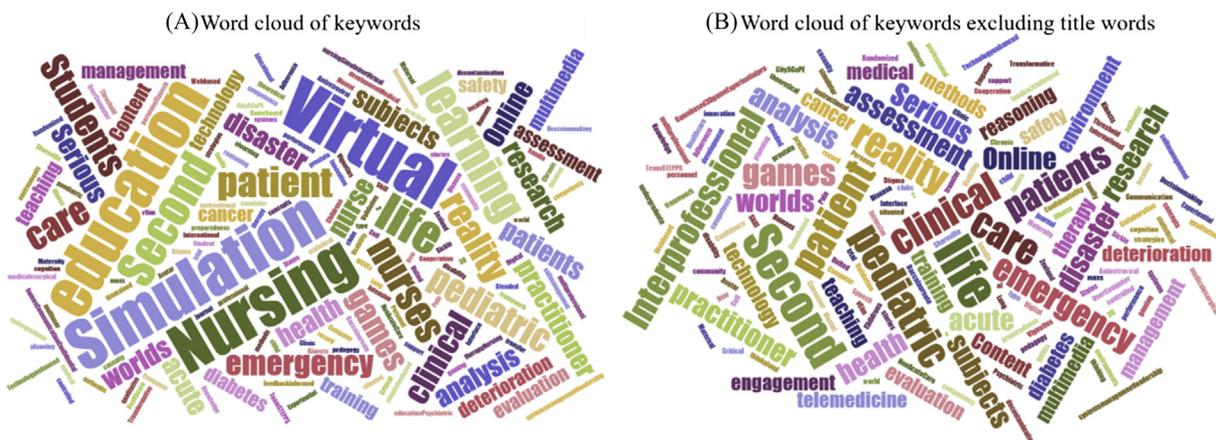


Figure 2 (A and B) Word clouds of virtual simulation in nursing.

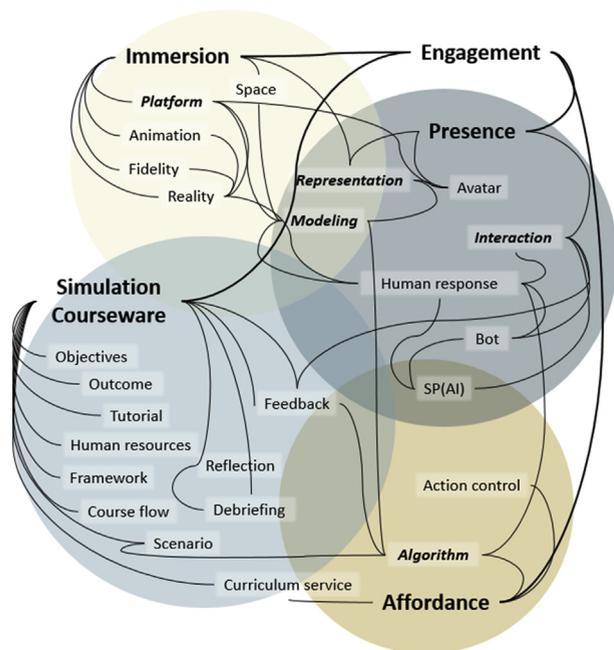


Figure 3 Clusters from concept mapping. *Note.* SP, standardized patient; AI, artificial intelligence.

education, and learning), the larger text segments were reasoning, Second, Life, interprofessional, pediatric, emergency, research, disaster, analysis, technology, online, practitioner, assessment, evaluation, multimedia, subjects, patient, and so forth (Figure 2B).

Figure 3 shows the four clusters that emerged from the concept mapping: (1) presence, (2) immersion, (3) affordance, and (4) simulation courseware. Cluster 1 contained the elements of interaction, avatar, modeling, accessory, human response, and bot. Cluster 2 included space, reality, fidelity, and animation. Cluster 3 consisted of action control and algorithm, whereas cluster 4 contained educational outcome, educational objectives, scenario, course flow,

tutorials, curriculum service, debriefing, reflection, and feedback. Representation, SP, platform, and curriculum service were elements common to all clusters.

