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Gamification as a learning strategy in the training of health science professionals in surgery: a systematic review.

Gamificación como estrategia de aprendizaje en la formación de profesionales de ciencias de la salud en cirugía: revisión sistemática.

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Summary.

The training of healthcare professionals faces significant challenges due to the constant evolution of pedagogical methodologies and technological tools applied to learning. The incorporation of disruptive educational technologies has transformed learning environments, both in the classroom and in clinical settings, fostering more dynamic, interactive, and student-centered learning experiences. These technologies facilitate the development of competencies and the simulation of clinical contexts, enabling the acquisition of essential skills and knowledge for professional practice in the healthcare field. **Objective:** To describe the different gamification strategies applied to the learning and training of healthcare professionals in the surgical context. **Methodology:** A systematic literature review was conducted using databases such as PubMed, Bireme, SpringerLink, Sage, Embase, Scopus, and ProQuest, employing a search strategy based on standardized terms. Data related to technological tools and the use of gamification in surgery were collected. **Results:** Nineteen articles were included in the review, with emphasis on the type of study, the surgical procedures in which gamification was implemented, the technological tools used, the platforms employed, and the specific elements of gamification. **Conclusion:** The implementation of gamified strategies positively influences the development of skills in surgical contexts.

Keywords: Gamification, Game-based learning, Serious games, Surgery, Technology-mediated learning

Resumen.

La formación de los profesionales en ciencias de la salud enfrenta importantes desafíos debido a la constante evolución de las metodologías pedagógicas y de las herramientas tecnológicas aplicadas al aprendizaje. La incorporación de tecnologías educativas disruptivas ha transformado los entornos formativos, tanto en el aula como en los escenarios clínicos, favoreciendo experiencias de aprendizaje más dinámicas, interactivas y centradas en el estudiante. Estas tecnologías facilitan el desarrollo de competencias y la simulación de contextos clínicos, permitiendo la adquisición de habilidades y conocimientos esenciales para el ejercicio profesional en el ámbito de la salud. **Objetivo:** Describir las diferentes estrategias de gamificación aplicadas al aprendizaje y formación de profesionales de ciencias de la salud en el contexto quirúrgico. **Metodología**: Se realizó una revisión sistemática de la literatura mediante búsquedas en bases de datos como PubMed, Bireme, SpringerLink, Sage, Embase, Scopus y ProQuest, utilizando una estrategia de búsqueda construida a partir de términos normalizados. Se recopilaron datos relacionados con las herramientas tecnológicas y el uso de la gamificación en cirugía. **Resultados**: Se incluyeron 19 artículos en la revisión, con énfasis en el tipo de estudio, los procedimientos quirúrgicos en los que se implementó la gamificación, las herramientas tecnológicas utilizadas, las plataformas empleadas y los elementos propios de la gamificación. **Conclusión:** La implementación de estrategias gamificadas influye positivamente en el desarrollo de habilidades en contextos quirúrgicos.

Palabras clave: Gamificación, Aprendizaje basado en juegos, Juegos serios, Cirugía, Aprendizaje mediado por tecnología

1. Introduction

Gamification can be defined as the intentional incorporation of game elements, dynamics, and mechanics into non-game contexts with the purpose of promoting motivation, engagement, active participation, and meaningful learning; in the educational field, especially in the training of health science professionals (1-2). This strategy seeks to transform traditional teaching models through interactive experiences based on challenges, continuous feedback, rewards, progression, and cooperative work, oriented towards the development of skills and the resolution of real-world problems (3-4).

Gamification has emerged as a teaching and learning strategy characterized by its immersive and motivational nature. It also enables the self-regulated and autonomous development of creative, investigative, and technological skills (5-6). The integration of game mechanics, interactive environments, and real-time feedback systems has been shown to improve motivation, knowledge retention, skills transfer, and problem-solving abilities in clinical and surgical settings. However, despite its benefits, implementing gamification in professional health training programs remains a challenge, with limited standardization in its application and impact assessment (7).

