

Review

Game-Based Learning in Graduate Nursing Education: A Narrative Review and Recommendations for Nurse Anesthesia Programs

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Students of the most recent generations, often called digital natives due to growing up with technology as an integral part of their lives, are technologically savvy and expect their educators to incorporate current technology into the classroom. Game-based learning is one way that technology can be utilized in the classroom. The purpose of this manuscript was to review the literature and explore the potential use of gaming in graduate nursing education, specifically nurse anesthesiology. Key themes emerged from the review of literature: (a) use of gaming in non-nursing higher education, (b) types of games used in nursing education, and (c) nursing content areas where games have been used. Nursing and non-nursing students in higher education have used game-based learning, gamification, and serious games. Studies of non-nursing students included various game types, such as online games and app-based games. The statistical impact of game-based learning was mixed; however, participants generally responded positively, even when measurable effects were limited. In studies of nursing students, commercially available games were reported most frequently. Benefits of commercially available games include various options for student interaction and active participation. Based on the literature, game-based learning could be effectively used as an alternative teaching strategy for master's and/or doctoral students in graduate nursing education, including nurse anesthesia education. Recommendations for game-based learning include using professional software, using pairs or teams of faculty to develop game-based learning strategies, using small groups of students compared with individual competitions, and providing immediate constructive feedback to students.

INTRODUCTION

The struggle to meet the changing needs of nursing students is not new.¹ Around the year 2000, a paradigm shift occurred in technology with the advent of newer handheld devices, mobile phones, smaller batteries, social media websites, and the ubiquity of applications or “apps”.² This shift in technology has also occurred in academic settings. In nursing education, teacher-centered modes of content delivery are being replaced with more innovative, active learning strategies.³ Nurse anesthesia residents are among current learners who desire a more engaging learning environment.⁴

Educators create meaningful learning experiences by applying effective teaching strategies and understanding how students learn best.⁵ Students of the most recent generations are often referred to as *digital natives*, meaning they have grown up with computer games, email, cell phones, and the internet playing an integral role in their lives.⁶ These students are quite technologically savvy and expect their educators to utilize current technology in the classroom.⁷ Therefore, teaching strategies used in higher edu-

cation must address the learning styles and technological needs of all students, especially digital natives.¹ An increased emphasis on teaching strategies that use technology is needed to match the digital environment that younger generations of students have become accustomed to and prefer. Shorey et al⁸ emphasized generational preferences of learning styles when describing the learning preferences and needs of healthcare students born from 1981 - 1994 (millennials), and from 1995 to around 2010 (Generation Z). These generations share an increased exposure and receptivity to technology. Millennials, the greater part of students in higher education, prefer a collaborative learning style with blended learning. Learners from Generation Z prefer visual and kinesthetic learning, honest feedback, and an independent learning style.⁸ As a result of these generations' close relationship with technology, they are accustomed to immediate feedback and positive reinforcement (for example, the “like” feature used on social media platforms). They are comfortable with multitasking between multiple devices. This may be perceived as inattentiveness by some, but it is an ingrained part of their learning style.⁹ Technology is used in nurse anesthesia ed-

Table 1. Gaming-Related Terms, Definitions, and Examples

Term	Definition	Practical Example
Game-based learning	The achievement of defined learning objectives or outcomes through game play ¹¹	Using an escape room to meet the learning objectives of a pharmacology class
Gamification	The application of game design elements such as levels, points, leader boards, and certificates in a non-gaming context such as education ^{3,11}	Use of polling software in a Q&A review session before an upcoming exam
Serious games	A full complete game which uses game design elements to improve student outcomes ³	A commercially available, online game to introduce content prior to an in-person classroom experience.

Table 2. Examples of Active Learning Activities

Active Learning Activity	Description	Examples
Simulation	An immersive teaching strategy designed to mimic reality-based scenarios where students can learn and practice in a safe environment. ¹⁶	Manikin-based simulation, standardized patients, virtual reality, screen-based simulation
Case-based learning	A description of a patient, event, or situation designed for students to engage and apply conceptual knowledge to practical scenarios. Cases are often based on actual patient scenarios. Cases may present a snapshot of a situation or may continuously unfold over the course of a learning activity. ¹⁵	A case of a patient presenting to an emergency department with sudden chest pain to teach students about acute coronary syndrome including risk factors, typical symptoms, ECG findings, treatment options, etc.
Concept mapping	A 2-dimensional schematic representation of concepts and their linking relationships ¹⁷	A concept map of types of chronic obstructive pulmonary disease (COPD) may be constructed in student groups to help them identify key concepts (e.g., COPD, asthma) and the web of connecting relationships (e.g., reversibility, age of onset, presence of inflammation)

ucation in myriad ways such as simulation, point-of-care ultrasound (POCUS), polling software, interactive whiteboards, learning management systems, and game-based learning.¹⁰ Game-based learning, gamification, and serious games are distinct concepts, and it is important for educators to understand the differences among these closely related terms. The terms, definitions, and practical examples are provided in [Table 1](#).

