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Curriculum, Instruction, & Pedagogy

Escaping the Lecture: Gamification in Anatomy & Physiology for Novice Nurse Anesthesia Residents

Amy M. Reed, Ph.D, CRNA[1,2]

[1] Anesthesia, WellSpan Health, [2] Nurse Anesthesia, York College of Pennsylvania

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Background

Expert knowledge of anatomy and physiology (A&P) is essential to the success of nurse anesthesia residents as it forms the foundation for advanced clinical reasoning and safe anesthetic management. However, residents enter programs with diverse educational and clinical backgrounds, and the dense, complex nature of A&P content can make traditional lecture-based instruction less effective.

Objective

To enhance learner engagement and perceived understanding, multiple gamification instructional strategies were introduced into a first-semester A&P I course for nurse anesthesia residents.

Methods

Gamified approaches were mapped to Keller's ARCS Model of Motivational Design and integrated throughout the course. Strategies included Kahoot! for real-time quizzes, WayGround (formerly Quizizz) for post-lecture self-assessment, microlearning lecturettes, and a physiology-based escape room developed with ChatGPT assistance. Learner perceptions were measured using pre- and post-course surveys, and qualitative feedback was gathered throughout the semester. Descriptive statistics and thematic analysis were used to summarize findings.

Results

Learners reported increased motivation, higher engagement, and greater enjoyment of course activities following the integration of gamified strategies. Participants expressed positive perceptions of their understanding of complex physiological content, though these findings reflect perceived rather than objectively measured retention. Faculty observations further indicated more robust discussion during gamified sessions. Challenges included time constraints and technology issues.

Conclusion

Gamification represents a feasible, learner-centered approach to delivering foundational A&P content in nurse anesthesia education. While results demonstrate strong perceived benefits, future work should incorporate objective performance measures to evaluate learning outcomes more directly. Thoughtfully designed gamified strategies may help promote motivation, engagement, and learner satisfaction without compromising academic rigor.

Historically, nurse anesthesia education has relied on a traditional didactic model, lecture-based instruction, printed materials, and standardized testing. While this model was effective in earlier decades, the field has shifted. Today's learners expect interactivity, relevance, and personalization.[1] The evolving demands of healthcare education, coupled with the growing diversity of nurse anesthesia cohorts, call for a new approach to teaching. Graduate nurse anesthesia education demands not only rigorous content delivery but also instructional innovation to engage nurse anesthesia residents and support long-term retention.[1,2] In an era where artificial intelligence (AI) and educational technology are increasingly accessible, faculty must be equipped to incorporate these tools appropriately.[3,4] A growing body of research highlights the transformative potential of AI and gamification in healthcare

education, particularly for nurse anesthesia residents.[3-5] Theses technologies are reshaping traditional pedagogies by fostering interactive, personalized, and competency-based learning environments.[6]

AI IN NURSING AND ANESTHESIA EDUCATION

AI is increasingly integrated into nursing curricula, offering adaptive learning platforms, virtual simulations, and AI-driven assessments that enhance clinical decision making and personalized learning experiences.[3,4] AI-powered simulation and content-creation tools have been shown to improve resident engagement, enhance case-management performance, and increase resident satisfaction, though they may also raise cognitive load and stress levels for some learners.[3,6] In anesthesia education specifically, AI can support realistic training simulations and individualized feedback, preparing learners for complex clinical scenarios and ongoing professional development.[7,8]

GAMIFICATION: PRINCIPLES AND EDUCATIONAL IMPACT

Gamification involves incorporating game elements such as leaderboards and point- systems into educational contexts to boost engagement and knowledge retention.[9] In nurse anesthesia and broader nursing education, gamified interventions have led to statistically significant improvements in knowledge, confidence, motivation, and satisfaction, as well as the development of critical thinking and non-technical skills.[7,9-11] Team-based competitions and simulation-based games create dynamic and interactive learning environments that encourage active participation and real-time feedback.[10,12]

COMBINED IMPACT ON ENGAGEMENT AND RETENTION

AI and gamification place learners at the center of the educational process, promoting active engagement and application of knowledge.[3,4,7] AI-driven gamified simulations can further enhance these effects by providing immersive and contextually relevant experiences.[7,12] These approaches have been linked to improve retention of information, greater self-efficacy, and better preparedness for clinical practice.[7,9-11] However, challenges remain, including the risk of superficial engagement if rewards are overemphasized, potential increases in anxiety, and the need for culturally sensitive and ethical safeguards.[3,7,13]