Furthermore, gamified experiences support Kolb's four stages of experiential learning—concrete experience, reflection, conceptualization, and active experimentation—as well as challenge-solving and continuous feedback, allowing students to analyze their performance and progress through learning cycles. In turn, Self-Determination Theory is related to gamified elements such as levels, rewards, badges, and progression, which strengthen intrinsic motivation (8-10). Finally, Flow Theory is linked to immersive design and the progressive levels of difficulty present in gamified strategies, fostering states of concentration and sustained engagement that allow for correlating self-perception of learning with the achievement of objectives associated with the development of technical skills, decision-making, and communication abilities.

The training of health science professionals faces constant challenges due to the evolution of teaching methodologies and technological learning tools. The incorporation of disruptive educational technologies has transformed learning environments, enabling interactive and student-centered experiences, which has driven a paradigm shift in education (11-12). However, the transition from traditional pedagogical models, based on empiricism and behaviorism, to more dynamic and experiential approaches remains a challenge. Factors such as anxiety, stress, and depression have been shown to impact student learning, highlighting the need for strategies that promote both the development of technical skills and emotional well-being (13-15).

In accordance with the above, the objective is to analyze the implementation of gamification as a learning strategy for training healthcare professionals in the surgical context. Based on the characterization of the studies, it will be possible to identify the strategies, dynamics, and mechanics used for gamification in surgical contexts as reported in the scientific literature.

2. Methods

This study is a descriptive and documentary systematic literature review aimed at describing the different gamification strategies applied in the learning and training of healthcare professionals in the surgical context. The *Joanna Briggs Institute Manual for Evidence Synthesis* (2021) (16) was used as a reference for the methodological development, supplemented by the AMEE 94 guide Systematic Reviews in Medical Education: A Practical Approach (17), which provided practical guidance for the development and application of systematic reviews in medical education. The synthesis of the findings was carried out using a qualitative approach based on a thematic analysis of the literature. The review was structured according to the PICOT strategy:

- **P (Participants):** students and health science professionals in training related to surgical contexts.
- **I (Intervention):** implementation of gamification strategies applied to learning in surgery.
- **C (Comparison):** traditional teaching methods.
- **O (Results):** development of technical and non-technical skills, retention of knowledge, motivation and strengthening of the learning process in surgical contexts.
- **T (Time):** publications between 2015 and 2025.

2.1 Search Strategies

The information was collected in Spanish, English, and Portuguese, using keywords from the DeCS (Health Sciences Descriptors) and MeSH (Medical Subject Headings) thesauri, which were applied to the PubMed, Bireme, SpringerLink, Embase, Scopus, and ProQuest databases. The data collection period was 10 years (2015-2025), and the following search terms were used:

- Gamification AND (medical education OR ("health professional" AND "education) AND surgery
- Gamification AND medical education AND surgery
- (Gamificação OR "Jogos sérios") AND ("medical education" OR ("professional* da saúde" AND educação) AND cirurgia
- (Gamification OR "Serious Games") AND ("medical education" OR ("healthcare professional*" AND education) AND surgery

The inclusion criteria were gamification focused on skills development at all levels of training in surgical contexts and a description of the gamification strategy (scoring, sequencing, avatars). The exclusion criteria were the use of gamification for skills development in animal surgery and healthcare professionals not enrolled in a formal education program.

For the organization and management of the information collected during the review, Rayyan software was used, which facilitated the import, classification, and filtering of the selected articles according to the inclusion and exclusion criteria. Subsequently, a data extraction matrix was constructed to systematize related variables such as: type of gamification employed, technological tools and media used, participant's level of training, surgical context, and reported learning outcomes.

3. Results

The search strategy conducted in five indexed databases identified a total of 275 articles. Of these, 31 were removed due to duplication and 10 for not meeting the eligibility criteria. Subsequently, 40 documents corresponding to letters to the editor and conference proceedings were discarded. Finally, an additional 216 articles were excluded for not meeting the established inclusion criteria. As a result, 19 articles were included in the review. The complete selection process is summarized in the PRISMA flow diagram. Table 1 shows the matrix of key findings from the 19 studies included in the review.