Students enrolled in nursing programs must gain knowledge and skills related to problem-solving, critical thinking, and decision-making.^{12,15} Nursing education is unique as it involves not only classroom teaching, but clinical teaching that requires students to provide hands-on patient care. As a result, nursing education has adopted an active learning model for content delivery to promote active participation and student engagement.¹² Active learning is a student-centered approach to learning where students are involved in constructing their learning, rather than passively receiving information from the educator.¹⁴ In addition to game-based learning, active learning strategies also include simulation, case-based learning, and concept mapping.^{14,15} Some examples of active learning activities are included in [Table 2](#).

Gamification is defined as “the application of the characteristics and benefits of games to real-world processes or problems”.^{18(p2)} Gamification is a teaching strategy that is visually appealing, provides immediate feedback, and pro-

vides an opportunity for independent student learning. Therefore, gamification shows promise as a teaching strategy for digital natives. When used as a teaching strategy in undergraduate nursing education, gamification has been shown to increase student motivation, preparation, and self-confidence in the skills lab.¹⁹ Although gamification has demonstrated positive outcomes in undergraduate nursing education, there is a gap in the literature regarding its use in graduate nursing education. The purpose of this manuscript was to review the literature to explore how gaming could be used in graduate nursing education, specifically nurse anesthesiology, and to provide recommendations for implementing the use of gaming in nurse anesthesiology programs.

REVIEW OF THE LITERATURE

To review the current literature, the databases Summons, CINAHL, PubMed, and Education Database were queried for peer-reviewed English-language articles published from 2018-2025. Search terms included combinations of “nursing education,” “higher education,” “gaming,” “nursing graduate students,” “nurse anesthesia,” and “generational learning differences.” The initial search yielded 123 articles, which were screened by title and abstract. After screening, the remaining articles were reviewed for relevance to the topic. To assess the most relevant literature,

articles were excluded if they did not discuss the use of gaming as an educational strategy or were published before 2018. A literature summary table is included in [Table 3](#). The following key themes emerged from the review of literature: use of gaming in non-nursing higher education, types of games used in nursing education, and nursing content areas where games have been used.

USE OF GAMING IN NON-NURSING HIGHER EDUCATION

Gamification can take many forms, including the utilization of quiz-show-like questions, simulation and/or virtual reality.^{19,21} For example, serious games are games that are designed for a specific educational purpose that extends beyond amusement and entertainment.²² Serious games have been utilized in higher education for both undergraduate and graduate students. Cook-Chennault et al²² conducted a mixed-methods study of undergraduate engineering students ($N = 201$) in which participants played an online engineering game designed to teach them about the stability of truss structures. Students who were accustomed to playing computer-based games, as opposed to phone-based games, demonstrated a statistically significant difference in ease of game play ($P = .007$), confidence in engineering skills ($P = .002$), and motivation to advance to higher levels ($P = .047$). In focus group sessions, students agreed that engineering games should reflect real-world problems but indicated they would be unlikely to use the online engineering game for exam preparation or interview preparation due to its perceived lack of detail and industry applicability.

Smiderle et al³⁸ conducted a randomized controlled trial that compared the gamified version and non-gamified version of a web-based system to teach computer programming to first-year undergraduate students ($N = 40$). As part of the study, students first completed a personality questionnaire to evaluate the personality dimensions of openness, conscientiousness, extroversion, agreeableness, and neuroticism. The results were used to assess the impact of personality traits on the effects of gamification. Personality traits were measured by the Reduced Inventory of the Big Five Personality Factors (IGFP-5R). Students identified as introverts demonstrated a statistically significant increase ($P < .05$) in the points scored in Feeper, a web-based design system used in computer programming classes. Introverted students, as measured by the IGFP-5R, had a statistically significant increase in their overall class rank compared to extroverts. This indicated that the gamified version of the computer programming system was more beneficial to students found to be introverts as measured by the personality questionnaire.

Gist et al²⁶ conducted an alternating treatment design study of 56 undergraduate education students who were randomized into 2 groups. Over a 15-week semester, the students were given weekly quizzes based on the week's assigned readings. The 2 groups shifted between 2 quiz conditions: completing quizzes on a personal electronic device or completing quizzes as a group with the quiz-style game *Kahoot!*⁴² The quiz conditions alternated so that both groups of students completed quizzes in both formats. Though students enjoyed the immediate feedback from *Ka-*

hoot!, there was no statistically significant difference in scores between the 2 quiz conditions, and some students found the music and immediate feedback from *Kahoot!* to be distracting while taking a quiz.

In a 2022 quasi-experimental study by Fusco et al,²⁵ an interprofessional group of pharmacy, physical therapy, dietetic, medicine, public health, athletic training, dental medicine, nursing, and social work students ($N = 229$) participated in a commercially available board game simulation designed to represent patients coming into an emergency department on a Friday evening. Students competed in teams of 4 to manage patient arrival, transfer, and discharge during a simulated 24-hour period in an emergency department. The game aimed to promote collaboration, solution generation, and cost-effective care. A 5-point Likert scale with responses that ranged from 1 (*strongly disagree*) to 5 (*strongly agree*) was used.²⁵ Of the 229 participants, 88% indicated that they "Agreed" or "Strongly Agreed" that learning objectives were met. There were no statistical differences found based on each profession. Participants commented that the game was fun, collaborative, and promoted system versus silo thinking, which contributed to increased competence as an interdisciplinary provider.