Figure 4 shows the themes that emerged from our integrative analysis of the educational characteristics of virtual simulation, which were immersion, presence, and affordance. The strategies for implementing these characteristics included mode of representation, interaction, algorithm, modeling, and platform. Interestingly, the general simulation characteristics emerged as scaffolding to enhance learner engagement for virtual simulation in nursing. These characteristics were teaching method, objectives, tutorial, scenario, feedback, reflection, debriefing, and outcomes. In summary, learners appear to participate in a cycle of engagement and experience toward better learning achievements.

Discussion

This integrative review identified the general and virtual-specific characteristics of virtual simulation in nursing education. The general simulation characteristics reflected the key components of simulation education suggested by Fey, Gloe, and Mariani (2015), whereas the virtual-specific characteristics highlighted the effective simulation components when applying virtual simulation. We further found that learners’ engagement in virtual simulation to achieve learning outcomes was driven by three factors: immersion, affordance, and presence, which were in turn implemented by the strategies of representation, interaction, algorithm, modeling, and platform.

The general simulation characteristics were theoretical framework, teaching method, simulation feedback, debriefing method, purpose of simulation, scenario, and outcome. In studies using a theoretical framework, experiential learning was the most frequently mentioned. As for teaching methods, active learning methods such as problem-

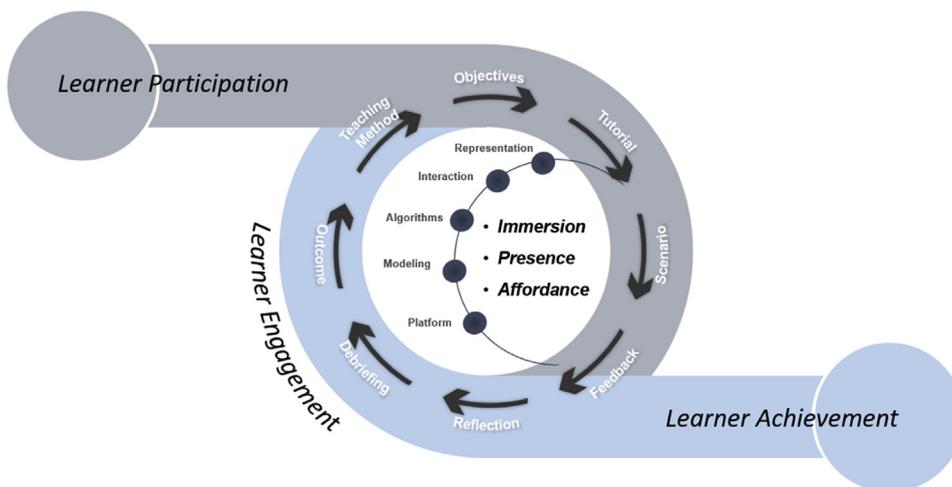


Figure 4 Feature of virtual nursing simulation (circle of engagement). *Note.* MMAT, Mixed Methods Appraisal Tool.

based, case-based, and team-based learning were the most frequently mentioned. Simulation strategies in nursing education were initially primarily based on experiential and active learning (Bland, Topping, & Wood, 2011), and this basis seems to have carried over to virtual simulation. The most effective teaching and learning methods center on learner engagement, as it is a key factor of successful learning (Bland et al., 2011; Foronda & Bauman, 2014; Koivisto, Niemi, Multisilta, & Eriksson, 2017). Virtual simulation in this review was found to be a suitable learning methodology when it was based on the use of learners' own experiences to identify and solve problems in a given context, as in previous simulation methods.