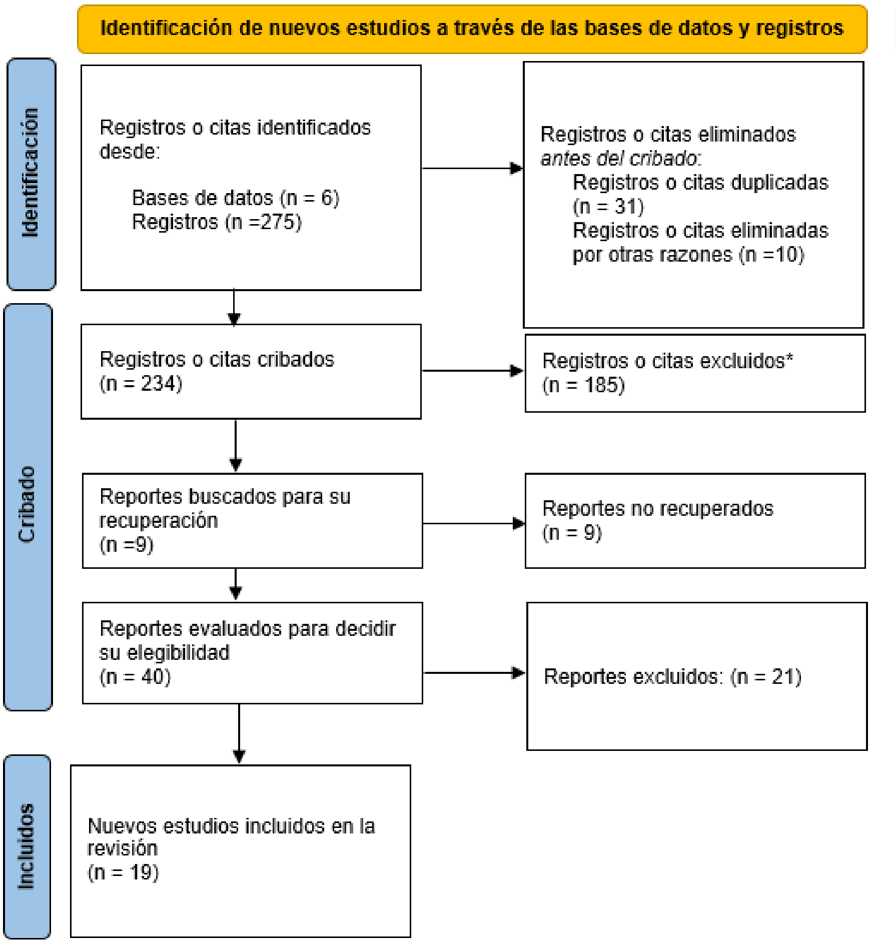

Figure 1. PRISMA diagram.

Source. Haddaway, NR, Page, MJ, Pritchard, CC, and McGuinness, LA (2022). PRISMA2020: An R package and Shiny application for producing PRISMA 2020-compliant flowcharts, with interactivity for optimized digital transparency and open synthesis. Campbell Systematic Reviews, 18, e1230. https://doi.org/10.1002/cl2.1230

3.1 Characterization of the methodologies in the studies

Among the most relevant findings regarding the methodology employed, the quasi-experimental and descriptive study designs stand out, as well as the controlled trials in the student exposure groups. In the studies that used gamification in intervention or controlled trials, it was evident that it is aimed at postgraduate students. The specialties in which the greatest use of these tools is observed are general surgery residency programs at the postgraduate level, and at the undergraduate level, among medical and surgical nursing students. It is important to highlight that, in the articles that include residents in training, gamification is mainly used during the first years of their medical-surgical specialty (19, 31). Similarly, some authors, such as Nakamoto et al. (30), describe the implementation experience using quasi-experimental designs, successfully integrating these tools into postgraduate training and demonstrating a 50% improvement in robotic surgery skills across various surgical disciplines (30). In this regard, another author suggests that a controlled trial with general surgery residents improved the identification of operating room problems related to laparoscopic procedures. Participants were exposed to a game-based learning curriculum, achieving a 59% improvement compared to 33% for students who did not participate in the gamified strategy. These results were evaluated using a post-test and the overall score obtained on the gamification tool (21).