Gamification has been successfully used in graduate medical education. Ohn & Ohn³⁵ conducted a qualitative study of 32 medical students using focus groups and interviews to evaluate their experiences of ECG interpretation through a web-based, gamified learning platform. Responses revealed that medical students felt motivated and engaged using leaderboards, badges, and social interactions. According to the students' interviews and focus group discussions, the game's simplicity and lack of difficulty were drawbacks.

Haubruck et al³⁰ conducted a randomized control trial with medical students ($n = 95$) to compare the operative performance of chest tube insertion on a porcine model. Students were randomized into a control group and a treatment group. Students in the control group received a standard theoretical lecture by an experienced surgeon and were instructed to engage in additional self-study. Students in the treatment group received the same standardized lecture as the control group but were instructed to use an app-based serious game for supplemental teaching. In subsequent days, student performance of chest tube insertion was compared using an objective structural assessment of technical skills (OSATS). The OSATS was conducted via video observation, where only students' hands and the porcine model were visible. The students who used the app-based game to review the steps of chest tube insertion performed significantly better ($P < .001$) when compared with the control group.

In addition to app-based or web-based games, escape rooms have also been used as an educational gaming strategy.^{20,24} In a 2020 study of 18 dental students, there was a statistically significant increase ($P < .05$) in post-test scores in dental students after completing an escape room with topics such as root canal procedures, management of endodontic emergencies, and endodontic instrument classification.²⁰ To escape from the rooms, students had to solve

Table 3. Literature Summary Table

Author(s)	Country	Year	Population	Type of Game(s)	Study Design	Findings
Aubeux et al. ²⁰	France	2020	Dental students (N = 18)	Escape Room	Descriptive, cross-sectional	Post-test scores significantly increased compared with pre-test scores ($P < .05$).
Blanié et al. ²¹	France	2020	Undergraduate nursing students (N = 146)	Computer-based simulation game	Randomized controlled trial	No significant difference was noted between the intervention and control groups immediately following the intervention ($P = .043$) nor 1 month later ($P = .077$). Satisfaction and motivation were higher in the gaming group.
Cook-Chennault et al. ²²	United States	2022	Undergraduate engineering students (N = 201)	online engineering educational game	Mixed method	Participants accustomed to playing games on their mobile phones or computers had post-test scores that were statistically significant ($P < .05$). Free text responses revealed that most students did not think the game would be helpful for exam preparation nor for job interviews due to a lack of alignment between course homework and lecture material problems.
Darby et al. ²³	United States	2020	Undergraduate nursing students (N = not reported)	Relay race, escape room	Descriptive, cross-sectional	Anecdotal comments were positive from students. Faculty felt that it changed skills lab from bland to engaging.
Elzeky et al. ¹⁹	Egypt	2022	Undergraduate nursing students (N = 128)	Gamified quizzes using Moodle	Randomized controlled trial	No statistically significant difference in student skills' performance following the gamified intervention ($P = .163$). There was a statistically significant difference in self-confidence ($P = .021$), skills knowledge ($P < .001$), intensity of preparation ($P < .001$), and motivation ($P < .001$) with the intervention group compared to the control group.
Franco & DeLuca ²⁴	United States	2019	PhD students in healthcare leadership (N = not reported)	Escape Room	Case report	Students commented on the innovation, strategy, collaboration and real-life applicability of the game.
Fusco et al. ²⁵	United States	2022	Interprofessional healthcare students (N = 229)	Commercially available board game simulation called "Friday Night in the ER"	Quasi-experimental	> 88% of participants agreed or strongly agreed that learning objectives were met. When analyzed by professions, there was no difference in the frequency of respondents who agreed or strongly agreed with learning objectives about communication ($P = .77$), collaboration ($P = .84$), innovation ($P = .41$), or teamwork ($P = .22$). There was no difference between professions regarding the value of the learning experience ($P > .021$). Qualitative responses indicated that students enjoyed collaborating with other students, felt that the experience contributed to their competence as an interprofessional healthcare provider, and wished for shorter debriefing and more students from other professions.
Gist et al. ²⁶	United States	2019	Undergraduate education students (N = 56)	Kahoot!	Quasi-experimental	There was no statistically significant difference in quiz performance between groups of students who used Kahoot and individual students who used their personal device ($P = .216$).