In many of the included studies, researchers actively included feedback, scenarios, and debriefing in the virtual simulation, which corresponds with best practice guidelines for simulation in health care education (Motola, Devine, Chung, Sullivan, & Issenberg, 2013). Indeed, in half the studies, the researchers mentioned using structured debriefing methods or newly developed scenarios. We extracted 85 outcome indicators from the included studies, most of which were affective indicators, followed by cognitive and psychomotor indicators. Feedback, whether audio or visual, was given to learners during the simulation process in many of the studies (Farra et al., 2013; LeFlore et al., 2012; Liaw et al., 2014). Effective feedback is a pedagogical factor that should be taken into consideration when designing virtual simulation, as it provides learning direction and helps learners to reach their goals (Motola et al., 2013). Feedback can be provided in on-site, post hoc, or embedded forms, but the distinct advantage of virtual simulation is that it provides more opportunities for embedded feedback. However, due to technical difficulties, the authors of the studies included in this review rarely provided embedded feedback. The use of collaborative approaches by multidisciplinary teams (Motola et al., 2013) might help create more advanced virtual environments that enable teachers to more easily implement embedded feedback.

Debriefing is the process by which learners acquire knowledge while experiencing cognitive reasoning in the course of identifying and reconstructing their and others' behaviors. Although debriefing is considered a cornerstone of educational simulation (Motola et al., 2013; Neill & Wotton, 2011), it was not mentioned in more than half the studies in this review. However, researchers used unstructured debriefing in a few of the studies. Debriefing can be divided into structured and unstructured types. Structured debriefing is currently more common in nursing simulation (Benham-Hutchins & Lall, 2015; Foronda, Gattamorta, Snowden, & Bauman, 2014; Jane Cook, 2012), and researchers have demonstrated its effectiveness from an educational point of view (Neill & Wotton, 2011). Unstructured debriefing, however, may be useful for revealing various aspects of learners' experience. One common debriefing involves the use of an AVS to aid in recall of one's behavior; however, it was not actively applied to

virtual simulation in the reviewed studies. An AVS can be a powerful tool for maximizing learning because learners cannot remember all their behaviors (Motola et al., 2013); however, AVS requires technical resources, which limits its active application in virtual simulation. Given the benefits of AVS, however, it might be necessary to find a way to integrate it into virtual simulation in nursing education on a wider scale (Motola et al., 2013).

The learning outcomes of virtual simulation were evaluated using various indicators, with the most common being satisfaction (affective domain) and improvement of knowledge (cognitive domain). According to these results, virtual simulation in nursing education seems to remain in its initial stage. The aim of simulation is mostly to enhance learners' metacognition, and although virtual simulation can be a way of facilitating effective learning (Tschannen, Aebbersold, McLaughlin, Bowen, & Fairchild, 2012), further research on the relationship between virtual simulation and metacognition is required. As Koch (2014) stated, psychomotor outcomes might be neglected without the presence of a didactic interaction between the preceptor and student. These outcomes might also be restricted with the use of digital technology for experiential and social learning. Haptic devices that rely on augmented reality might help overcome those restrictions in the near future.

As for the virtual-specific characteristics, they included instructor competency, mode of representation, participant role, interaction, type of platform, theoretical framework, and virtual ethics. Simulation methods, especially virtual simulation, are essential for helping faculty or instructors advance newly emerging educational strategies (Reilly, Vandenhouten, Gallagher-Lepak, & Ralston-Berg, 2012; Robin, Mcneil, Cook, Agarwal, & Singhal, 2011). In this review, the researchers of only a few studies described factors related to faculty or instructor competency. Instructor competency has a strong impact on the educational effectiveness of learners (Skiba, 2010); thus, it should be carefully considered when using virtual simulation as a new educational environment. Moreover, previous studies mentioned technical resources (Foronda et al., 2014), human physiobiological responses (Jane Cook, 2012), representations, interactions, and roles (Foronda et al., 2014) among the various virtual characteristics to be considered by virtual simulation instructors.

