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Review Article

A Review of Game-Based Learning in Higher Education: Exploring Escape-Room Methodologies in Educational Settings

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ABSTRACT

Conventional teaching approaches that lack interactive techniques may hinder the effectiveness of knowledge acquisition and student engagement. Innovative teaching approaches are essential to engage with tech-savvy Generation Z students. Game-based concepts, particularly educational escape rooms are gaining attention as effective teaching tools in higher education. This review explores the development and implications of educational escape rooms in terms of student knowledge, engagement, problem-solving skills, and teamwork. Studies showed that it is evident that educational escape rooms exhibit positive impacts towards the students' learning, attributed to increased motivation, satisfaction, and peer learning. Notably, escape rooms facilitate a shift from traditional didactic methods to more interactive and immersive learning experiences. Despite the promising outcomes, further research is necessary to further refine the design and maximise the impact of the educational escape room. This review provides valuable insights for educators and researchers, highlighting the potential of educational escape rooms to transform higher education and suggesting directions for future research.

Keywords: Active Learning, Educational Games, Game-Based Learning, Higher Education.

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INTRODUCTION

Higher education has undergone significant transformations to meet the changing demands of the industry and students are expected to possess a broad range of knowledge and skills.[1] Courses in higher education are crucial aspects that play a pivotal role in the development of the students. Despite the importance of these topics, some students struggle to engage with the content.

Game-based learning is an effective educational approach to improve student engagement and build teamwork.[2,3] It aligns with the humanism and constructivism theories. It is a new concept that has shown a great impact on student engagement and could further improve students' academic achievement and knowledge retention.[4,5] It encompasses various activities that stimulate critical thinking, and problem-solving and move learners to full immersion in learning, instead of entertainment.[1] Game-based learning is closely related to gamification. Gamification utilises components of games in real-world environments whereas game-based learning involves full-fledged games. Both principles aim to improve student learning experiences and motivation while achieving specified learning outcomes.

Popular game-based learning is an educational escape room which utilises live-action team-based games.[6] Participants must discover clues, solve puzzles, and accomplish tasks to achieve a specific goal, typically leaving the room within a set time limit.[7] These game-based strategies helped to improve learning outcomes through repetitive practice, active engagement, and instant feedback throughout the learning process. Educational escape room facilitates socio-constructivist teaching approach that is well-adapted to the needs of contemporary students.[5] In this review, we will explore conventional teaching approaches, game-based learning, and the development and implications of educational escape rooms.

Teaching Approaches in Higher Education

Higher education, in its most comprehensive sense, aims to prepare graduates with fundamental expertise and to empower them for continual learning and skill development in both scientific principles and practical applications throughout their

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professional lives.[8] Recognizing that there is no one-size-fits-all learning or teaching style, it is crucial to understand that effectiveness hinges on the specific requirements of students and their surroundings. However, this part delves into several prevalent approaches in higher education, elucidating the reasons behind their suitability.[9] Table 1 summarizes the current teaching approaches in higher education in terms of advantages, disadvantages, outcomes and measures for improvement.

The initial teaching method is the traditional or didactic lecture that aligns with the classical teacher-centered pedagogy.[10] It is a very common approach but was found with several weaknesses. Traditional lectures consist of instruction delivered to large groups in a one-way format, where the lecturer speaks, and students receive the information passively. Instead of being encouraged to participate and assess problems actively, students are only expected to listen and learn from the lectures.[11] Thus, some students may feel that they are not in control of their learning and become reliant on the lecturer to provide them with the knowledge.

Lengthy lectures with minimal interactions have led to students being less engaged and ineffective in critical thinking skills development.[12,13] However, this can be improved with the supplement of interactive components that promote discussions and opportunities for students to voice their opinions.[14] Complement with good presentation skills by the lecturer can further motivate and engage the students, which makes this traditional teaching method relevant till now.[9]

Besides, the incorporation of a post-lecture quiz into the didactic approach was proven to be effective. A study by Vinall *et al.*, evaluated the impact of formative evaluations on student performance through a crossover trial design.[15] The findings indicated that more difficult questions in the quiz improved the performance of first-year pharmacy students in their exams, typically in higher-level exam questions. The results align with another study that supports the "testing effect" approach, which suggests that through assessments, students' memory retention and educational outcomes were improved.[16]

A study by Calabrese investigated the impact of active learning and traditional lectures on 26 first-year graduate students through knowledge and perception assessments.[17] Active learning includes educational videos, class discussions, and case studies while traditional lectures only comprise of PowerPoint-taught lecture format. Both active learning and traditional lectures showed significant improvement in their post-test scores ($p<0.05$). As for perception, most students preferred active learning as it allows them to self-reflect and improve their self-efficacy. However, some students felt that traditional lectures were more concise, easier to follow, and able to grasp the important points.[17] While this study highlights the importance of active learning in students' perceptions, the small sample size limits the generalizability of the findings. Additionally, the impact of confounding variables such as prior knowledge was not accounted for in the study.

