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THE ROLE OF GAMIFICATION IN MEDICAL EDUCATION: EXPERIENCE REPORT AND INTEGRATIVE REVIEW

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Abstract: Introduction: Implementing active methodologies often requires a cultural change in educational institutions, teachers and students. In this context, the gamification system, widely accepted by students, represents an innovation, as it makes the learning process more playful and participatory, enhancing the holistic training of academics. **Objectives:** To evaluate student perception of the gamification strategy in medical education, as well as to provide an integrative review of the literature on this subject. **Methodology:** Word searches, crossword puzzles and the online games Kahoot and Quizizz were used to review pathology content with second to fifth year medical students and then an objective questionnaire was applied for feedback, ending with an open space for any comments the students felt were pertinent. **Results:** 451 students from the second to fifth year of the medical course took part in this study. The games developed in the classroom were perceived as promoting a collaborative, albeit competitive, environment by 97.5% of the students. Among the participants, 93% showed an increase in motivation for unfamiliar subjects. Notably, 95.5% considered that the games were aligned with previously established learning objectives, and 99.1% expressed interest in using them in future tutoring activities. In addition, 93% of participants preferred active methodologies over traditional ones. **Conclusion:** In this study, we explored student perceptions of gamification as an innovation to enhance active learning. The students' positive reception reinforces the viability and relevance of using gamified strategies to develop a collaborative environment, greater motivation and greater engagement with active methodologies. The analysis of the integrative literature review shows a significant positive impact on medical education, especially with regard to student motivation, engagement and learning.
Keywords: gamification, active methodologies, students, teachers

INTRODUCTION

Brazilian educational research has been dedicated to a series of discussions on the use of games in education, covering analysis of applications, studies on game design, creative processes, typological investigations, as well as the involvement of social and developmental psychology. In addition, the effects of the phenomenon of playing games on students are also explored, with a diversity of approaches and research fronts that reflect the Brazilian educational reality (1).

In medical education, studies on the use of games, here called gamification, have simply tripled since 2019. However, the number of Brazilian studies is still quite small compared to international studies. França Junior & Maknamara (2) explored the impact of active methodologies, including gamification, on the curriculum reform of medical courses, highlighting both advances in collaborative learning and gaps in the effective transformation of graduate profiles. Paiva and colleagues (3) observed that 81.25% of students considered the integration of playful approaches to be a necessity within curricular activities, suggesting that gamification can contribute significantly to creating a more engaging learning environment. Santos et al. (4), when developing a digital platform for evidence-based medical summaries through gamification, observed that the construction of the platform fostered interdisciplinarity and also allowed reflection on innovative educational processes, in which learning based on real-life problems and the construction of knowledge in a collaborative way are integrated. Moraes and Vargas (5) point out that gamified activities on the web, such as games, are widely accepted by undergraduate medical students, favoring the development cognitive and motor skills, although they point out the need for standardization in assessment instruments and greater exploration of team games.

Recognizing the distinct educational needs of medical students, who as a result of the need to assimilate both theoretical knowledge and practical skills, there is a particular applicability of gamification in medical education. In this study, we explore the role gamification through the perceptions of academics, as well as reviewing the international literature on the subject. The aim is to provide an expert analysis that contributes to the implementation of future studies, thus filling the knowledge gap generated by fragmented and disconnected studies on gamification. We hope that teachers, in turn, can contribute to the development of critical minds, with notions of ethics and citizenship, regardless of results and winners.

EXPERIENCE REPORT

This study involved 103, 106, 108 and 134 students, from the second to the fifth year of the medical course, respectively, from a higher education institution (HEI) in the city of Olinda - PE/Brazil.

Online games such as word searches, crosswords, Kahoot and Quizizz were used to gamify the learning objectives of the Morphofunctional Laboratory.