3.2 Findings related to learning and performance

Hosseini (27), using a quasi-experimental design, exposed one group of students to a gamified game for learning surgical instruments, while the other group received only lectures. The groups were evaluated using an OSCE (Objective Structured Clinical Examination) (24). Similarly, Akbari (26) described his studies as multicenter and quasi-experimental. He randomly assigned two groups of students: 27 to game-based training and 24 to lecture-based training. The results for the group exposed to gamification were 40% better than those of the students who received a more traditional methodology (23). Overall, these authors obtained positive results by exposing students to technology-mediated tools, demonstrating positive outcomes measured using valid and feasible instruments.

The objectives of these studies clearly focus on evaluating the implementation and use of these tools among various healthcare professionals, exploring competency development, increased engagement and motivation, and their influence on the teaching and learning process. Overall, the studies reflect a growing interest in integrating innovative methodologies that promote more dynamic and student-centered training.

Regarding the learning objectives proposed by the authors, these converge on the safe development of surgical skills, as well as technical and cognitive competencies. Studies suggest that greater exposure to these types of tools promotes learning in environments where students can make mistakes and learn from them (20, 23, 32). However, some authors do not focus exclusively on strengthening technical skills, but also on developing socio-emotional competencies, such as decision-making based on clinical cases and the identification of problems in laparoscopic surgery related to the patient and biomedical equipment (21).

It is important to highlight how gamification can be used to develop skills in procedures such as eye trauma, coronary artery bypass, and craniotomies. However, skills development is not limited to surgery; some articles describe its implementation in the basic instruments used in surgery. It is important to mention that one study focuses on the knowledge of what they call surgical sets for each specialty (24).

3.3 Technologies and platforms used for the design and management of gamification

The studies demonstrate the use of interactive mobile platforms such as Touch Surgery (23), which allows users to visualize anatomy and compare the entire surgical procedure, integrating real videos for learning basic skills such as gallbladder dissection from the liver bed, inguinal hernia dissection, and extraction of complicated appendices. Other technological tools were also identified, such as LapBot-Safe Chole (30), an application that guides the safe dissection of the hepatocystic triangle and provides automatic feedback using artificial intelligence. Platforms like PlaSurIn (25) and ENT SURGERY SET'S (26), educational software designed for developing technical skills related to the recognition and use of surgical instruments, were also included. The GEN platform (22), for its part, is conceived as an integrated network aimed at health sciences students. Along the same lines, robotic simulators with virtual reality (VR) components stand out, such as SimNow (Da Vinci) (29), which offers high-fidelity simulation, cloud-based performance tracking, and real-time virtual clinical scenarios.

3.4 Mechanics, dynamics and strategies used in gamification

Regarding the mechanics used in the articles, an intuitive design stands out, allowing students to engage in active learning. Students complete practical tasks and receive individual scores and a global ranking, thus facilitating personalized progress. Interaction mechanics such as drag and drop, immediate feedback, and step-by-step evaluation allow students to continuously monitor their performance. Some include checklists and various types of grading to reinforce learning. Furthermore, the environment, which creates a sense of urgency when incorrect answers are made, fosters intrinsic motivation in students, encouraging them to continue through the game levels.

The relationship between the dynamics, mechanics, and strategies identified in gamified experiences, the elements of each game, and how they are integrated into the teaching and learning process allows students to maintain active participation throughout the acquisition of the proposed outcomes. In turn, strategies such as immediate feedback, adaptive learning, deliberate repetition, and the progressive resolution of challenges facilitate self-assessment and continuous improvement of performance.

From an experiential learning perspective, strategies such as immediate assessment, role-playing, and problem-solving enable cycles of concrete experience, reflection, conceptualization, and active experimentation through repetitive practice and error analysis in safe environments. Furthermore, Self-Determination Theory demonstrates how rewards, progressive levels, and recognition strengthen students' autonomy, perceived competence, and intrinsic motivation.

Finally, Flow Theory explains how immersive scenarios, progressive challenges, and interactive simulations promote states of sustained concentration and commitment to learning, fostering the gradual development of technical, cognitive, and decision-making skills in surgical contexts.

Similarly, it's important to mention that the use of advanced technologies such as artificial intelligence (AI) with deep neural networks allows for feedback based on the recognition of real images and expert-supervised training. Furthermore, some platforms offer online virtual mentors, available when frequent errors are detected. While most have time limits, there are also applications without time limits that allow for the repetition of procedures as part of the learning process.