Another teaching approach is Team-Based Learning (TBL) which allows the students to actively apply their knowledge and skills, and collaborate within group activities.[9] The primary aim of TBL is to support interactive learning experiences instead of mere reception and recall. Bleske *et al.*, showed that students engaged in TBL have a greater accumulation of knowledge, with an average of 89.2±10.6%, compared to 85.0±10.2% in conventional lectures ($p<0.03$). These findings suggest that by tackling various challenges within the TBL framework, students not only improve their knowledge but also enhance their critical thinking skills through application.[18,19]

The third teaching method is Problem-Based Learning (PBL), which has gained global popularity since its introduction in 1969.[20] While this approach is primarily utilised in health sciences education, PBL is now being adapted across disciplines such as education, nursing, physical therapy, and architecture. PBL is a student-centered approach which requires students to address different scenarios tailored to their learning outcomes in teams of around 8 to 10 members. In this model, lecturers act as facilitators, guiding the students through the discussions, rather than delivering traditional lectures.[9] Through PBL, students' capabilities in self-directed and collaborative learning have shown to be enhanced.[21] The fourth teaching approach involves students engaging in role-playing activities and simulating scenarios.[9] These activities provide hands-on learning opportunities for healthcare professionals, allowing them to gain practical experience while mitigating ethical considerations and safety linked to actual patient interactions.[22,23]

While the conventional teaching approaches are effective, their relevance to the current generation may be diminishing. Hence, it is essential that we explore innovative educational approaches to align with the needs of today's students.

Game-Based Learning in Higher Education

Game-based learning is an educational approach that integrates game design dynamics into the learning environment and has received increasing attention in recent years.[24] It uses game mechanics such as badges and awards to boost motivation for the users to engage with the gamified program.[25] This allows direct engagement between the lecturers and students while stimulating their social, cognitive, and academic skills.[26,27] It also supports socio-constructivist pedagogy whereby the students construct their understanding through engagement and interaction with their peers.[28]

Game-based learning offers several advantages such as improved student engagement, cost-effectiveness and active participation in contrast to the conventional teaching approaches (Figure 1).

As game-based learning aims to stimulate critical thinking among the students, it allows the students to take control of their learning paces while trying to apply the knowledge to real-world-simulated scenarios.[29] By tackling these challenges within the game, students not only learn through the instant feedback mechanism but also experience an immediate sense of achievement.[30] This is in contrast to the conventional approaches that only prioritise the outcomes of the assessments which were mainly achieved through repetition and memorizing skills.[11]

A study by Putz *et al.*, explored the impact of game-based learning in 617 secondary and tertiary education students. The participants showed no significant differences in prior knowledge, gender, or age and were divided into gamified and non-gamified groups. The overall findings revealed that participants in the gamified workshop showed significant knowledge retention regardless of age and gender as compared to non-gamified groups, with average scores of 3.32±1.32 and 3.15±1.61, respectively.[31] Similar findings were demonstrated in another published study.[32]

Besides, Turan *et al.*, investigated the impact of game-based learning in technologies and software courses in 94 students whereby they focused on students' accomplishments, cognitive load levels, and perceptions. They revealed that students who learned through the gamification approach achieved higher mean scores compared to the students in the traditional teaching group, showing averages of 58.92 and 36.55%, respectively ($p<0.05$).[33] This aligns with the findings by Simões *et al.*, who also observed an increase in interest, motivation, and learning levels with educational games. Notably, this study also identified that games, structured with achievement goals, may strain their memory capacity and potentially impact their cognitive load levels.[34,35]

Furthermore, Tan *et al.*, highlighted the impact of gamified Student Response Systems (SRS) such as Kahoot and Survey Monkey on 103 students who were assessed through 7 multiple-choice questions. The post-test scores improved significantly to 89% as compared to the pre-test scores of only 28% ($p<0.01$). This further reinforces the positive impact of the gamified approach on students' understanding and application of course content.[36] Besides, Lin *et al.*, (2018) also revealed that 100% of the students agreed that Kahoot! was efficient in instilling both intrinsic and extrinsic motivation while 96% felt engaged and inspired to answer the question.[35] These positive results are aligned with Wang *et al.*,'s study, which showed that Kahoot promotes motivation and engagement in student learning.[27]

