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Review

Educational games developed for students in perioperative nursing: A systematic review and appraisal of the evidence

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ABSTRACT

A systematic review was conducted on electronic databases of MEDLINE/PubMed, Scopus, ISI Web of Science, CINAHL, and Embase until December 2017, using relevant keywords for educational games developed for nursing students in perioperative field. To evaluate the level of strength and quality of the evidence, the Association of periOperative Registered Nurses (AORN) revised model for evidence appraisal was used. Of the 852 evidence, only 10 met the criteria and were reviewed and appraised. Educational games had focused on different learning domains, including skills, feelings, emotion, knowledge, performance, attitude, motivation, and interest. With respect to the evidence level, most evidence was categorized as V (expert opinion = 2, case report = 2, literature review = 1, and organizational experiences = 1), and only one was in level I (randomized controlled trial). The quality level of most evidence was high (n = 4) and low (n = 4), and the rating of most of them was moderate (n = 4) and limited (n = 4). Based on the findings, most evidence had inappropriate quality and was found to be weak. It seems that the investigated games are insufficient to promote the nursing students' learning outcomes in different domains. Accordingly, more high-quality studies are required to design and develop innovative and practical games for students in perioperative nursing by considering validity and reliability process.

1. Background

Game-based education is one of innovative methods, which has attracted much attention in perioperative nursing (Ford and Brown, 1996; Flurry et al., 2012; Mullen and Byrd, 2013; Perkins et al., 2015; Ingadottir et al., 2017). This type of education considers trainees as players and provides learning activities in a recognizable delivery model (Bigdeli and Kaufman, 2017). Educational games provide a safe environment, and are effective means of learning for clinical and practical experiences (Akl et al., 2010). These games can foster collaboration and critical thinking amongst the trainees by assisting them to be successful in dealing with the fear of unknown, recognize changes in the sequence of events, decrease their environmental stress, and prevent medical errors; all ultimately lead to patients' safety (Clark et al., 2016).

Although educational games have been reviewed extensively in different fields of nursing (Ulione, 1983; Royse and Newton, 2007; Skiba, 2008; Gibson and Douglas, 2013; Silveira and Cogo, 2017; Pakarinen et al., 2017), to the best of our knowledge, there is no review, which has discussed this type of educational strategy in perioperative nursing comprehensively and systematically. In a narrative review (Carifa and Goodin, 2011), it has been stated that there is substantial content in perioperative nursing that could be implemented in these games to create engagement, stimulation, realism, and entertainment. Since the practical use of educational games depends on the quality of the evidence, we conducted a systematic review and appraisal of the

Abbreviations: AORN, Association of periOperative Registered Nurses; CINAHL, Cumulative index to nursing and allied health library; OR, Operating room; PRISMA, Preferred reporting items for systematic reviews and meta-analyses; RCT, Randomized controlled trial

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evidence to firstly explore and describe the educational games developed for students in the area of perioperative nursing and secondly examine the quality of the evidence to determine whether the findings are valuable, relevant, and applicable.

2. Methods

2.1. Design

This review was performed in accordance with the Cochrane Collaboration guidelines (Green and Higgins, 2008), and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Moher et al., 2015).

2.2. Search strategy

A systematic search was conducted on electronic databases of MEDLINE/PubMed, Scopus, ISI Web of Science, the Cumulative Index to Nursing and Allied Health Library (CINAHL), and Embase until 25 December 2017 for published full-text evidence. To find all qualified evidence addressing the issue, we used a combination of the following Mesh or terms based on the databases: 1) relevant to game: “game” OR “gaming” OR “gamification” OR “serious game” OR “computer game” OR “video game” OR “digital game” OR “electronic game” OR “simulation game”; 2) relevant to game-based educational intervention: “game-based learning” OR “virtual learning” OR “simulated learning” OR “education” OR “students”; and 3) relevant to perioperative nursing: “perioperative nursing” OR “perioperative skills” OR “surgical procedures” OR “operating room nursing” OR “nursing”. To include all relevant evidence, no restriction on language and date range of publication was considered. However, the original language of all included evidence was English.