After each gamified approach, the students received a structured feedback questionnaire via (Virtual Learning Environment), containing 5 closed questions in a dichotomous format (yes/no). At the end of the questionnaire there was also an open space for ideas, suggestions or observations that the students felt were pertinent. After analyzing the questionnaire, it became clear:

- 93% showed an increase in motivation for unfamiliar subjects after the gamification strategies developed in class.
- Although the HEI uses 100% active methodologies in its curriculum, there was some resistance to active teaching methodologies (27% opted for traditional methodologies).
- The games were perceived as fostering a collaborative, albeit competitive, environment by 97.5% of the students.
- 95.5% considered that the innovative strategies were aligned with the established learning objectives
- 9.1% expressed interest in using it in future monitoring activities.

DISCUSSION

For the integrative literature review, a PubMed search was carried out using the words "gamification AND medical education", which initially generated 393 results. After applying the filters "last 5 years", "free full text", "clinical trial", "review" and "English", the number of articles was reduced to 44. Of these, 23 were selected and are shown in Table 1. It was observed that gamification has proved to be a promising approach to medical education, with positive results in terms of motivation, engagement and the development of specific skills.

Gamification has been widely explored as a teaching strategy in the context of medical education, with a variety of impacts on student learning and motivation. Several studies have investigated students' perceptions of the use of gamification in the educational process and in increasing engagement and motivation. This engagement, in turn, is directly related to improving the educational environment, as highlighted in other studies, such as that by Kaul and collaborators (11), which emphasizes the increase in collaborative learning and engagement provided by gamified tools. In addition, gamification has been shown to have a positive impact on student motivation, a key aspect for medical education. Studies such as that by Yang and colleagues (16), which evaluated the use of immersive virtual reality in teaching neonatal resuscitation, showed that the use of gamified technologies can increase self-confidence and reduce anxiety, crucial factors for performance in high-pressure clinical situations.

In relation to specific areas of medical education, several studies have shown the effectiveness of gamification in improving clinical skills. Szeto and collaborators (10) reported that in dermatology teaching, gamification improved students' diagnostic accuracy, as well as increasing their interest in the field. The same trend was observed in orthopaedic teaching, where Tung and colleagues (30) confirmed that gamification was associated with an improvement in learning orthopaedic techniques, particularly in collaborative and competitive environments. In addition, Mansoory and colleagues (31) reported that the use of gamification in the teaching of ocular trauma resulted in significantly better student performance compared to traditional methods, which reinforces the potential of gamification in specific clinical areas.

The use of emerging technologies, such as virtual reality (VR) and artificial intelligence (AI), has also been widely investigated within the context of gamification in medical education. Tolks and collaborators (24) pointed out that the integration of AI with gamification has great potential, especially in the areas of motor and cognitive rehabilitation, pointing to the need for more research to develop more interactive and efficient game designs. Larsen and colleagues (18) investigated the use of VR in lung ultrasound training, suggesting that VR can be an effective tool for autonomous education, even outside the hospital environment. These technological advances indicate that gamification can be even more effective when combined with new technologies, expanding the possibilities for immersive and autonomous learning.

However, despite the benefits pointed out, the implementation of gamification in medical education faces challenges. Studies such as those by Westenhaver et al. (12) and Xu et al. (19) highlight the need for standardization of gamified methods and further research into the most effective elements to promote student adherence. Personalizing approaches, with a focus on student preferences, is another crucial aspect for the success of gamification, as suggested by Szeto et al (10) and Aguado-Linares et al (20). Furthermore, the lack of robust scientific studies on the effectiveness of gamification in specific areas, such as radiology, is still a major limitation, as shown by Aguado-Linares et al (20).

The gamification of medical education proposed in this study included the use of word searches, crossword puzzles and two online games: Quizizz and Kahoot to teach histopathology to students from the second to the fifth year of medical school.