Chans & Portuguenz Castro evaluated the efficacy of game-based learning in 48 engineering students using pre- and post-tests consisting of 12 multiple-choice questions.[37] The findings revealed a significant improvement of 22% in the students' knowledge. Besides, the final grade results also showed an improvement of 24% in the pass rate, which further demonstrated the long-term positive impact of game-based learning on students' comprehension and academic performance.[37] However, several limitations such as the sample size, depth and validity of the knowledge assessment should be considered.

Hence, the incorporation of game-based learning showed positive impacts on the students which can be further integrated into

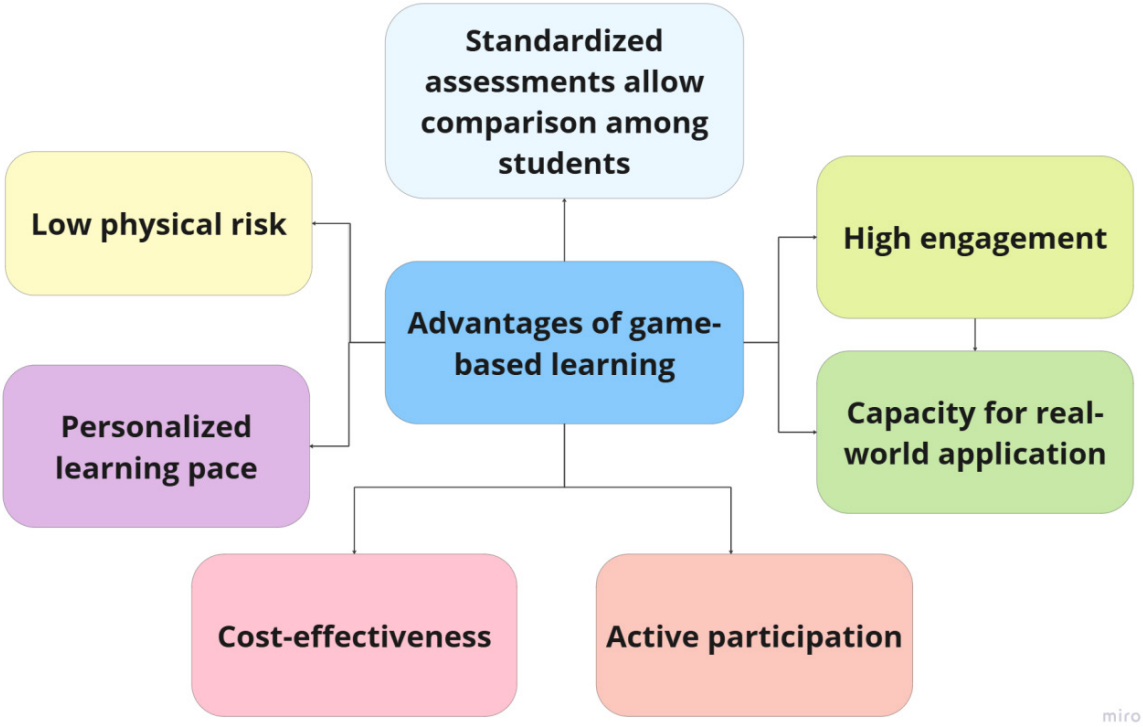

Figure 1: The advantages of game-based learning.

Table 1: Different teaching approaches in higher education.

Teaching Approaches	Advantages	Disadvantages	Outcomes	Improvements
Didactic	Convenient Less preparation time needed.	Unidirectional flow of information. Low engagement from the students Limited opportunity for feedback.	Knowledge retention. Basic understanding of concepts.	Supplement with interactive components or post-lecture quiz. Use multimedia to stimulate interest.
Team-based learning	Promotes collaboration through structured group activity. Opportunity for students to apply knowledge.	Requires greater preparation time Potential for bias in group allocation.	Increase in knowledge acquisition. Enhance problem-solving skills Foster respect between peers.	Use randomization in group allocation to reduce bias. Provide clear guidelines for group dynamics.
Problem-based learning	Promotes self-directed learning. Promotes collaboration and teamwork.	Can be time-consuming. May require facilitator training.	Development of critical thinking. Better preparation for real-world challenges.	Regular feedback on group progress. Ensure adequate resources and guidance.
Role-playing	Hands-on learning with practical experience Encourage active participation.	Can be time-consuming to set up and run. May induce anxiety in some students.	Improved communication skills. Greater knowledge retention.	Use a variety of scenarios to make it engaging.

the curriculum to help the development of cognitive and social aspects of the students. This helped to nurture an all-rounded future generation of students.