EFFECTS OF AI AND GAMIFICATION IN NURSE ANESTHESIA EDUCATION

Today, the profile of a nurse anesthesia resident encompasses a wide range of ages and professional backgrounds. Some enter nurse anesthesia programs as recent Bachelor of Science in Nursing graduates while others bring over a decade of critical care experience. Learning preferences vary as much as the learners themselves. Some thrive on self-paced modules and digital platforms, while others prefer tactile and in-person discussion-based learning.[14] This diversity enriches the learning environment, but it also highlights the inadequacy of a one-size-fits-all education.[14] AI and gamification offers adaptive learning, real-time feedback, and can help identify knowledge gaps.[15] Meanwhile, gamification, or the application of game design elements in educational settings, is emerging as a highly effective strategy for increasing motivation, improving retention, and promoting mastery of complex material.[15] Table 1 summarizes the effects of AI and gamification on nurse anesthesia education as well as the potential outcomes and barriers to the learning interventions.

The research presented here describes the integration of multiple gamified learning strategies into an Anatomy and Physiology I (A&P I) course for first-semester nurse anesthesia residents and examines learner feedback. The instructional design incorporated interactive in-lecture quizzes using *Kahoot!,* post-lecture assessments through *WayGround*, asynchronous micro-lecturettes, and an escape room generated with AI assistance which was aimed at applying foundational concepts in a dynamic, team-based format. The primary objective of these approaches was to enhance learner engagement and perceived understanding of complex content in an A&P I course for first -semester nurse anesthesia residents.

FRAMEWORK

Gamified strategies in this course were intentionally aligned with Keller's Attention, Relevance, Confidence, and Satisfaction (ARCS) Model of Motivational Design to guide the development of engaging and learner-centered instructional components. Developed by John Keller in 1987, the ARCS model outlines 4 key elements; attention, relevance, confidence, and satisfaction, that support the systematic design of instruction aimed at increasing learner motivation.[16] Using this framework, gamified elements were selected and integrated to address the motivational challenges commonly encountered in rigorous nurse anesthesia coursework.

In the context of nurse anesthesia education where content is dense, pace is rapid, and cognitive demands are high, maintaining learner motivation is essential for long-term success and the ARCS model offered a structured approach for designing instructional activities. *Kahoot!* and *WayGround* were incorporated with the intent of capturing and sustaining learner attention through competitive, interactive, and formative assessments that introduced variation into lecture-based sessions. These platforms were also used to support confidence-building, as they provide immediate feedback and enable learners to gauge their current understanding in a low-stakes environment.[17] To enhance relevance, a series of anesthesia-specific escape room activities were created embedding key physiological and clinical concepts into case-based problem-solving tasks that require application of knowledge, teamwork, and clinical

Table 1. Effects of AI & Gamification on Nurse Anesthesia Education

Intervention	Impact	Outcomes	Challenges	References
AI Simulations	Deepens engagement & supports individualized learning	Improves critical thinking & learner satisfaction	Increase cognitive load & ethical considerations	3,4,6
Gamification	Increases motivation & active participation	Enhances knowledge retention & self-efficacy	Superficial engagement & cultural fit concerns	7,10-13
Combined AI & Gamification	Immersive with real-time feedback	Greater preparedness and skill acquisition	Integration complexity and learner anxiety	3,4,7,12

reasoning.[18] Collectively, these design choices allowed the course structure to intentionally reflect the motivational components of the ARCS model, ensuring that gamified tools were purposefully integrated rather than added superficially.

THE LEARNER

The A&P I course enrolled 18 first-semester nurse anesthesia residents, representing a diverse mix of clinical backgrounds and demographics. Learners ranged in age from 25 to 37 years (mean: 29.6 years) and predominantly resided in Pennsylvania (67%), with additional representation from Maryland (28%) and Indiana (6%). All students entered the program with the required critical care foundation, bringing between 3 and 14 years of experience (median: 5 years). The majority had worked in Open Heart or Cardiothoracic (CT) Intensive Care Units (ICU), followed by Surgical, Medical, Pediatrics ICUs and 1 resident was a member of the Critical Care Air Transport Team (CCATT) prior to starting the program. Several learners contributed unique expertise from the military and aeromedical evacuation environments, further broadening the diversity of the cohort. Collectively, these backgrounds provided a rich clinical context that informed classroom discussion, supported engagement with complex physiological content, and shaped how learners interacted with the gamified instructional strategies used throughout the course. See Table 2 for demographic characteristics of the learners enrolled in the course.