Author(s)	Country	Year	Population	Type of Game(s)	Study Design	Findings
Grech & Grech ²⁷	Malta	2021	Undergraduate nursing students (N = 40)	Gamified webinar using Mentimeter®	Quasi-experimental	There was no statistically significant difference in any of the 6 component scores on the Students Evaluations of Educational Quality instrument ($P = .347 - .915$). Students in the gamified group felt that gamification increased their engagement.
Haamankuli et al. ²⁸	United States	2024	Nurse practitioner students (N = 109)	High-fidelity simulator	Quasi-experimental	Post-test scores about comfort with POCUS were significantly increased compared with pre-test scores ($P < .001$).
Habes et al. ²⁹	Netherlands	2020	Undergraduate nursing students and graduated vocational nurses (N = 240)	Interactive, video-based educational tool with some gamified elements	Mixed method	Scores on the Knowledge of Older People questionnaire were statistically significantly higher after playing the game ($P = .002$). Qualitative results indicated that participants felt the intervention was an effective educational tool.
Haubruck et al. ³⁰	Germany	2018	Medical students (n = 95)	App-based game	Randomized controlled trial	The intervention group showed significantly improved scores in time ($P = .004$), required less help ($P < .01$) and were more confident ($P < .001$).
Ignacio & Chen ³¹	Singapore	2020	Undergraduate nursing students (N = 49)	Kahoot!	Mixed method	Post-test scores ($P = .14$) and post-intervention skills assessment ($P = .88$) were not significantly different between the intervention group and the control group. Focus groups reported positive findings: helpful to review concepts, helpful to link concepts, facilitated application to the clinical setting.
Inangil et al. ³²	Turkey	2022	Undergraduate nursing students (N = 70)	Kahoot!	Randomized controlled trial	The experimental group had statistically significant difference in diabetes knowledge ($P < .05$) and significantly higher attention and satisfaction scores ($P < .001$).
Keys et al. ³³	Canada	2021	Undergraduate nursing students (N = 26)	Virtual simulation game	Randomized controlled trial	Overall performance was statistically higher in the intervention group ($P = .003$).
Kinder & Kurz ¹	United States	2018	Undergraduate nursing students (N = 47)	Kahoot!	Quasi-experimental	The intervention group had higher final exam test scores than the control group ($P = .005$).
Lange et al. ³⁴	Germany	2020	Undergraduate nursing students (N = 12)	Virtual reality	Qualitative	Overall perception of the participants was positive toward virtual reality. The greatest influence on the perception of virtual reality was personal attitude toward technology.
Mims et al. ⁴	United States	2024	Nurse anesthesia students (N = 51)	TV-style game show and outdoor relay race	Quasi-experimental	The post-test scores indicated significant increases in perceived level of confidence in performing regional anesthesia ($P < .001$), perceived motivation to learn ($P < .001$), and perceived knowledge of ultrasound ($P < .001$).
Ohn and Ohn ³⁵	Malaysia	2019	Medical students (N = 32)	Web-based gamified learning platform	Qualitative	Interviews revealed that participants valued the gamification elements (e.g., leaderboards) and real-life applications. Participants expressed concerns that the game simulation was too simple and had decreased usability when played on a mobile phone.
Reed and Ferdig ³⁶	United States	2021	Undergraduate nursing students (N = 14)	Escape room	Quasi-experimental	Post-intervention anxiety scores were significantly decreased compared with pre-test scores ($P = .013$). Student enjoyment mean scores all fell between 4 (agree) and 5 (strongly agree).

Author(s)	Country	Year	Population	Type of Game(s)	Study Design	Findings
Rosa-Castillo et al. ³⁷	Spain	2022	Undergraduate nursing students (N = 106)	Instagram-based game	Descriptive, cross-sectional	Satisfaction scores indicated that > 67% of respondents felt that the game helped them learn content, should be used in other courses, would recommend gaming to other students, enjoyed the experience, felt motivated to learn about the topic, and aided with comprehension.
Smiderle et al. ³⁸	Brazil	2020	Undergraduate computing students (N = 40)	Web-based gamified learning platform	Randomized controlled trial	Introverted participants had a significantly higher number of points ($P = .03$) and accuracy ($P = .01$) compared with extroverted participants. Extroverted participant scores were moderately negatively correlated with number of badges earned ($r = .52, P = .01$) and number of points earned ($r = .52, P = .01$).
Verkuyt & Hughes ³⁹	Canada	2019	Undergraduate nursing students (N = 127)	Virtual gaming simulation	Mixed method	Satisfaction with Current Learning Survey indicated 81% satisfaction. Simulation Design Scale had a mean score of 81%. Focus group themes were virtual gaming simulation design elements, expanding knowledge, and experiential learning.
Weiss ⁴⁰	United States	2018	Nurse practitioner students (N = not reported)	"Promote Your Favorite Organ" with game-based competition	Descriptive, cross-sectional	Strategy not formally evaluated; however, a higher percent of A's noted, no change noted in students not passing. The number of students dropping the course decreased and faculty evaluations by the student improved.
Wingo et al. ⁴¹	United States	2019	Undergraduate nursing students (N = 13)	Quiz gaming	Qualitative case study	Mixed feelings noted among students concerning playing in teams. Two themes that motivated participation were competition and personal challenge. Students expressed an interest in having more questions.
Zehler & Musallam ¹³		2021	Undergraduate nursing students (N = 26)	Minute to Win It® TV show format.	Quasi-experimental	Test average improved ($P = .0001$). Based on students' perception, the game increased motivation, and facilitated learning and retention of knowledge.