Educational Escape Rooms

An educational escape room is an example of game-based learning whereby the participants collaborate to achieve a specific objective, which is escaping the room.[7] As educational escape rooms are relatively new in higher education, studies found in the literature mainly focused on small-scale implementation across specific subjects like biology,[38] computer science,[39,40] and pharmacy.[4,41] The integration of escape rooms into the education sector has been shown to enhance teamwork, leadership, innovative thinking, and effective communication skills. Educators find these benefits valuable, in assisting the students in mastering subject-specific knowledge and skills while fostering an engaging learning experience.[40] The next section will explore the development and design of an educational escape room to maximise these advantages.

Development of Educational Escape Rooms: Design and Characteristics

Educational escape rooms are designed to provide an immersive and captivating experience where participants find themselves confined in a themed environment. They consist of a sequence of puzzles, riddles, and challenges that need to be solved in a specified time frame.[7] These games are specifically designed to be constructively aligned with the course learning outcomes. Meanwhile, it cultivates collaboration, problem-solving, critical thinking, and teamwork among the students. To ensure that the educational escape room fits the intended goals and offers an engaging learning experience, researchers must take into account: i) the target audience, ii) the theme, iii) puzzles, iv) learning objectives, and v) desired outcomes or feedback mechanism (Table 2).

A well-developed theme provides engaging learning experiences for the students.[42] The themes need to be engaging, and cohesive, aligning with the puzzles designed. Nicholson classified puzzles into four organizational methods, open, sequential, patch-based and pyramid structures.[7] In an open framework, riddles can be solved simultaneously before tackling the final puzzle. For the sequential method, the challenges are introduced successively in which solving one puzzle will unlock the subsequent puzzles. The path-based system has a similar sequential concept but with additional routes and pathways towards the final puzzle. A pyramid structure is a complex framework that combines open, sequential and patch-based structures in the design.[7]

An immediate feedback session post-educational escape room proved to enhance the learning experience as it encourages the students to self-reflect and improve their strategies and problem-solving skills.[5] Thus, an effective educational escape room design comprises a careful balance of various elements that lead to an engaging and challenging experience while achieving the learning outcomes.

Table 2: Overview of the design and characteristics of educational escape rooms.

Sl. No.	Characteristics	Remarks
1.	Theme and Narrative	A well-developed theme and storyline serve as the foundation for the escape room, providing context and immersion for the participants.[42] The narrative needs to be engaging, coherent, and aligned with the puzzles and challenges presented.
2.	Puzzles and Challenges	They are designed to test participants' knowledge, skills, and problem-solving abilities.[5] They should be appropriately challenging, logically connected to the theme, and progressively unlock new clues or areas as they are solved.
3.	Multimedia Elements	Incorporating multimedia elements such as audio, video, or interactive props can enhance the immersive experience and provide additional layers of engagement and complexity.[55]
4.	Collaboration and Teamwork	Escape rooms are inherently collaborative experiences, requiring participants to work together, communicate effectively, and leverage each other's strengths and perspectives [6]. The design should encourage and facilitate teamwork throughout the experience.
5.	Time Pressure	The time constraint is a crucial element of escape rooms, creating a sense of urgency and adding a layer of challenge.[7,55] The time limit should be carefully balanced to provide an appropriate level of difficulty without being too restrictive or overwhelming.
6.	Debriefing and Feedback	Incorporating a debriefing or feedback session after the escape room experience can enhance the learning outcomes and allow participants to reflect on their strategies, problem-solving approaches, and areas for improvement.[5]

Implication of Educational Escape Room: Knowledge Assessment

Knowledge refers to the understanding or familiarity with facts, information, descriptions, or skills. Meanwhile, assessment is the process of examining and forming a judgment about an individual's knowledge, capabilities, and abilities.[43] Thus, knowledge assessment remains the standard to evaluate an individual comprehension and application of information.