We found that avatars were often used for participant representation, and that the interaction mode was primarily two-way. Second Life was the most commonly used platform for the virtual environment. Currently, many different forms of interface are being used in 3D screens to enhance the sense of reality (Jenson & Forsyth, 2012). Through the use of a scaffolding cyclic learning structure, participants can take part in the learning experience with their own identities, which in turn facilitates more authentic experiential learning moments (Jenson & Forsyth, 2012; Kao & Harrell, 2015). From this perspective, avatars and two-way interaction might work as helping devices to

induce concrete experiences in the virtual simulation. In only one study did researchers use an AI avatar (LeFlore et al., 2012), which indicates that the application of nursing behavior patterns in virtual reality remains insufficient. Nursing behavior patterns, particularly those that involve human interaction and communication, are not simple when responding to anticipating syntax in a two-way interaction with an avatar. Therefore, further research is needed to explore human behavior and communication patterns in AI syntax development. Previous studies on virtual simulation in nursing education focused on learners who adopted the fixed role of nurse; however, given that virtual simulation is quite flexible in terms of the roles taken, it might be necessary to give learners more opportunities to experience other roles. Experience of multiple roles might help participants in virtual simulation with opportunities to develop leadership or teamwork skills (Young, Billings, & Kowalski, 2018; Yu & Kang, 2017).

The diagram (Figure 4) we constructed of the integrative review shows that the virtual-specific characteristics of simulation were clustered into three themes—immersion, presence, and affordance—that enhanced learner engagement and achievement. The major strategies by which these characteristics achieved learner engagement were representation, interaction, algorithm, modeling, and platform. This cycle of engagement also relied on the general simulation characteristics, including teaching method, objective, tutorial, scenario, feedback, reflection, debriefing, and outcome. In the virtual space, which is different from reality, the level of representation and interaction must be considered (Lin & Wang, 2014), as these can increase the learners' sense of immersion, presence, and affordance (Turchet, 2015). Moreover, the interaction between the learner and computer enhances affordance (Dicheva, Dichev, Agre, & Angelova, 2015). In virtual simulation in nursing, most interaction between the user and computer is two-way, such as human-controlled or AI avatar interaction. The frequent use of two-way interaction suggests its high performance in virtual nursing simulation (So, 2010). A previous study (Huang, Rauch, & Liaw, 2010) reported that immersion, interaction, and imagination in virtual reality positively and significantly affected motivation and problem-solving capability, based on the results of a regression analysis. In their game-based learning study, Hamari et al. (2016) reported that perceived learning was facilitated by engagement, challenge, skills, and conditions. They also found that immersion had a positive direct effect on challenge and skills but not on learning or engagement. Therefore, further study is needed to identify the relations between learning, engagement, and conditions in virtual simulation, considering immersion, affordance, and presence.

Few of the studies in our review addressed ethical considerations or used theoretical frameworks. More specifically, in all the reviewed studies, researchers used a very limited structured framework for education and lacked ethical considerations regarding human participants and their mental health, as well as safety procedures, warnings,

and devices. This lack of consideration is a considerable limitation that should be addressed. LaFond et al. (2015) stressed that nursing education using virtual reality requires consideration of the ethics of using such media, as well as formal approval to do so. Levett-Jones et al. (2015) suggested that enhanced accessibility could increase fair opportunities for education. In general, researchers seem to believe that virtual space and procedures might not have any harmful sequelae; however, there is no clear boundary between educational and entertainment properties, which may result in ethical issues such as addiction, confusion, and doubts regarding the effects of the educational methods. As Kimball and Kim (2013) suggested, virtual simulation in nursing education needs to include appropriate ethical considerations for learners in the virtual space.

Conclusion

Through an integrative review, we identified the educational characteristics (both the general and virtual-specific characteristics) of virtual simulation in nursing education. Three distinct factors of virtual simulation in nursing emerged: presence, immersion, and affordance, which in turn could be integrated into a cycle of engagement that promoted learner achievement. However, the ethics of virtual reality, virtual-specific theoretical frameworks, and the use of technology must be considered when studying virtual simulation in nursing education. Researchers should also further explore how the circle of engagement arises in educational situations, identify the detailed effects of virtual simulation, and seek systematic advancements in the virtual structure of education.

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Supplementary Data

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