Table 1. Revision of the included articles.

Title (reference)	Year	Formation level	Surgical procedures
Gamification in thoracic surgical education: Using competition to fuel performance (18)	2015	Cardiovascular residents	Vascular anastomoses
Simulation-based training for burr hole surgery instrument recognition (19)	2016	Neurosurgery Residents	Craniotomy
Validation of the mobile serious game application Touch Surgery™ for cognitive training and assessment of laparoscopic cholecystectomy (20)	2017	General Surgery Residents	Laparoscopic cholecystectomy
Game-based training improves the surgeon's situational awareness in the operation room: a randomized controlled trial (21)	2017	General Surgery Residents	Laparoscopy
Touch Surgery: a Twenty-First Century Platform for Surgical Training (22)	2018	Undergraduate students	Neurosurgery, general surgery, ophthalmology
An Educational Network for Surgical Education Supported by Gamification Elements: Protocol for a Randomized Controlled Trial. (23)	2020	Medical students	Subcutaneous suturing in different types of wounds
Evaluation of Surgical Improvement of Clinical Knowledge Ops (SICKO), an Interactive Training Platform (24)	2021	General Surgery Residents	Laparoscopic appendectomy and cholecystectomies
Using gamification to increase resident engagement in surgical training: Our experience with a robotic surgery simulation league. (25)	2022	General Surgery Residents	Laparoscopic procedures
Comparison of the effects of virtual training by serious game and lecture on operating room novices' knowledge and performance about surgical instruments setup: a multi-center, two-arm study (26)	2022	Undergraduate Nursing	Basic surgical instruments
Can gamified surgical sets improve surgical instrument recognition and student performance retention in the operating room? A multi-institutional experimental crossover study (27)	2023	Health sciences undergraduates	Instruments for procedures: General surgery, orthopedics
Puzzle game-based learning: a new approach to promote learning of principles of coronary artery bypass graft surgery (28)	2023	Surgical nursing students	Coronary artery bypass surgery
EndoTrainer: a novel hybrid training platform for endoscopic surgery (29)	2023	Gynecology, Urology	Hysteroscopies and cystoscopies
Gamification of robotic simulation to train general surgery residents (30)	2023	General Surgery Residents	Surgeries on abdominal organs
Serious gaming and virtual reality in the multimodal training of laparoscopic inguinal hernia repair: a randomized crossover study (31)	2023	General Surgery Residents	Inguinal hernia
Effectiveness of gamification-based teaching in approach to eye trauma: a randomized educational intervention trial. (32)	2024	Ophthalmology Residents	Ocular trauma and foreign bodies in the eyeball
LapBot-Safe Chole: validation of an artificial intelligence-powered mobile game app to teach safe cholecystectomy. (33)	2024	General Surgery Residents and medical stduents	Laparoscopic cholecystectomy
Design and Effect of Neurosurgical Educational Software Using Gamification on Students' Learning and Motivation – PMC (34)	2024	Medicine, Surgical Nursing	Peripheral nerve surgery, brain surgery, and spinal surgery
Integrating UVCeed Technology into Operating Rooms: A Narrative Review of Its Applications and Efficacy (35)	2025	Surgical Nurses, Orthopedic Surgeons	Orthopedic procedures
Use of virtual simulation for regenerative endodontic training: randomized controlled trial (36)	2025	Postgraduate Studies in Dentistry/Endodontics	Regenerative endodontic procedures.

Table 2. Relationship between Mechanics, Dynamics and Strategies in Gamification for Surgical Training.