LEARNING ENVIRONMENT

METHODS AND EDUCATIONAL STRATEGIES USED

KAHOOT!

Kahoot!, a live quiz-based learning platform, was strategically integrated into lecture sessions to reinforce content and sustain learner attention which is a key component of the ARCS model.[16] Quizzes were administered after the first hour of lecture and again after the second and third hour, intentionally interrupting extended lecture segments to re-engage learners. This pacing created predictable opportunities for active recall, reinforcing newly introduced material while offering brief mental breaks from prolonged didactic content.[19] Because learners anticipated these checkpoints, learners exhibited a heightened attentiveness, likely driven by the increasingly competitive nature of the cohort once *Kahoot!* was implemented.

Kahoot!'s gamified and competitive structure promoted focused participation, as learners were motivated to perform well while simultaneously enjoying the social dynamics of gameplay.[19,20] In this high-performing nurse anesthesia cohort, the competitive, yet playful, environment enhanced attentiveness and strengthened peer connection. This manifested as livelier discussion, more frequent requests for clarification during lecture, and an overall increase in classroom engagement. Learners often cheered for one another or exchanged spirited teasing, especially when a classmate made an unexpected "podium comeback." Achieving a 'top-three' placement became a moment of celebration, eliciting laughter, pride, and fist-bumps, which transformed the traditional lecture setting into a socially rich and encouraging learning environment.

The cohort's experience using these tools are consistent with existing literature supporting the educational value of *Kahoot!*. A recent meta-analysis reported an average effect size of 0.772 (95% CI 0.540–1.004), indicating a significant moderate positive effect on academic achievement.[19] The analysis also identified a large positive impact on retention (average effect size = 1.492), suggesting that learners who used *Kahoot!* exhibited substantially higher retention of the material compared to non-users.[19] Additionally, an article exploring the influence of *Kahoot!* on learning outcomes showed significantly improved motivation, engagement, enjoyment, and concentration, reinforcing its role as a tool that not only enhances cognitive outcomes, but also strengthens affective dimensions of learning.[20]

WAYGROUND

WayGround, formerly known as *Quizizz*, was implemented as a post-class, formative, low-stakes assessment tool designed to reinforce key concepts and promote learner reflection. Each quiz consisted of 10–12 multiple-choice questions drawn directly from the lecturer's PowerPoint slides to ensure alignment with the content presented in class. Nurse anesthesia residents were required to complete the activity within 12 hours of the lecture, ideally while the material was still fresh. In contrast to *Kahoot!,* which emphasized real-time, competitive interaction, *WayGround* offered a self-paced and relaxed environment, enabling residents to progress through questions at their own speed and receive immediate feedback.[21] The assessment was deliber-

Table 2. Demographic Characteristics of Learners Enrolled in Anatomy & Physiology I (N = 18).

Variable[a]	Category / Statistics	n (%) or Value
Home State	Pennsylvania	12 (67%)
	Maryland	5 (28%)
	Indiana	1 (6%)
Age (years)	Mean	29.6 (approx.)
	Range	25–37
Critical Care Background	Open Heart ICU; CTICU	8 (44%)
	Surgical ICU; CCATT	7 (39%)
	Pediatric ICU	1 (6%)
	Medical ICU	1 (6%)
	Shock Trauma	1 (6%)
Years of Critical Care Experience	Median (Range)	5 years (3–14 years)
Military Experience	Prior military service	3 (17%)

[a]Categories reflect self-reported professional experience, grouped by clinical specialty.

ately non-punitive and framed as a self-check to build confidence without the pressure of grading, encouraging learners to take ownership of their knowledge retention and identify areas for review.