puzzles, demonstrate a comprehensive consultation, and demonstrate appropriate techniques.²⁰ Students acknowledged the relevance and usefulness of the escape room game while also reporting that they felt engaged. Study authors attributed this to students who were digital natives and already accustomed to playing games outside of the educational environment. An escape room was also utilized in a doctoral course in healthcare leadership.²⁴ The case report recognized the escape room's practical application of complex concepts and its promotion of teamwork. One drawback of a collaborative game like an escape room is its measurement of group knowledge rather than individual knowledge, which could limit its application as an evaluation tool.

GAMING IN NURSING EDUCATION

Gaming, in various forms, has been used in higher education with favorable results,^{20,25,30,35} and the use of serious games has also been reported in nursing education. In the literature, quiz-style games were the most frequently reported type of game used in nursing education.^{1,19,27,31,32,41} Quiz-style games are conducted in the style of a game show where students compete against one another to answer questions quickly and correctly.²⁶ The reported benefits of quiz-style games include immediate student feedback,^{1,31,41} student engagement,^{1,27,31,41} student satisfaction,^{19,41} and competition with points, badges, and leaderboards.⁴¹ The previously discussed quiz-style game *Kahoot!*, was the most common quiz game described in the nursing literature.^{1,31,32}

Ignacio & Chen³¹ conducted a mixed methods study with first-year undergraduate nursing students ($N = 49$) enrolled in a Pathophysiology and Pharmacology course in a Singapore university. The quantitative portion of the study included a randomized controlled trial where students were divided into a control group ($n = 26$) and an intervention group ($n = 23$). Both groups completed a knowledge pre-test and then received instruction through classroom case discussions. In addition to the case discussions, the intervention group was presented with 10 clinical application questions that were delivered via *Kahoot!* A post-test was given to both groups at the end of the intervention and knowledge and skills were evaluated using a simulation-based assessment tool that used a Likert scale. Quantitative findings revealed no significant difference between quiz scores ($t = 1.50$) and simulation performance scores ($t = 1.19$) of the 2 groups. The qualitative portion of the study consisted of focus groups that were conducted 5 months after the *Kahoot!* gaming intervention. The length of time between the intervention and the focus group was intentional to assess students' effectiveness at integrating their knowledge into clinical practice. Although there was no reported difference in knowledge and skills between the control and intervention groups, the focus group interviews revealed that gaming was (a) useful for revision of concepts and topics, (b) provided the opportunity to link concepts together, which helped during clinical rotations, and (c) offered a challenge that encouraged the students to remain engaged in their studies so they could improve their scores and not

fall behind their peers. Therefore, the authors concluded that gaming could be an effective adjunct teaching strategy.

A quasi-experimental study by Kinder & Kurz¹ also used *Kahoot!* as the intervention when comparing final exam scores of senior nursing students ($N = 98$). Students in the control group ($n = 51$) and the intervention group ($n = 47$) received the same class lectures and the same final exam. The students in the intervention group played four 20-minute sessions of *Kahoot!* in addition to class lectures. The intervention group had statistically significant higher test scores than the control group ($P = .005$). The researchers concluded that, because *Kahoot!* is available internationally, educators in all levels of nursing programs worldwide can use it to reinforce teaching, flip the classroom, and enrich learning.

Wingo et al⁴¹ conducted a qualitative study ($N = 13$) using focus groups, observations, and student documents to understand the experiences of first-semester undergraduate nursing students enrolled in a fundamental nursing skills course who played Kaizen, a software-based quiz game developed by the School of Medicine at the study university, and then shared with the School of Nursing. Four themes emerged from the data collection: (1) learning in teams, (2) motivators to play, (3) learning course content, and (4) suggestions for game improvement.⁴¹ Student responses from the focus groups were overwhelmingly positive. For example, 1 student reported that "[Kaizen] helped me with test-taking skills...It helped train my brain a way to think, when I get ready to take my test" while another student stated that "It made it more exciting, being on a team...you wanted your team to do well, and you wanted to do well for your team".^{41(p83)}

In a randomized controlled trial of 128 nursing students, Elzeky et al¹⁹ used Moodle™ to create a gamified flipped classroom experience.⁴³ Students in the intervention group ($n = 64$) used Moodle™ to complete gamified quizzes, compete for badges, points, and ranking on a leaderboard.^{19,43} Gamified quizzes contained videos, images, and varying types of questions (e.g., multiple choice, drag and drop, fill in the blank). The control group ($n = 64$) received flipped classroom education that included only pre-class materials and in-class demonstrations. Although there was no difference in students' skills performance, there was a statistically significant difference in the intervention group's self-confidence ($P = .021$), skills knowledge ($P < .001$), intensity of preparation ($P < .001$), and motivation ($P < .001$). These findings support using gaming to create a positive competitive environment and increase student motivation.