2.3. Eligibility criteria

The evidence was included if it addressed any type of educational games (i.e., card games, board games, simulation, role-playing, frame games, puzzles, cross-words, TV show format, virtual learning 3D platform game show, slide presentation, multimedia, and strategy game) designed for nursing students in perioperative field with both clinical and theoretical issues. We included any type of evidence including research (systematic review, randomized controlled trials, quasi-experimental, non-experimental, and qualitative studies) and non-research (clinical practice guidelines, consensus or position statement, literature review, case reports, expert opinion, and organizational experience).

2.4. Exclusion criteria

The evidence that: 1) was not specifically related to perioperative nursing, 2) had considered nursing students in non-surgical courses/wards, 3) was conducted on only nursing staff, instructors, patients, residency or medical students, and medical professionals (i.e., surgeons and specialists), 4) used other types of educational technologies in addition to educational game, and 5) was conference paper, dissertation, book, and evidence appraisal was excluded.

2.5. Identification and selection of the evidence

The evidence was identified and selected independently by two investigators (MN and MA), and any disagreement was resolved through discussion until a consensus was reached. To find further relevant evidence, we conducted manual checking of the reference list of the included evidence. During the initial search, a total of 852 items were identified. After removing the duplicates, a total of 729 search results were kept. On the basis of title and abstract screening, 663

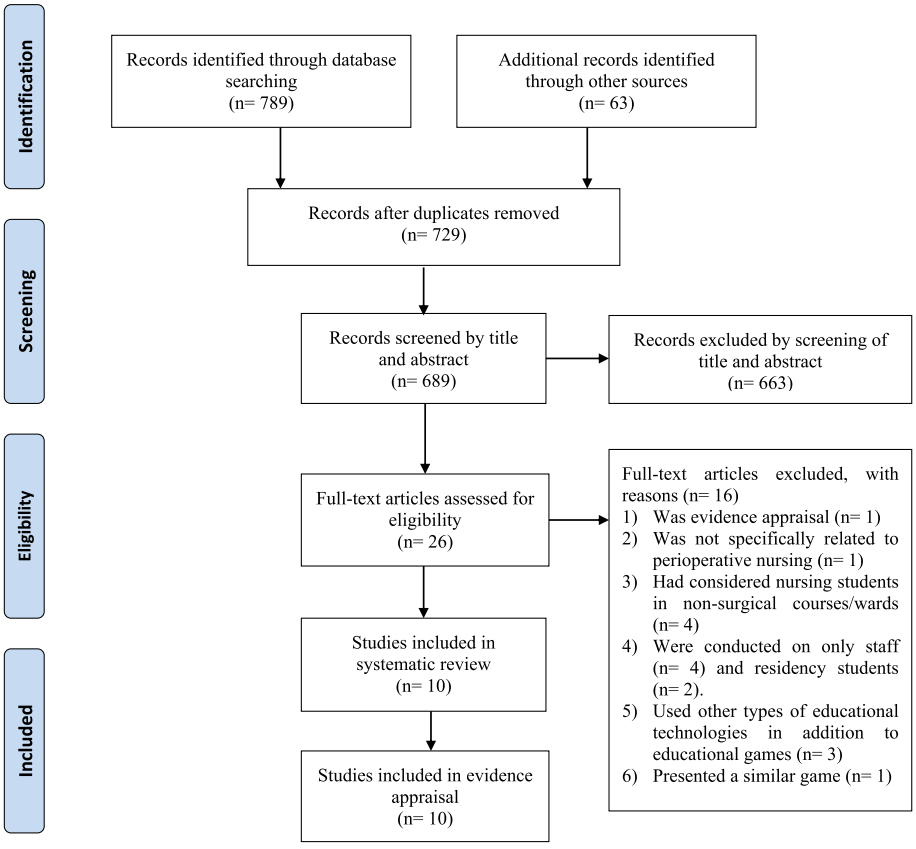

Fig. 1. PRISMA 2009 flow diagram for identification of the evidence and selection process.

irrelevant publications were excluded. After reviewing the full-text of the 26 remaining evidence, 15 were excluded. Finally, we identified 11 publications to be eligible for inclusion. Of these, two studies (Del Blanco et al., 2013, 2017) presented a similar game with different designs; hence, we included only one which introduced the game with more details (Del Blanco et al., 2017). Consequently, we included 10 publications in the final review (Fig. 1).