Although the platform underwent a name change during the educational intervention period, the existing body of research, still published under *Quizizz,* consistently identifies it as an effective tool for assessing retention and engaging learners in the instructional process.[21-23] Studies describe its strengths as promoting motivation, reinforcing learning, and supporting active engagement.[21-23] At the same time, a recent article noted important limitations, including technological glitches and variability in question difficulty, highlighting that the effectiveness of digital learning tools is highly dependent on the quality of the instructional design and instructor familiarity with the platform.[21] These considerations show that while technology-enhanced formative assessment can be useful, its success relies heavily on intentional implementation and faculty readiness.

LECTURETTES: A FORM OF MICROLEARNING

Lecturettes, or short, focused micro-lectures, were piloted during the hematology unit to explore whether breaking complex content into smaller, digestible segments could enhance learner comprehension and perceived retention. This strategy was intentionally designed to address the high cognitive load associated with foundational hematology topics including the oxygen-carrying capacity equation, the oxygen-hemoglobin dissociation curve, the clotting cascades, and ABO/Rh compatibility during the first semester of nurse anesthesia training. To implement this approach, the traditional lecture structure was reorganized into 3 distinct modules: *Blood Overview, Coagulation,* and *Hemostasis,* enabling residents to engage with concentrated blocks of related material 1 segment at a time.

Microlearning is recognized as an innovative pedagogy that delivers tightly focused, well-planned instructional units aimed at improving processing efficiency.[24] Each lecturette in this pilot promoted targeted learning and was reinforced with corresponding PowerPoint visuals to support concept clarity.[24] Importantly, the lecturette format also aligned with the course's broader gamification strategy by creating natural checkpoints where interactive tools such as *Kahoot!* quizzes or *WayGround* self-checks could be embedded to promote active recall and reinforce key concepts immediately following each micro-lesson. This design helped maintain engagement while reducing cognitive load, a central goal of both microlearning and gamified instruction.[24,25]

A recent systematic review and meta-analysis of microlearning in higher education, found that students who engaged in microlearning (n = 344) demonstrated significantly higher academic performance compared to those taught via macro-learning approaches (n = 310, P = .03).[26] The authors concluded that microlearning improves academic performance by reducing cognitive load, increasing learner focus, and providing a more flexible, adaptive learning environment.[26] These findings align with the positive outcomes reported in the gamification literature, where breaking learning into shorter, interactive segments has been associated with enhanced attention, motivation, and retention.[3,6,24] Overall, the incremental delivery model created built-in pauses for comprehension which is an important consideration for novice nurse anesthesia residents encountering dense physiological material for the first time.

ESCAPE ROOM USING CHATGPT

An interactive escape room activity was developed as a capstone review for foundational physiology content, specifically guiding learners through the sequential pathway from the neuronal action potential to skeletal muscle contraction. The purpose of this activity was to reinforce complex material using an approach that emphasized active learning and collaboration.[27] ChatGPT was used during the design phase as a creative aid to generate content-aligned puzzles, narrative elements, sequencing challenges, and physiologic

clues, which helped streamline development and ensure conceptual consistency across the activity. Specifically, the platform assisted with early-stage brainstorming, drafting preliminary puzzle concepts, and suggesting themes aligned with the targeted physiological learning objectives. Iterative prompting was utilized to align clues with course content and ensure that tasks required application of foundational concepts rather than rote memorization.

All educational content, learning objectives, final puzzle mechanics, and assessment strategies were developed, reviewed, and approved by the course faculty. ChatGPT-generated ideas were critically evaluated for scientific accuracy, relevance to nurse anesthesia education, and alignment with curricular goals prior to implementation. Faculty further modified scenarios to reflect realistic clinical contexts, appropriate cognitive load for learners, and consistency with existing instructional materials. Importantly, ChatGPT did not interact with students nor analyze learner performance data. Its role was limited to supporting faculty creativity and efficiency during the instructional design process.

Nurse anesthesia residents worked in small groups to "escape" by solving a series of interconnected challenges that required the application of key physiological principles. Tasks included sequencing ion channel events, interpreting membrane potential graphs, identifying neurotransmitter pathways, and mapping the steps of excitation-contraction coupling. This gamified learning experience aligned strongly with the ARCS model as it captured the learner's attention through innovation and immersion of the material, promoted relevance through direct alignment with required physiology competencies, supported confidence as teams successfully progressed through clues, and enhanced satisfaction upon "escaping" the room as a team.[16,27]

Evidence supporting educational escape rooms in nursing is emerging. A systematic review noted that although escape rooms are increasingly used in nursing education, implementation is often limited by technological constraints, making it difficult to broadly evaluate their full educational impact.[27] Despite these challenges, escape rooms can significantly improve critical thinking, problem-solving, motivation, and retention, highlighting their potential as additional instructional approaches.[28] Within anesthesia education specifically, most published escape rooms have focused on simulation-based crisis management, such as airway emergencies or high-acuity perioperative events.[29,30] Far fewer have been designed to target didactic foundational sciences, demonstrating both the novelty and importance of integrating gamified escape room methods into preclinical anesthesia coursework.