Grech & Grech²⁷ conducted a randomized control trial using Mentimeter to gamify a public health educational webinar for first-year nursing students.⁴⁴ Mentimeter is an audience engagement platform that allows educators to create presentations that can integrate assessments or quizzes for use in the classroom.⁴⁴ In the study, the control group received the webinar via a PowerPoint lecture. The intervention group received the webinar through Mentimeter, which contained multiple-choice questions throughout the lecture. Points were awarded for correct answers, and a leaderboard displaying top scores was shown. Mean scores

of a post-webinar survey were not statistically significant between the groups. However, students received an online questionnaire at the end of the webinars, and participants in the intervention group felt that gamification in online learning helped increase student interactions and engagement.

SIMULATION BY GAMING

Simulation by gaming is another type of game-based learning frequently reported as a teaching strategy.^{21,33,39,45} Simulation by gaming allows students to apply theoretical concepts in a practical scenario, which is particularly appealing in nursing education. In a study by Blanié et al,²¹ a total of 146 undergraduate nursing students studying clinical scenarios of patient deterioration were randomized into 2 groups: simulation by gaming ($n = 73$), and traditional teaching ($n = 73$). The groups were presented with clinical scenarios of patient deterioration and expected to identify pertinent signs of deterioration and then escalate care. Though motivation and satisfaction were higher in the intervention group, there was no statistically significant difference in assessment scores between the groups immediately afterward ($P = 0.43$) nor 1 month later ($P = 0.77$).

Keys et al³³ conducted a pilot randomized controlled trial involving a virtual simulation game by undergraduate nursing students ($N = 26$) learning to perform cardiac resuscitation. Students were randomized into a control group and an intervention group. Both groups received Basic Life Support and Advanced Cardiac Life Support algorithms and attended a resuscitation-oriented lab. However, the intervention group participated in an additional 15-minute virtual simulation game that allowed the user to function as a nurse caring for a patient who experienced a cardiac arrest. The virtual simulation game was filmed from the perspective of a nurse who first encountered a patient in cardiac arrest. Multiple-choice questions were provided at key decision points in the scenario. Participants who answered the question correctly advanced to the next scene in the game. Incorrect answers resulted in participants being shown a video demonstrating their actions' effects. A 12-item performance checklist was used to assess student success. Participants in the intervention group scored higher than those in the control group on 10 of 12 items, but only 1 item ("*immediately resumes cardiopulmonary resuscitation following shock*") demonstrated statistical significance ($P < .05$). Despite these results, the authors noted that students in the intervention group appeared better able to consolidate knowledge and learn from the virtual simulation.

Verkuyl and Hughes³⁹ conducted a mixed-method study of a virtual simulation game integrated into a mental health and community practicum course for registered practical nurses (the Canadian equivalent of a licensed practical nurse). Students ($N = 127$) played a home visit simulation game focused on making decisions about mental health assessments and interpersonal violence. Data was collected from focus group sessions and 4 surveys: demographic survey, self-confidence in learning survey, satisfaction with current learning survey, and simulation design scale to measure student perception of simulation. Stu-

dents reported favorable satisfaction and self-confidence scores on post-simulation surveys, though statistical evidence was not provided. A team approach was used to analyze the themes of transcribed focus group interviews. Focus group interview responses indicated that the virtual simulation gaming experience was engaging and effective and allowed a suspension of belief, contributing to the game's usefulness. The 3 themes that emerged from the focus groups were (1) virtual gaming simulation design elements, (2) expanding knowledge, and (3) experiential learning. The increased motivation and engagement that comes with simulation by gaming is promising for its continued use in nursing education.

USE OF GAMING TO TEACH SPECIFIC NURSING CONTENT

Game-based teaching has been used in a range of nursing content areas. Darby et al²³ described their innovative strategy of incorporating 2 gaming strategies, a relay race and an escape room, to assess students' competency in obstetric skills. Learning stations in the escape room included skills such as sterile gloving, interpretation of fetal monitoring strips, and medication administration. Upon completion of a station, an Olympic-style torch was passed from 1 student to another to signify station completion and readiness to move to the next station. Students found the experience motivating and engaging, turning a traditional skills lab into something more exciting. The authors noted that game-based strategies incorporated students' varied learning styles and fostered teamwork.

Zehler & Musallam¹³ conducted a pilot study with junior-level baccalaureate nursing students ($N = 26$) enrolled in a maternal-child course. The format was similar to the televised game show Minute to Win It[®], where teams compete in timed challenges. The students competed against each other in teams by completing learning activities related to the assessment, intervention, or evaluation of a patient experiencing a postpartum hemorrhage (PPH). Learning stations included identifying PPH risk factors, quantifying blood loss, and administering blood products. Post-test scores were significantly higher ($P < .0001$) than pre-test scores, and students reported high satisfaction and motivation on reflective surveys administered at the conclusion of the activity. The course leaders who designed the study noted that the adapted Minute to Win It game for PPH is easily modifiable and can be used in other nursing content areas.