2.6. Data extraction

A designed data extraction form was used to obtain the characteristics of the eligible evidence. First, author(s) name, year of publication, design and objective, target participant, study setting, measured outcomes, and the main findings of all eligible evidence were extracted. Then, the game characteristics including name, type, learning domain (s), and procedures were summarized. If it was necessary, contact was made with the author(s) of the selected evidence to elaborate on the required details.

2.7. Appraisal and rating of the evidence

Two reviewers (MN and CP) independently appraised and rated each eligible publication. A consensus was reached by discussion in cases of disagreement. We used the Association of periOperative Registered Nurses (AORN) revised model for quality appraisal of the included evidence. This model includes the evidence rating model, hierarchy of evidence model, and expanded appraisal tools (Spruce et al., 2016) (Table 1). Of the expanded appraisal tools, we used the research evidence appraisal tool-study for research evidence, and non-research evidence appraisal tool for non-research evidence.

2.8. Data synthesis

Together with the data extraction, the data synthesis was performed by two reviewers (MN and CP), and if it was necessary, a discussion was made with other experts (MA, LA, AM, and MBBS). Most evidence had non-experimental designs and was performed with instructional technique development or educational technology innovation methods. Accordingly, no statistical analysis was reported in most included evidence about the students' learning outcomes following the implementation of the designed games. Also, in the evidence that reported statistical analysis, different learning outcomes were presented. Hence, we could not perform a meta-analysis for data pooling, and the findings were reported only systematically.

3. Results

3.1. Characteristics of the included evidence

The included evidence was published from 1981 to 2017, and had different designs including interventional research (Del Blanco et al., 2017), educational technology innovation (Fawcett and Dodd, 2009; Koivisto et al., 2016; Paim and Goldmeier, 2017), instructional technique development (Girard, 1981; Rothrock, 1986; Fawcett, 1994; Mole and McLafferty, 2004), review (Carifa and Goodin, 2011), and editorial (Baker, 2009). With respect to the type of the game, the evidence had

Table 1
The Association of periOperative Registered Nurses (AORN) revised model for evidence appraisal and rating (Spruce et al., 2016).

Models	Explanations	Categorization			
Evidence rating model	This model rated evidence from the strongest to the weakest based on the type of evidence (using the hierarchy of evidence model) and quality level (using expanded appraisal tools). In this model, quality for each evidence is collectively evaluated, and it indicates how the unique AORN appraisal score showing the level of strength.	Evidence rating	1 (Strongest)		Regulatory requirement Strong
			2		High
			3		Moderate
			4		Limited
			5 (Weakest)		Benefits balanced with harms
Hierarchy of evidence model	This model demonstrates the type of evidence from the strongest evidence to the weakest evidence.	Types of evidence	1) Federal, state, or local regulatory requirement (designed only for regulatory requirement of evidence rating)		
			2) Research	Evidence level I	a) Systematic review of all randomized controlled trials (RCTs) b) RCT
				Evidence level II	a) Systematic review of all quasi-experimental studies or a combination of RCTs and quasi-experimental studies b) Quasi-experimental studies
				Evidence level III	a) Systematic review of all non-experimental studies or a combination of RCTs, quasi-experimental, and non-experimental b) Systematic review of any or all qualitative studies c) Non-experimental studies d) Qualitative studies
			3) Non-research	Evidence level IV	a) Clinical practice guidelines b) Consensus or position statement
				Evidence level V	a) Literature review b) Case reports c) Expert opinion d) Organizational experience
			4) No requirement-benefits outweigh potential harms (designed only for benefits balanced with harms of evidence rating)		
Expanded appraisal tools	These tools determine the quality of evidence based on the type of evidence and level of evidence.	Tools	1) The AORN research evidence appraisal tool-summery 2) The AORN research evidence appraisal tool-study 3) The AORN non-research evidence appraisal tool		
		Quality level	A	High	
			B	Good	
			C	Low	

Table 2
Characteristics of the evidence on educational games developed for perioperative nursing students.