During the pandemic, the study by Zamani et al. (32) compared the learning level of speech therapy students and observed that the experimental group (hybrid method: crossword puzzles plus lectures) obtained a higher average knowledge and learning score than the control group traditional method) immediately after (17.14 vs. 16.02; P=0.036) and one month after training (18.26 vs. 16.10; P=0.001). An observational study of 267 pharmacy students evaluated the perceptions of pharmacy students about the use of crossword puzzles as a learning tool in the cardiovascular pharmacotherapy module, with a focus on anticoagulant therapy. The authors reported an improvement in the memorization and retention of information with the strategy (33). Another study evaluated the level of learning of physiology with the use of crossword puzzles, in which 64.9% of the students indicated that the puzzles helped them to memorize definitions and terminology (34). Termbot, accessible via the LINE platform, offers crossword puzzles that turn boring medical terms into a fun learning experience (35). This study found that students who used Termbot made significant progress in learning medical terms, indicating the model's effectiveness improving learning outcomes. More

recently, a study compared the effect of gamification on pharmacy students over three years and found that crossword puzzles and escape room promoted a significant improvement in assessment scores, from an average of 79.9% in 2021 to 90.1% in 2022 and 90.6% in 2023 ($P < 0.05$). In , there was a reduction in the number of requests for assistance by email and an increase in the confidence reported by students (36). Finally, a systematic review found 29 studies that used crossword puzzles as a gamification technique in the context of health professions education, observing a positive educational impact; however, it reaffirms the need for future studies with more robust methodologies that not only evaluate the effects on knowledge, but also carry out statistical analyses (26).

With regard to the online games Quizizz and Kahoot, a greater number of papers were found. During the epidemiological context of COVID-19, for example, Flores-Angulo (37) observed that the inverted classroom methodology using Edpuzzle associated with the case study using Quizizz encouraged the development of generic skills and was well evaluated by the students. In addition, the Quizizz game improved competences related to basic knowledge, pharmaceutical care, essential practices and approach to care, with a statistically significant difference in all parameters between the control group and the experimental group (38). Recently, Romero-Alemán (39) also observed an increase in the motivation and satisfaction of medical and physiotherapy students following gamified strategies with Quizizz, facilitating medium-term knowledge retention. The Kahoot game, on the other hand, has been used in a much larger number of medical education projects. Kahoot has been widely used as a tool to facilitate learning in subjects such as pathology (40), anatomy (41), immunology (42), pharmacology (43,44) and histology (45), demonstrating its potential to promote engagement and improve students' acquisition of basic knowledge. It has also used in specific medical areas such as pediatrics (46), obstetrics and gynecology (47) and dermatology (48). Many of these studies mention that the COVID-19 pandemic has accelerated the integration of digital technologies into teaching, highlighting the potential of gamification strategies in adapting curricula for remote teaching. Despite methodological limitations in some studies and barriers to validation and implementation, teachers' and students' perceptions of gamification are largely positive. Although the performance of groups using gamification has, in many cases, surpassed that of groups subjected to traditional methods, the effectiveness of games varies according to the context and content covered.

CONCLUSION

The continued integration of innovative methodologies, such as gamification and the use of digital platforms, represents important step in the evolution of medical education, promoting more efficient training adapted to the demands of the contemporary educational scenario. The integrative review and students' perceptions following the different gamification techniques used in this study show a significant positive impact on medical education, especially with regard to student motivation, engagement and learning. Future research is needed as many of the studies reviewed here have methodological limitations and need to assess the long-term impact.