This project was implemented as part of routine curricular improvement and program evaluation aimed at enhancing learner engagement and educational quality. Under institutional guidelines, formal Institutional Review Board (IRB) review was not required for this activity. All data were collected for instructional and quality-improvement purposes, analyzed in aggregate, and reported without identifying information.

RESULTS

This section summarizes findings from the Pre-Gamification Survey, Post-Gamification Survey, and Escape Room Evaluation conducted in the A&P I course for first semester nurse anesthesia residents. The purpose of these assessments was to explore learners' perceptions of engagement, motivation, and perceived learning following the introduction of gamified instructional strategies. Of the 18 enrolled nurse anesthesia residents, 17 completed the pre-survey, 14 completed the post-survey, and 16 completed the escape room evaluation. All surveys were administered through the institutional learning platform (*Qualtrics*). The lower response rate for the post-survey may be attributed to the timing of its distribution. The survey was available during a period when students were preparing for final examinations and end-of-semester requirements, which may have limited their availability to complete the survey and contributed to the reduced participation.

PRE-GAMIFICATION RESULTS

The pre-survey, distributed at the beginning of the semester, showed that learners generally entered the course with positive attitudes toward interactive learning. Eighty-two percent agreed that they enjoy classroom activities involving games or interactive elements, yet only 6% strongly agreed that they could easily maintain focus during traditional lectures, suggesting moderate comfort but not strong preference for conventional formats. Learners expressed high confidence (89%) in their ability to understand complex physiological content, and 94% expressed openness to trying unconventional instructional strategies. Analysis of open-ended responses revealed 3 primary themes. See Table 3 for pre-gamification survey qualitative themes.

Qualitative responses emphasized a strong preference for visual learning, repetition, active recall, and applied learning. Participants described themselves as highly receptive to new teaching approaches, particularly those that provided variety and broke up long lecture periods. The Pre-Gamification Survey and corresponding quantitative results for all Likert-scale questions are provided in Appendix A.

POST-GAMIFICATION RESULTS

The post-survey, administered 1 week prior to the final exam, revealed positive perceptions of the gamified strategies used throughout the course. Most of the respondents (86%) strongly agreed that activities such as *Kahoot!, WayGround*, and the escape room increased their engagement, and all found the tools easy to use. Although 79% 'agreed' or 'strongly agreed' that they felt they retained information more effectively than with traditional methods, these findings reflect perceived, rather than measured, retention. Qualitative feedback showed consistent appreciation for the low-stakes competition, immediate feedback, and active breaks from routine lecture structures. Learners valued the opportunity to assess their own comprehension in real time and identified this as a helpful cue for targeted study-

Table 3. Pre-Gamification Survey Qualitative Themes

Preference for Visual & Repetitive Learning	Learners frequently describe themselves as visual learners who benefit from diagrams, drawing pathways, and repeated exposure.
Desire for Active & Applied Learning	Many expressed interests in interactive techniques such as discussion, teach-back, practice questions, and hands-on elements.
Openness to Non-Traditional Methods	Several noted a willingness to try innovative approaches, particularly those that break up long lecture periods.

Table 4. Post-Gamification Survey Qualitative Themes

Enhanced Engagement Through Competition and Variety	Learners appreciated low-stakes competition, immediate feedback, and the break from traditional lecture routines.
Value of Immediate Self-Assessment	Activities helped students gauge comprehension and identify areas for targeted studying.
Technology-Related Challenges	Reported barriers included internet issues, *WayGround* expiration timing, and desire for clearer instructions prior to activities.
Suggestions for Expansion	Learners requested longer games, more post-class review options, and broader integration across the curriculum.

ing. Reported challenges centered primarily on technology issues and the desire for clearer instructions before activities. Qualitive themes from the Post-Gamification Survey can be found in Table 4.