Author(s), Publication year	Study method	Study objective(s)	Game details					Main findings or conclusion
			Name	Type[1]	Target population and setting	Learning domain(s)	Procedure	
Del Blanco et al. (2017)	Interventional research (RCT)	To improve novices' perception and performance in OR	Not provided	Simulation	Nursing and medical students with no previous experience in surgery	Knowledge feelings, emotions, and attitudes	A computer-based game was developed by combining pictures and videos. In the game, the users played the role of a student who visits OR for the first time. The game shows how to act in the OR and includes detailed information about the structure and common elements of OR and scrubbed and non-scrubbed surgical staff. Sixty-two students were allocated to a control group with no access to the game and 70 to an experimental group, played the game online on the day prior to their first experience in OR. The next day after their first visit to OR, all students' feelings, emotions, attitudes, and experiences were assessed with online questionnaire and scales.	Students in the experimental group showed to have higher perceived knowledge, more collaborative attitude, less fear, and also it appeared that they had committed fewer errors.
Paim and Goldmeier (2017)	Design research (Educational technology innovation)	To develop a perioperative nursing game in order to evaluate users' understanding and skills, when they set up basic surgical instruments on the Mayo stand or back table in the OR	Playing with tweezers	Simulation	Students in a surgical instrumentation course and nursing staff in continuing education	Knowledge and skills	A computer-based game was developed based on Bloom's taxonomy and Galvis Panqueva methodology including three phases of analysis and design, development, and evaluation. The game was evaluated for its usefulness and learning potential by 15 participants including students and experts in various areas of knowledge such as nursing, information technology, and education. After modifying the game based on pilot results, the final version was created with an initial screen, menu buttons containing the rules of the game, and virtual tour modes for learning and assessment. In the game, the user plays the role of a perioperative nurse in the OR.	The developed game showed good navigability and accessibility, and it could be used as a visual and intuitive virtual environment for perioperative nursing instructors and students. The authors suggested further experimental studies to assess the effect of designed game on learning outcomes.
Koivisto et al. (2016)	Design research (Educational technology innovation)	To investigate nursing students' experiences in learning clinical reasoning process by playing a simulation game	Not provided	Simulation	Nursing students in a surgical nursing course	Knowledge	A Finnish computer-based game with single-player format was designed involving two to five postoperative patient scenarios, which events were designed around a specific clinical situation, requiring clinical reasoning. The game includes a 3D character (the patient) in a 3D environment showing hospital ward, with real-time reactions and equipment. In the game, the user takes the role of a perioperative nurse. The game guides users through collecting and processing information, identifying problems/issues, establishing goals, taking action, and evaluating outcomes. Interactive elements include students' reactions to the patients' clinical condition and patients' reactions to the received care. Users played the game at least once in 13 gaming sessions with 30–40 min duration. An online researcher-made questionnaire was filled out to measure the learning of the clinical reasoning process by playing.	In respect to the clinical reasoning process, majority of students felt that they learned the phases of clinical reasoning quite or moderately well. The students reported that they learned best to take action and collect information, but were less successful in learning to establish goals or to evaluate outcomes. The students reported that they learned mainly to apply theoretical knowledge during the game.

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Table 2 (*continued*)