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Reference	Newspaper	Objective of the study	Type of study	Main results	Conclusion	Level of Evidence
Siqueira et al, 2020 (6)	Rev Gaucha Nursing	To analyze the scientific evidence available in the literature on the use of serious games to teach cardiopulmonary cardiopulmonary resuscitation (CPR) for health students.	Review Integrative.	The search resulted in 115 studies, 8 of which were selected. Medical students were identified as the main target audience.	The serious serious showed effective for o learning of resuscitation cardiopulmonary.	Medium.
Andrews & Barta, 2020 (7)	Curr Pharmacol Rep.	An overview on simulation as an effective and developments in the teaching of clinical pharmacology in health professions.	Review Narrative.	Serious games and augmented reality, and simulation have shown potential, although their application is not uniform in all educational programs.	Incorporating these tools into the curriculum can help overcome barriers e improve the effectiveness of teaching.	Medium.
Blanié et al., 2020 (8)	BMC Med Education.	Compare o value educational from simulation through games (SG) and traditional traditional of teaching (TT) to improve reasoning skills clinical (RC).	Study Prospective Multicenter and Randomized	Satisfaction and motivation of the students were highly valued in both groups, with a highest value recorded in the SG group ($p< 0.05$).	The study did not found differences educational significant between the groups.	High
van Gaalen et al, 2021 (9)	Adv Health Sci Educ Theory Pract.	Review the evidence empirical evidence on the effectiveness gamified approaches in vocational education health.	Review Systematic	A total of 44 studies indicating that gamification can improve behaviors and learning.	Gamification can improve results of learning in education. Future studies are necessary.	High.
Szeto et al., 2021 (10)	JMIR Dermatology	Review current applications of gamification in general medical education, in dermatology dermatology and in patient education actions.	Narrative Review.	In dermatology, there has been an increase in diagnostic accuracy, interest in the field and the effectiveness of gamified interventions in educating patients about melanoma.	A gamification improves learning, motivation eperformance in medical education and dermatology.	Moderate.
Kaul et al., 2021 (11)	Chest.	Exploring the use of "Escape Rooms" in medical education as remote learning during the COVID-19 pandemic.	Experience Report	The Escape Room was effective as an innovative strategy, promoting collaborative learning and engagement.	Remote adaptation during the pandemic has highlighted opotential of emerging technologies in medical education.	Moderate.

Westenhaver et al., 2021(12)	Laryngoscope Investig. Otolaryngol.	Evaluate o use gamification in educational platforms of medical residency programs.	Narrative Review.	Thirteen studies were identified. Elements such as rankings, feedback and social interaction were the most common.	Gamification needs to be standardized and preferred elements identified for greater adherence.	Moderate.
Staziaki et al., 2022 (13)	J Digit Imaging.	Report on the experience of developing a POC (proof of concept) for learning radiology.	Experience Report	Using a live league table, it was possible to give points to the trainees based on the accuracy of their annotation compared to the radiologists' annotation.	Gamification has the potential to promote greater engagement in teaching programs inradiology.	Bass.
Mandal et al., 2022 (14)	Cureus.	Review the use and impact of extended reality technologies in orthopedic surgical training.	Narrative Review.	Promising technologies in surgical training and rehabilitation allowing for greater precision, collaborative teaching and potential cost savings.	Potential to revolutionize surgical training e orthopedic rehabilitation.	Bass.
Tran et al., 2022 (15)	Dermatol Pract Concept.	To review innovative approaches to education in the interpretation of dermoscopic interpretation.	Narrative Review.	Gamification, social media and PALMs stood out for providing immediate feedback and personalizing training.	Intuitive teaching strategies optimize learning.	Bass.
Yang et al., 2022 (16)	Nurse Educ Today.	Evaluating the effects of gamification for neonatal resuscitation using immersive virtual reality.	Non-randomized controlled study	The virtual reality group showed greater gains in knowledge of neonatal resuscitation, motivation, problem-solving and self-confidence, as well as lower anxiety.	A viable educational alternative during restrictions on face-to-face practice.	Medium.
Bigdeli et al., 2023 (17)	Med J Islam Repub Iran.	Explore thetheoretical theoretical foundations àgamification in medical education.	Scope Review.	10 studies were included, the behavioral, cognitive and constructivist theories were highlighted.	We recommend to integration of theoretical approaches in program design.	Medium.
Larsen et al., 2023 (18)	Ultrasound Med Biol.	To evaluate lung ultrasound training using immersive virtual reality (IVR). reality (IVR).	Experimental study	The groups with and without gamification were equal, suggesting effectiveness for autonomous training outside the hospital environment.	IVR modules can beused astraining training tools.	Medium.
Xu et al., 2023 (19)	Front Public Health.	Discuss the effectiveness, limitations and future directions of gamification.	Narrative Review.	Promising approaches by integrating feedback, testing and spaced repetition, with active participation and autonomy.	Gamification can transform medical education, but more research is needed einnovation.	Bass.
Aguado-Linares et al., 2023 (20)	Radiology (Engl Ed).	Survey on the use of gamification in medical training, with an emphasis on radiology education.	Narrative Review.	Gamification in radiology for undergraduate students and residents is promising.	It requires further exploration to maximize its impact on medical training.	Bass
Kirsch et al., 2023 (21)	BMC Med Educ.	Evaluating the impact of gamification on the assessment of risks and uncertainties in medical contexts.	Experimental study.	Most students reported enjoying the experience, increased motivation, but rejected the competitive element.	Collaborative approaches rather than competitions can be more effective	Medium.
Edwards et al., 2023 (22)	Neurol Educ.	Offer an overview about agamification ineducation in neurosciences.	Narrative Review.	Games aimed at neuroscience education were identified and strategies were proposed for developing effective games.	Gamification is a promising approach neuroscience education.	Bass.
Nowbuth et al., 2023 (23)	JACAntimicrob Resist.	To review the literature on the use of games in the education of future antimicrobial prescribers. antimicrobial prescribers.	Systematic Review.	Six studies were identified, predominantly board and card games with scoring systems.	The gamesimproved students' knowledge of prescriptions.	Medium.