Suggestions for improvement included expanding the length or frequency of games, offering more post-class review opportunities, and enhancing technological support. The Post-Gamification Survey and corresponding quantitative results for all Likert-scale questions are provided in Appendix B.

ESCAPE ROOM EVALUATION

The escape room evaluation further reflected strong learner enthusiasm. Sixteen residents completed this survey immediately after the activity, with 81% strongly agreeing that the puzzles effectively reinforced the content and all reporting that the activity promoted critical thinking and problem-solving. Learners overwhelmingly described the escape room as fun, engaging, and the "highlight of the semester." In addition, all survey participants expressed interest in implementing the activity in subsequent courses. Qualitative responses indicated that learners valued the balance between challenge and enjoyment, the opportunity to collaborate, and the interactive reinforcement of physiology concepts. Some participants suggested improving flow through clearer instructions or auditory cues, and others expressed interest in expanding the activity to include more questions or additional stations. See Table 5 for escape room evaluation qualitative themes.

Overall, learners perceived the escape room as an engaging and productive way to apply complex material reinforcing lecture content. The Escape Room Evaluation and corresponding quantitative results for all Likert-scale questions are provided in Appendix C.

LIMITATIONS

This project has several limitations that should be considered when interpreting the findings. The small sample size (N = 18) limits the generalizability of results. Attrition between the pre- and post-surveys (from 17 to 14 respondents) introduces the possibility of response bias, as individuals with more positive perceptions may have been more likely to complete the post-survey. Because all outcomes were self-reported, the findings represent perceptions of learning rather than objective measures of knowledge acquisition or retention. Additionally, faculty involvement in the implementation of gamified activities may have influenced learner responses, and participants may have provided favorable feedback due to the simple novelty of gamification in the course. Finally, technological challenges may have influenced learner experiences but were not measured systematically.

DISCUSSION

The implementation of gamification strategies in this nurse anesthesia course resulted in several notable benefits, most prominently increased learner engagement, heightened motivation, and positive perceptions of the learning experience. These findings are consistent with a growing body of literature suggesting that gamification can enhance learner interest and foster more active participation in health professions education.[10,13] In addition, gamified strategies offer opportunities for immediate feedback, active recall, and peer interaction factors known to support learner engagement and satisfaction.[9,10]

In this educational intervention, nurse anesthesia residents reported feeling more motivated, more engaged, and better able to monitor their own learning following the implementation of gamified elements such as *Kahoot!, WayGround*, lecturettes, and the escape room. The surveys used in this project were perception-based and did not include

Table 5. Escape Room Evaluation Qualitative Themes.

High Enjoyment and Engagement	Learners consistently described the activity as a "highlight of the semester."
Perceived Reinforcement of Course Content	Many reported the activity helped integrate concepts, though a few felt it reinforced more than it taught new material.
Team Collaboration as a Strength	The group-based nature supported communication and shared reasoning.
Suggestions for Improving Flow and Clarity	Requests included auditory confirmation cues, clearer starting instructions, and more structured progression.
Expanded Scope Desired	Learners suggested adding more questions, expanding to multiple rooms or stations, and using escape rooms for broader exam review.

performance metrics or pre/post assessments of knowledge. Therefore, conclusions regarding actual learning gains or long-term retention cannot be drawn. Instead, the results highlight the value of gamification in supporting motivational and affective dimensions of learning, which are important precursors to deeper engagement with course material.

Each of the gamified strategies was designed to be a low-stakes challenge that provided immediate feedback to the learner. The escape room was consistently identified as one of the most enjoyable and memorable components of the course. Learners described it as an opportunity to actively apply physiological concepts in a collaborative, low-pressure environment that encouraged critical thinking and problem-solving. The integration of AI (ChatGPT) during the design process further demonstrated the potential of emerging technologies to support faculty creativity, reduce development time, and enhance instructional design coherence.

A notable aspect of this initiative was its feasibility and low resource burden. The digital quiz platforms were freely available, required minimal setup, and integrated easily into the existing learning environment. Likewise, the escape room relied on creative use of space and simple materials rather than costly technology. This highlights that effective gamification does not require extensive budgets or sophisticated equipment, but rather, thoughtful design.