Author(s), Publication year	Study method	Study objective(s)	Game details					Main findings or conclusion
			Name	Type[1]	Target population and setting	Learning domain(s)	Procedure	
Carifa and Goodin (2011)	Review	To narratively review educational games for interactive perioperative education	N/A	Serious games	Nursing students, staff, and educators in perioperative practices	N/A	N/A	The authors discussed games used in educational settings, the perioperative Quizbowl game, implications for the effective use of educational games, limiting factor, solution, effectiveness evaluation, and finally reaching a conclusion. They concluded that perioperative nurse educators can use games to supplement curriculum and staff development programs, foster team collaboration, and support critical thinking in nursing practice.
Baker (2009)	Editorial	To provide an opinion on serious games in perioperative nursing	N/A	Serious games	Nursing students and staff in perioperative practices	N/A	N/A	The author believed that serious games can provide opportunities for students to achieve technology and informatics competencies, experience an environment for practice without real risk to patients, and engage in a synchronous classroom with disparate geographic members. However, there are some challenges and barriers such as cost of producing the game.
Fawcett and Dodd (2009)	Design research (Educational technology innovation	To redesign original version of Periopardy game (using readily available technology) in order to be applicable for a larger groups and maximize participants' learning and engagement	Periopardy game	Slide presenta-tion	Nursing students in a perioperative nursing course or perioperative nurses in a facility	Skills, knowledge, motivation, and interest	A Microsoft Office Power-Point® 2007 was used to develop an electronic Periopardy game board. The designed game includes the first or home screen or a Periopardy screen displaying: a) five categories and point values from 100 to 500 hyperlinking to a corresponding clue screen, b) five clue screens for each category hyperlinking to corresponding point (did not include the correct responses), and c) a home button which will return the game to the home screen. Key players were considered as: 1) three participants at a time (students or nurses), 2) three judges (faculty members or nurses, or other students) to determine the correct answers based on supplied resources used to set up the clues, 3) audiences (the rest of students, nurses or faculty members), 4) a manger (instructor or nurse) to provide resources for participants before the game begins, open the Power-Point file before participants arrive, and return the game to the home screen, 5) a timekeeper (instructor or nurse or other participants) to monitor time, 6) a scorekeeper (from judges or audiences), and 7) an emcee. Before the games, all rules should be presented to players and each participant should complete a background reading assignment. For each participant, an electronic ring is provided to show when he/she is ready to answer a clue. If a participant does not answer a clue correctly in a specific time, he/she will lose the point and the other two participants will have a chance to response by ringing. If none of the participants answered the clue correctly, an additional time is assigned for any clue. The game should continue until all clues are selected. The participant with the highest score is considered a winner in the final step.	The authors introduced the game as an effective learning method for acquiring or updating participants' skills and knowledge in perioperative practices. Also, they described how to develop categories, rules for playing, and web site addresses to download a template of the game board for personal usage.

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Table 2 (*continued*)

Author(s), Publication year	Study method	Study objective(s)	Game details					Main findings or conclusion
			Name	Type[1]	Target population and setting	Learning domain(s)	Procedure	
Mole and McLafferty (2004)	Design research (Instructional technique development)	To design and implement a simulated surgical in-patient ward to enable students to work as a team when delivering patient care, provide an opportunity to consolidate students' clinical, managerial, and organizational skills, and encourage them to critically examine their clinical practice	Not provided	Role-playing	Third year nursing students on the higher educational diploma in a nursing program	Skills, performance, and attitudes	A simulated busy ward was created for 123 students to work in their designated problem-based learning teams (10–12 students) approximately in 90 min to manage and organize the ward and its resources, manage the delivery of care, and deal with outstanding problems and issues. Students were asked to assign their own roles within the nursing team to indicate an appropriate skill in the ward. Instructors performed various functions throughout the practice including setting the scene for students, preparing simulated patients or manikins and models of body parts (for invasive procedures), coordinating clinical activities, giving and receiving ward reports, making and receiving telephone calls, coordinating events for maximum impact and finally identifying critical incidents for discussion during the formal ward handover report. Even though required instructors offered minimal guidance to students, the teams are expected to run the ward independently until the next shift comes on duty. Simulated patients played the roles of post-operative patients, new admission patients, and their relatives.	Most of the students strongly agreed that the simulated ward enabled them to work as a team when delivering patient care. Also, majority of students agreed that the simulated ward encouraged them towards critically examining their clinical practice. However, most students believed that the simulated ward was not so positive in providing an opportunity to consolidate their clinical, managerial, and organizational skills. Both students and instructors positively rated simulated ward for the practice. The authors recommended that the designed simulated ward should be evaluated in a cohort and comparison study.
Fawcett (1994)	Design research (Instructional technique development)	To stimulate students' thinking skills and encourage their learning and teamwork in basic perioperative concepts	Periopardy game	Card games	Nursing students in an introductory perioperative nursing course	Skills, knowledge, motivation, and interest	Based on the Jeopardy game show, the author designed Periopardy game. Two physical poster boards, including 25 squares and a set of index cards, were provided. For the first board, five categories and five clues for each category (25 clues in total) were written in each square on the game board. Clues were phrased as answers, and students were asked to provide correct answers in the form of a question. On one side of each index card, the correct response and on the opposite side the related points (from 100 to 500) were written. Then the index cards were attached to the game board. The students were divided into three teams, and any member of the team was asked to provide correct response with no collaboration among the team members, and the entire team was given the points. The second poster board was made identical to the first (except the points on this board ranged higher from 200 to 1000).	Students were extremely enthusiastic about playing the game to earn a better grade. The author recommended the game for any class regardless of size to promote students' motivation and interest.
Rothrock (1986)	Design research (Instructional technique development)	To assist new perioperative nursing students in their role adjustment in an strange OR environment	Ba Fa Ba Fa™	Role-playing	Students in a perioperative nursing course	Attitude	A cross-cultural game was developed to obtain players' attitudes toward assimilating themselves into a strange environment. The students were divided into two groups of Betan (as experienced OR nurses) and Alphan (as new OR nurses) societies. The Betan society was considered as a competitive trading society with self-assertion, personal mobility, and profit-making qualities, but those assigned to the Alphan society were considered as friendly and warm, and interact	The students learned that what seems to be in OR is often far from what is in reality. Also, they believed that feelings are not necessarily facts and more time is needed to know the OR environment before making a judgment. The author identified that game can contribute to socialization by allowing students to experience the roles of insider versus outsider and the new person versus experienced person.