Mechanics	Dynamics of learning	Strategies pedagogical	Theoretical relationship
Points, levels, rewards, and progression	Progress, self-improvement	Continuous feedback, positive reinforcement	Self-determination theory: strengthens competence and autonomy
Badges, achievements, and cumulative scores	Competition, challenge	Avatar customization, playful environment	Flow theory: maintains interest through progressive challenges
Leaderboards, challenges, and sequential goals	Curiosity, engagement	Immediate assessment, adaptive learning	Kolb's experiential learning: promotes reflection and experimentation
Ranking, virtual medals and results comparison	Competence, achievement	Social comparison, extrinsic motivation	Self-Determination Theory: Perception of Competence and Performance
Virtual scenarios, clinical narratives, and interactive objects	Narrative, immersion	Role-playing, intrinsic motivation	Flow Theory: Immersion and Sustained Concentration
Immediate feedback and step-by-step evaluation	Progress, personal growth	Continuous feedback, positive reinforcement	Kolb's experiential learning: critical reflection on experience
Interactive simulation and repetition of procedures	Confidence, deliberate practice, and skill consolidation	Safe training, risk-free repetition, and error-based learning	Kolb and Flow: active experimentation and progressive immersion
Clinical challenges and case resolution	Critical thinking and decision making	Problem-based learning and progressive clinical scenarios	Experiential learning and intrinsic motivation

4. Discussion

Gamification emerged within the context of emerging technologies as an educational strategy aimed at promoting self-directed learning through student motivation and active participation. In this regard, the findings of this review demonstrate a growing interest in implementing gamified strategies in surgical settings and at different levels of health sciences training. These results align with Krishnamurthy's (37) assertion that the application of gamification in hospital settings positively influences the training of healthcare professionals (34-35).

Furthermore, it was identified that the evaluation of gamification implementation at different educational levels is primarily conducted through quasi-experimental studies and controlled trials. The results report that students exposed to gamified strategies show better performance compared to those trained using traditional methodologies, in addition to demonstrating improvements in the development of technical skills, knowledge retention, and motivation towards learning (36-37).

The findings are consistent with recent literature, which promotes gamification as an effective tool for strengthening technical, cognitive, and socio-emotional skills (42-43). Along these lines, several authors agree that incorporating these strategies into curricula and exposing students to highly complex situations, procedures, and environments, such as surgery and critical care areas, fosters active and experiential learning (38-39).

Furthermore, van Gaalen et al. (47), in their systematic literature review, suggest that active learning enhanced by interactive platforms significantly improves the understanding and application of clinical skills. Similarly, they highlight that the integration of hybrid simulators mediated by virtual reality and artificial intelligence technologies strengthens a global trend toward the incorporation of immersive digital environments, which facilitate autonomous learning and the progressive development of clinical competencies (40-42).

Based on the results obtained, it is recommended to strengthen and promote the design and implementation of gamified strategies in surgical training, both at the undergraduate and postgraduate levels, as they have proven effective in developing technical, cognitive, and socio-emotional skills (43-44). Integrating these tools into curricula can boost student motivation and strengthen the learning of competencies specific to each area of training. Furthermore, it is suggested to encourage the use of accessible technological platforms compatible with mobile devices that incorporate immediate feedback, level progression, and immersive dynamics (45-46).

However, although the reviewed studies suggest potential benefits associated with the implementation of gamified strategies in surgical education, it is important to consider the existing barriers to their incorporation in Spanish-speaking contexts. Among the main limitations are the high costs of acquiring and maintaining technological platforms, as well as unequal access to digital resources among educational institutions. These conditions can generate gaps in learning opportunities between students and academic programs, highlighting the need to promote accessible, sustainable tools adapted to the educational and economic realities of Latin American contexts (47).

Finally, it is essential to foster interdisciplinary and interprofessional collaboration in the design and development of these tools, ensuring relevant, up-to-date, and student-centered learning experiences. In conclusion, the implementation of gamified strategies allows for a gradual and safe approach to surgical procedures (48). Furthermore, the accessibility of mobile platforms and the possibility of unlimited repetitions of procedures promote a flexible and personalized practice environment, thus strengthening autonomous learning.

5. Conclusions

- This systematic review suggests that gamification is a pedagogical strategy with high potential for strengthening teaching and learning processes in the surgical training of healthcare professionals. The implementation of these tools fosters flexible, interactive learning environments that can be adapted to students' needs. Furthermore, elements such as level progression, positive reinforcement, and personalized learning experiences contribute to increased intrinsic motivation and interest in learning.
- The included studies show that gamified strategies promote motivation, active participation, and the development of both technical and non-technical skills in students. Similarly, technologies such as simulators, virtual reality, and artificial intelligence can enhance these learning experiences when appropriately integrated into gamification-based pedagogical strategies.

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