Tolks et al., 2024 (24)	JMIRSerious Games.	eview of the literature on the integration of artificial intelligence (AI) and gamification in healthcare.	Scope Review	Sixteen studies were included, most of which focused on the rehabilitation of motor (63%) and cognitive (19%) disorders.	The development of game designs with AI interaction should be prioritized in future research. in future research.	Bass.
Quek et al., 2024 (25)	Nurse Educ Today.	Analyze the use of escape rooms as strategies strategieslearning and evaluation in education.	Systematic Review	Fifty-two studies were included. Escape rooms were considered engaging and had a positive impact on students' cognitive and psychomotor skills. of the students.	Escape rooms are a promising tool withpotential to train interprofessional teams.	Bass.
Arnold et a., 2024 (26)	Med Sci Educ.	Evaluate the impact and characteristics of using crossword puzzles as a gamification tool.	Systematic Review.	29 studies were included Crossword puzzles were considered an enjoyable learning activity.	Crossword puzzles are an effective and engaging learning strategy. in learning.	Medium.
Sundareswaran et al., 2024 (27)	J Educ Health Promot.	Analyze odevelopment and for the teaching and assessment of Medical Physiology.	Narrative Review.	The absence of studies. Practical faced by educators were listed.	Gamification is aligned with the learning and assessment styles of of generations Y and Z.	Bass.
Sendra-Portero et al., 2024 (28)	J Med Internet Res.	To review the use of the "Second Life" (SL) metaverse in medical education.	Narrative Review	24/7 availability 24/7, sense of immersion and co-presence, reproduction of 3D environments, real-time interaction and engagement.	Additional efforts are needed expand and validation its educational impact.	Bass.
Ghafouri et al., 2024 (29)	BMC Med Educ.	To compare the impact of different teaching methods on students' performance, satisfaction and self-efficacy in assessing patients' physical health.	Randomized Clinical Trial	Gamification in the flipped learning environment was more effective than the other methods, while there was no significant difference between the flipped and traditional classroom.	The integration of different methods can make teaching more effective, depending on the context, resources and creativity of the teacher.	Medium.
Tung et al., 2024 (30)	Cureus.	Systematically review the use of gamification in improving ofskills in orthopedics.	Systematic Review	Four studies were included, showing a positive correlation between gamification and the effectiveness of competitive and collaborative environments for training residents.	A gamification has potential to improve orthopedic education.	Medium.
Mansoory et al., 2024 (31)	BMCOphthalmo.	Investigating the impact of gamification onlearning of residents and medical students on the approach to ocular trauma.	Randomized Intervention Trial.	Residents and medical students presentedscore statistically higher than the control group.	Teaching based on gamification using virtual reality é an effective educational strategy.	Medium.

Table 1. Integrative Review on Gamification in Medical Education