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Table 2 (*continued*)

Author(s), Publication year	Study method	Study objective(s)	Game details: Name	Type[1]	Target population and setting	Learning domain(s)	Procedure	Main findings or conclusion
							socially within the context of the prescribed rules and norms. Students in both societies were asked to attempt to assimilate themselves based on limited knowledge of the other society when a member of one group visited the other group. A faculty member played as a group facilitator and observer and led the groups in making comparisons between the game and the real experience of being a newcomer to the OR.	
Girard (1981)	Design research (Instructional technique development)	To teach important surgical terminology in a short time program	Surgical terminology word game	Cross-words	Nursing students in a surgical course	Knowledge and attitude	A series of irregular words following the surgical lecture was provided to students and then they were asked to circle the word in the correct direction to describe the selected terminology. The correct answers were posted on the class bulletin board the next day.	The author found that the terminologies were easily and interestingly identified upon examinations and the students enjoyed the game.

1. According to type of educational games for medical education, classified by Bigdeli and Kaufman (2017).

focused on computer-based simulation (Koivisto et al., 2016; Del Blanco et al., 2017; Paim and Goldmeier, 2017), serious games (Baker, 2009; Carifa and Goodin, 2011), role-playing (Rothrock, 1986; Mole and McLafferty, 2004), slide presentation (Fawcett and Dodd, 2009), card games (Fawcett, 1994), and cross-words (Girard, 1981). Regarding the target population, most games were specifically designed for nursing students (Girard, 1981; Rothrock, 1986; Fawcett, 1994; Mole and McLafferty, 2004; Fawcett and Dodd, 2009; Koivisto et al., 2016), and the other games for nursing students as well as nursing staff (Baker, 2009; Paim and Goldmeier, 2017), nursing staff and educators (Carifa and Goodin, 2011), and medical students (Del Blanco et al., 2017).

From the included evidence, three were designed for OR setting (Rothrock, 1986; Paim and Goldmeier, 2017; Del Blanco et al., 2017) and the others were planned either for surgical wards (Mole and McLafferty, 2004; Koivisto et al., 2016) or classroom settings (Girard, 1981; Fawcett, 1994; Fawcett and Dodd, 2009). Two other evidence discussed perioperative practices for both clinical and theoretical settings (Baker, 2009; Carifa and Goodin, 2011). Educational games were designed for different learning domains, including skills, feelings, emotion, knowledge, performance, attitude, motivation, and interest. Overall, the included evidence reported that application of educational games could be effective on different learning outcomes. Characteristics of the included evidence are summarized in Table 2.