Gaming has been used to teach mental health nursing content. Rodríguez-Ferrer et al⁴⁶ used a digital escape room to assess whether this game-based teaching strategy could modify the stigmatizing behavior of nursing students ($N = 253$) toward patients with serious mental illness. Both the experimental group and control group attended their regular online classes, but those in the experimental group also participated in an online escape room where the character was a person with a serious mental illness. All participants completed pre- and post-tests that consisted of the Stigmatizing Attitudes Questionnaire and the Cooperative Learning Questionnaire. The students in the intervention group

completed an additional Stigmatizing Attitudes Questionnaire 6 months after the escape room. The retest aimed to assess the long-term retention of attitude changes produced by the escape room. The participants who utilized game-based learning had a statistically significant reduction in their stigmatizing attitude scores on the post-test and 6-month retest ($P = .000$), demonstrating that the use of an online escape room can be an effective method for incorporating game-based learning.

In addition to the above content areas, the following nursing-related content has been effectively taught using game-based strategies: nursing fundamentals,^{19,41} medical-surgical nursing,³⁶ geriatrics,²⁹ public health,²⁷ anatomy,³⁴ pathophysiology,³¹ diabetes,³² and nutrition.³⁷

USE OF GAMING IN GRADUATE NURSING EDUCATION

Limited research is available regarding the use of gamification in graduate nursing education. One study by Weiss⁴⁰ reported the feasibility of incorporating competitive gaming into graduate nursing online courses such as pathophysiology. Nurse practitioner students were allowed to complete a bonus assignment called *Promote Your Favorite Organ* after each of 12 pathophysiology modules. The assignment encouraged students to develop a creative presentation in a style they chose, such as a poem, a rap, a cartoon, or PowerPoint. The assignment was considered a competitive game, and students were asked to peer evaluate the presentations at the conclusion of each module. After implementing *Promote Your Favorite Organ*, the number of students achieving a grade of A increased, and the number of students withdrawing from the course decreased.

Haamankuli et al²⁸ conducted a study of Adult-Gerontology Acute Nurse Practitioner students ($N = 109$) to assess the effectiveness of gamification (the Vidimex augmented reality ultrasound simulator) to teach basic POCUS skills. Student teams competed in bracket-style elimination to work through POCUS cases where they were evaluated on time and accuracy. Pre- and post-intervention questionnaires were completed to assess student comfort with POCUS skills. Post-intervention results indicated an increase in overall comfort level (from 2.12 to 3.78 on a 5-point scale) with a large effect size ($d = 2.24$).

In a study of nurse anesthesia students ($N = 51$), Mims et al⁴ reported on the use of 2 games used as a review of ultrasound-guided peripheral nerve blocks (PNB). Following a weeklong intensive about PNB, students competed in a TV-style game show to evaluate tactile ultrasound skills, and then an outdoor relay race where teams had to correctly answer knowledge-based questions about peripheral nerve blocks. Post-game surveys reflected a statistically significant difference ($P < .001$) in responses compared with pre-game surveys. Qualitative responses affirmed the immediate feedback and collaboration associated with game-based learning.

DISCUSSION

Game-based learning, gamification, and serious games have been used with both nursing and non-nursing students in higher education. Studies of non-nursing students included a wider breadth of game types such as online games, app-based games, board games, and escape rooms. Non-nursing student participants were drawn from various disciplines including engineering, computer programming, education, and healthcare, demonstrating the broad applicability of game-based learning. The statistical impact of game-based learning was mixed; however, participants generally responded positively, even when measurable effects were limited. The positive feelings toward gaming might be attributable to immediate feedback, positive reinforcement, and collaboration that accompany this technology. These aspects of game-based learning are consistent with the learning preferences of millennials and Generation Z.

In studies of nursing students, commercially available games (e.g., Kahoot!, Moodle™, Mentimeter) were reported most frequently. Benefits of commercially available games include various options for student interaction and active participation. Students can respond to live polls, submit answers to a word cloud, answer questions, and ask anonymous questions. All of this can be accessed from their own device or smartphone. Commercially available games are often integratable into existing lecture delivery software like PowerPoint. Virtual simulation games were also used in nursing studies to allow students to assume the role of the nurse. These simulation games did not always result in statistically significant outcomes, but they did increase student motivation and satisfaction, which make them a non-inferior alternative to a traditional learning format.

Game-based learning was used in a wide variety of undergraduate nursing content areas. Topics ranged from core courses (e.g., nursing fundamentals, anatomy and physiology, pathophysiology) to more specialized, advanced courses (e.g., obstetrics, mental health). The wide range of content incorporating gaming again highlights the adaptability of games and game-based learning to nearly any subject an instructor is willing to explore.

Graduate nursing is underrepresented in the literature on gaming, game-based learning, and serious games. Nurse practitioner and nurse anesthesia students have participated in game-based learning with good effect. However, the mentioned studies are all descriptive, nonexperimental designs. Stronger research designs are needed in graduate nursing education to build upon the foundation established by our colleagues in undergraduate nursing programs. Experimental designs can compare the use of game-based learning against a control or even compare multiple game-based approaches.