The findings highlight the promise of gamification as a practical and learner-centered instructional approach within nurse anesthesia education. Future research should incorporate objective performance measures to evaluate the impact of gamification on actual learning outcomes, examine use across the curriculum, and explore applications within simulation-based training and clinical decision-making situations.

CONCLUSION

Gamified instructional strategies, including digital quizzes, microlearning lecturettes, and a physiology-based escape room, were well received by first-semester nurse anesthesia residents and were associated with improvements in engagement, perceived retention, and overall learning experience. Looking forward, 2 key challenges present: designing learning experiences that meet the diverse needs and preferences of nurse anesthesia residents, and ensuring faculty have the training and support needed to adopt these innovative approaches. By embracing pedagogically sound innovations, supporting faculty development, and remaining attentive to learner feedback, nurse anesthesia programs can cultivate educational environments that are rigorous, responsive, and in alignment with the evolving demands of advanced practice nursing.

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APPENDICES

APPENDIX A

PRE-GAMIFICATION SURVEY & RESULTS

Q1-Q5: 5-point Likert Scale

Question	Response Option	n (17)	%
Q1. I usually enjoy classroom activities that include game of interactive components.	Strongly Agree	7	41%
	Somewhat Agree	7	41%
	Neither Agree nor Disagree	2	12%
	Somewhat Disagree	1	6%
Q2. I find it easy to stay focused during traditional lectures.	Strongly Agree	1	6%
	Somewhat Agree	12	71%
	Neither Agree nor Disagree	3	18%
	Somewhat Disagree	1	6%
Q3. I feel confident in my ability to retain complex physiological concepts.	Strongly Agree	3	18%
	Somewhat Agree	12	71%
	Neither Agree nor Disagree	2	12%
Q4. I am open to trying new learning methods, even if they are unconventional.	Strongly Agree	11	65%
	Somewhat Agree	5	29%
	Neither Agree nor Disagree	1	6%
Q5. I expect gamification to enhance my understanding of the course content.	Strongly Agree	7	41%
	Somewhat Agree	7	41%
	Neither Agree nor Disagree	2	12%
	Somewhat Disagree	1	6%

Q6-Q7: OPEN ENDED

Q6. Do you have any ideas about implementing different learning techniques into your classes? If so, please share.

Q7. How do you best learn?

APPENDIX B

POST-GAMIFICATION SURVEY & RESULTS

Q1-Q5: 5-point Likert Scale

Question	Response Option	n (14)	%
Q1. The use of digital quizzes and escape room activities increased my engagement.	Strongly Agree	12	86%
	Somewhat Agree	2	14%
Q2. Gamified activities helped me retain information more effectively than traditional methods.	Somewhat Agree	7	50%
	Strongly Agree	4	29%
	Neither Agree nor Disagree	3	21%
Q3. I was more motivated to prepare for and participate in class because of these activities.	Strongly Agree	6	43%
	Somewhat Agree	6	43%
	Neither Agree nor Disagree	2	14%
Q4. The gamified tools used in this course were easy to understand and use.	Strongly Agree	11	79%
	Somewhat Agree	3	21%
Q5. I would recommend using similar strategies in other courses.	Strongly Agree	10	71%
	Somewhat Agree	4	29%

Q6-Q8: OPEN ENDED

Q6. What did you like most about the gamified activities?

Q7. What challenges or barriers did you experience?

Q8. How could these activities be improved?

APPENDIX C

ESCAPE ROOM EVALUATION & RESULTS

Q1-Q5: 5-point Likert Scale

Question	Response Option	n (16)	%
Q1. The puzzles reinforced the content effectively.	Strongly Agree	13	81%
	Somewhat Agree	3	19%
Q2. I made new insights or connections with the content taught in class during the	Strongly Agree	7	44%
	Somewhat Agree	6	37%

Question	Response Option	n (16)	%
escape room.	Neither Agree nor Disagree	3	19%
Q3. The escape room promoted critical thinking and problem-solving.	Strongly Agree	16	100%
Q4. The escape room was fun, engaging, and a productive experience.	Strongly Agree	15	94%
	Somewhat Agree	1	6%
Q5. I would like to do an escape room in AP II.	Strongly Agree	16	100%
Q6. I would recommend doing the escape room for the next cohort.	Strongly Agree	15	94%
	Somewhat Agree	1	6%

Q7: OPEN ENDED

Q7. Please share thoughts about the escape room experience. What improvements would you make?