3.2. Appraisal and rating of the included evidence

Appraisal of the evidence is provided in Table 3. Based on the AORN hierarchy of the evidence model, the type of most included evidence was non-experimental (Mole and McLafferty, 2004; Koivisto et al., 2016; Paim and Goldmeier, 2017), and most evidence was categorized as level V (Girard, 1981; Rothrock, 1986; Fawcett, 1994; Baker, 2009; Fawcett and Dodd, 2009; Carifa and Goodin, 2011). According to the AORN evidence appraisal tools, the quality level of most evidence was considered as either high (A) (Baker, 2009; Fawcett and Dodd, 2009; Koivisto et al., 2016; Del Blanco et al., 2017) or low (C) (Girard, 1981; Rothrock, 1986; Fawcett, 1994; Paim and Goldmeier, 2017). Most included evidence was rated as moderate (rating 3) (Mole and McLafferty, 2004; Baker, 2009; Fawcett and Dodd, 2009; Carifa and Goodin, 2011) or limited (rating 4) (Girard, 1981; Rothrock, 1986; Fawcett, 1994; Paim and Goldmeier, 2017), based on the AORN evidence rating model.

4. Discussion

As far as we know, this is the first study to comprehensively review and appraise the existing evidence related to the educational games developed for nursing students in perioperative field. Previous systematic reviews had paid attention to educational games in perioperative medicine (Graafland et al., 2012; Robertson et al., 2017), and there is limited evidence in perioperative nursing in this regard. In a narrative review, it was stated that educational games could simulate perioperative practices and bridge theory and application or connect previous knowledge with new knowledge (Carifa and Goodin, 2011). Moreover, in the literature it was proposed that educational games in perioperative nursing field could provide opportunities for students to learn problem-solving skills, hypothesis testing, logic, facts and principles, deductive reasoning, social and communication skills, and acquire technology and informatics competencies (Schmaus, 1991; Baker, 2009; Carifa and Goodin, 2011).

The evidence reviewed in this study indicated that application of educational games could be effective on some students' learning outcomes (Table 2). It was revealed that game-like simulation had a significant positive effect on learning domains by facilitating and improving performance of the students' first practice in the OR with real patients. In a randomized controlled trial (RCT), conducted on nursing and medical students with no previous experience in surgery, a videogame was developed by combining the pictures and short videos, where

Table 3
Appraisal of the evidence on educational games developed for perioperative nursing students.

Author(s), Publication year	Evidence rating[a]	Evidence level[b]	Type of evidence[b]	Quality level[c]
Del Blanco et al. (2017)	1	I	RCT	A
Koivisto et al. (2016)	2	III	Non-experimental	A
Baker (2009)	3	V	Expert opinion	A
Fawcett and Dodd, 2009	3	V	Expert opinion	A
Carifa and Goodin (2011)	3	V	Literature review	B
Mole and McLafferty (2004)	3	II	Non-experimental	B
Paim and Goldmeier (2017)	4	III	Non-experimental	C
Fawcett (1994)	4	V	Case report	C
Rothrock (1986)	4	V	Organizational experiences	C
Girard (1981)	4	V	Case report	C

[a] Based on the AORN evidence rating model (1: strong, 2: high, 3: moderate, and 4: limited).
[b] Based on the AORN hierarchy of evidence model (I: a-systematic review of all RCTs, and b- RCT; II: a-systematic review of all quasi-experimental studies or a combination of RCTs and quasi-experimental studies, and b-quasi-experimental studies; III: a-systematic review of all non-experimental studies or a combination of RCTs, quasi-experimental, and non-experimental, b-systematic review of any or all qualitative studies, c-non-experimental studies, d-qualitative studies; and V: a-literature review, b-case reports, c-expert opinion, and d- organizational experiences).
[c] Based on the AORN research evidence appraisal tool-study or the AORN non-research evidence appraisal tool (A: high, B: good, and C: low).