Nurse anesthesia programs are rigorous and fast-paced. The volume of content to be covered in each class period might lead some faculty to fear that gamification or game-based learning might take up valuable time. However, faculty who avoid active strategies might be able to cover all the required learning objectives, but at the cost of student

engagement. Strategies such as gamification do not have to be used in every class. They are not intended to be a panacea, but 1 strategy among many for engaging current generations of nurse anesthesia residents.

Commercially available platforms such as *Kahoot!*, *Mentimeter*, *Moodle™*, and *Poll Everywhere* are designed to be user-friendly and appealing for students. These technologies can be used to present multiple-choice questions, word clouds, and free text responses to faculty inquiries. In a nurse anesthesia classroom, they could be utilized in a review session before an upcoming exam, or as a comprehension check at the beginning of a class to assess for knowledge retention from assigned readings. Many of these platforms contain ready-to-use templates that can be customized for the user's needs. A game modeled after the TV game show *Jeopardy* is also a popular, interactive way to review content. Websites are available that provide templates or allow the user to create questions from scratch.

The task of planning a game-based learning activity might feel daunting for some faculty. Using pairs or groups is one way to spread out the workload and creative effort. If some faculty feel especially comfortable with technology and have experienced success with game-based learning, they can serve as a mentor or superuser for other faculty who have less experience. Students are not a monolith; some might feel more comfortable with game-based learning than others. Group work is one way to relieve pressure from individual students while providing an engaging learning method. Working in groups also promotes collaboration, which aligns with the learning preferences of current students.

A wide variety of game styles have been successfully implemented as teaching strategies in higher education, including undergraduate nursing education, to teach a variety of content areas. Based on the literature, game-based learning could be effectively used as an alternative teaching strategy for master's and/or doctoral students in graduate nursing education, including nurse anesthesia education. This strategy encourages a student-centered approach to learning, which benefits student learning.⁸ The active learning environment created by student engagement is associated with increased confidence, knowledge, and skills.^{14,31} Game-based learning also provides opportunities for strategic thinking, honing analytical skills, multitasking, and collaborative learning.¹⁹ Recommendations for the use of game-based learning are included in [Table 4](#).

Technology in the classroom, including gamification, game-based learning, and serious games, must be implemented wisely. Brown⁴⁷ epitomized this when he wrote, "I believe the most important things to keep in mind about learning and technology is that they should be considered in that order." In other words, the technology should supplement or enhance the learning rather than overshadow it or serve as a hindrance. There is no single mode of technology that can be used to address all learning outcomes, and gamification is no exception.² It should be used as one tool among many for educators looking to diversify their teaching strategies. Another limitation may be faculty buy-in. Faculty have heavy workloads, and the prospect of includ-

ing unfamiliar technology may seem more trouble than it is worth. However, one need not overhaul an entire lecture or course to make a change toward active learning. Small changes, over time, are steps in the right direction of aligning teaching strategies with generational learning preferences.

SUMMARY

Current and future advanced practice nursing students entering our classrooms are considered digital natives, meaning they have grown up with technology such as the internet, smartphones, and laptop computers. Technology is an integral part of their lives, and they expect it to be included in their education as well.^{1,7} These students are primarily drawn from millennials and Generation Z. Their learning preferences include positive reinforcement, immediate feedback, use of technology, and collaborative learning. Game-based learning has the potential to meet these criteria.

Game-based teaching has been widely described in nursing literature, but the research leans heavily toward the undergraduate population. A noticeable gap remains for research on game-based teaching in graduate nursing students. The use of game-based learning strategies in nursing education is broad and can be applied to as many content areas as educators are willing to try. Research evidence supports the continued use of game-based learning as an effective teaching strategy in nursing education. Commercially available products (e.g., *Kahoot!*, *Mentimeter*, *Moodle™*, *Poll Everywhere*) are evidence-based places to start. Current research on game-based learning in graduate nursing is limited, with much of it consisting of descriptive, non-experimental designs. More rigorous research designs that compare gamification with traditional learning methods or examine differences between various game-based learning strategies, would be a valuable contribution to the existing literature on this relevant and timely topic.

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Table 4. Recommendations for Game-Based Learning

Recommendation	Rationale
Use professional software (e.g., <i>Kahoot!</i> , <i>Mentimeter</i> , <i>Moodle™</i>) to implement quiz-style gaming ⁴²⁻⁴⁴	• Professional software can assist faculty in implementing customized gamification for their course. • Game elements, like badges, increase student motivation. • Immediate student feedback is preferred by students.
Consider using a team to incorporate gamification ^{1,7}	• Faculty members may agree with the importance of using gaming in education but may not be comfortable with the technology. • Faculty who are more comfortable with gaming can provide assistance to others who need it.
Use small groups when competing ^{7,11}	• Small groups can decrease anxiety associated with competition.
Provide feedback ^{1,4,9,31,41}	• Younger generations desire constructive, immediate, honest feedback. • Feedback is immediately provided in quiz-style games.



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