students were interactively instructed to act at the surgical block. Students in the experimental group played the game online on the day prior to their first experience in OR, while those in the control group had no access to the application. After their first visit to OR, students in the experimental group showed to have less fear, higher perceived knowledge, and more collaborative attitude and it appeared that they had committed fewer errors (Del Blanco et al., 2017). Another study evaluated the nursing students' experiences in learning clinical reasoning process by playing a 3D simulation game in a surgical nursing course. The students reported that they learned best to take action and collect information, and apply theoretical knowledge during the game. Also, the majority of the students felt that they learned the phases of clinical reasoning quite or moderately well (Koivisto et al., 2016). In another study, a simulation game called “Playing with tweezers” was developed for students in a surgical instrumentation course and nursing staff in continuing education to evaluate their understanding and skills, when they set up basic surgical instruments on the Mayo stand or back table in the OR. The developed game showed good navigability and accessibility, and it was suggested to be used as a visual and intuitive virtual environment for perioperative nursing instructors and students (Paim and Goldmeier, 2017). Another form of simulation was creation of surgical ward for senior nursing students to work as a team to manage, organize, and deliver patient care. The predominant aim of the game was to have the ability in identifying the deficits of the skills as well as rectifying them. The data showed that reflection on clinical practice was encouraged when students actively participated in a simulation exercise, which is considered as appropriate and beneficial (Mole and McLafferty, 2004).

4.1. Implications of the findings

This study systematically reviewed and appraised the evidence on educational games developed for nursing students in perioperative field. Hence, it can guide the trainers and trainees in their selection of the games based on the best evidence. It seems that application of educational games can lead to an initial improvement in some students' learning domains, including skills, feelings, emotion, knowledge, performance, attitude, motivation, and interest. However, no follow-up data were reported in the investigated evidence on how long the improvement lasted. Also, in most evidence no educational intervention was performed to assess the effect of the designed game on the students' learning outcomes. Hence, further experimental research is needed to take long-term application of the designed games on different learning outcomes and domains into consideration.

In most evidence, the designed games were evaluated for neither reliability nor validity. Moreover, the rating of most evidence was found to be either moderate or limited. Hence, more high-quality research is recommended, considering reliability testing and validation process. Further research should consider the study design, sample size, trainers and trainees variables, games characteristics (i.e., objectives, learning domains, type, rules, settings, and evaluation process), and statistical methods to perform a high-quality study. Also, we suggest a collaboration of teams consisting of curriculum designers, educational psychologists, cognitive psychologists, educational philosophers, information system technologists, and technical game designers to develop a well-designed game. In addition, more attention should be paid to both clinical and theoretical issues because most investigated games were designed for clinical settings. Also, follow-up research in the case of theoretical issues is suggested to show if the learning was applied later in a clinical issue. Moreover, institutional supports and commercial entities must be available for both game and research development since the design and implementation of an educational game within the OR setting and surgical wards, especially digital games, are expensive and time-consuming.

4.2. Limitations

Although we used a comprehensive search strategy to ensure that it covers all evidence on educational games in the discipline of perioperative nursing, some evidence might not have been identified. Also, data pooling was not possible due to the heterogeneity of the evidence and their design.

5. Conclusion

Educational games might be useful to enhance the students' learning outcomes in perioperative nursing field. However, in most evidence, no data was reported about reliability and validity. Also, the rating of most evidence was found to be weak, suggesting the inappropriate quality of the evidence. Finally, the authors believe that the investigated games are insufficient to provide adequate skills and knowledge for further development of nursing students; hence, more high-quality studies and innovative and practical games are required by considering the validity and reliability process.

Declarations of interest

None.

Authors' contribution

MN: Study conception and design, data collection, data extraction, data synthesis, data interpretation, evidence appraisal, manuscript preparation, and critical revision of the paper; CP: Study conception and design, data extraction, data synthesis, data interpretation, evidence appraisal, and critical revision of the paper; and MA: Study conception and design, data collection, data interpretation, and critical revision of the paper. LA, AM, MBBS: data interpretation, evidence appraisal, and critical revision of the paper. All authors approved the final manuscript for submission.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nepr.2019.05.002.

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