Different methodologies have been used to evaluate knowledge, through exams and quizzes.[44] These tools measure the retention of information and the ability to recall concepts, providing a structured approach to evaluating learning outcomes. The educational escape room utilizes a combination of Performance-Based Assessment (PBA) and Game-Based Assessments (GBA). PBA is a modern evaluation method that connects theoretical knowledge to practical skills, enabling students to utilize lessons learned to solve real-world problems. PBA is well-recommended because it encourages students to think creatively and develop solutions for real-life situations.[45] Besides, PBA is designed to challenge learners to apply higher-level thinking skills like analysis and applying skills from different areas to complete tasks.[46] Thus, PBA offers insights into the competency levels of the learners.[47]

With the advancement of technology, GBA offers interactive ways to evaluate understanding and skills. GBA involves real-time and in-game activities as evidence to infer competencies. This assessment method adapts to the performance levels of the player by offering support, feedback, and challenging tasks.[48] The use of GBA has become more popular as it is efficient, convenient, and cost-effective.[49] For example, video games were designed with the incorporation of evaluations within the gameplay, allowing assessment to be conducted concurrently. Shute *et al.*, used stealth assessment in the game 'Use Your Brainz' to measure middle-school students' skills in solving problems. They developed a model based on problem-solving literature, identified observable actions as indicators, and utilized Bayesian networks to update competency beliefs in real-time during gameplay.[50]

Studies have been conducted to explore the implication of educational escape rooms in terms of student learning, either through self-reports or pre- and post-activity knowledge tests (Table 3). Caldas *et al.*, developed an educational escape room for a non-sterile compounding course. 30 students participated in the escape room and students showed improvement in their knowledge significantly, from 50% to 83.3% post-activity. However, the limited sample size may limit the application of the findings.[4] Moreover, Eukel *et al.*, revealed that the students perceived positively their diabetes-themed escape room in various aspects such as learning experience, engagement and teamwork, demonstrating its educational benefits in higher education.[51]

Table 3: **The knowledge implication of educational escape rooms.**

Field	Sample	Assessment	Findings	Reference
Biology	148	Pre- and post-test	96% completed the assessments. Evident improvement in the student performance, with 13.8% scoring higher on the final assessment. Findings showed an increase in scores for most of the questions, notably 20% significant improvement was observed in two questions.	38
Computer Sciences	162	Pre- and post-test	The average score for the pre-test was 68% while the post-test observed an improvement of 17%, marking an average score of 85% ($p<0.05$). This indicates that educational escape rooms effectively enhance the student's knowledge and skills in software modelling.	39
Pharmacy	53	Pre- and post-test	For the pre-test, the students scored an average of 70±11.6%. Following the activity, the assessment scores observed a slight decline, demonstrating an average score of 67±14.5%. Despite observing a lower mean score in the post-assessment, 96% of students perceived that the activity helped in their clinical skills and facilitated their learning.	41
Pharmacy	30	Pre- and post-test	Only 75% of the participants completed the escape room. Findings showed that participants with prior escape room experience were 4.33 times faster to complete the escape room. Following the activity, participants showed improvement in their knowledge scores, from 50.0 to 83.3% ($p<0.05$).	4
Pharmacy	83	Pre- and post-test	Only 89% ($n=74$) completed both the pre- and post-knowledge assessments. Following the escape room activity, participants showed an average score of 81%, a marked improvement of 25% from the pre-knowledge assessment ($p<0.05$).	51

Table 4: **Overview of the perception of the educational escape rooms in higher education.**

Course	Sample	Assessment	Findings	Reference
Management	141	Students' perception.	89% of the participants were satisfied with the escape room and 91% of them felt that they were more involved in the problem solving. Most of the participants agreed that their team worked constructively (93%, n = 129).	52
Heart failure	193	Change in student perspective from the time the activity ended to four weeks later.	Students were satisfied with the escape room experience and reported that they could effectively review the subject of heart failure (mean: 4.21). Positive attitudes remained even after four weeks of completion of the escape room.	53
State/University facts	127	Change in perceptions between before and after surveys.	All statements except for, "I am an integral member of the team" showed a statistically significant positive change in perception following the escape room activity.	54

In contrast, Clauson *et al.*, demonstrated a decline by an average of three points in the post-assessment scores of students recruited for the Advanced Pharmacy Practice Experiences (APPE) escape room which was inferred due to the broad emphasis on the escape room leading to limited cognitive space of participants to process the knowledge presented. Despite the lower post-assessment scores, 96% of students ($n=51$) stated that the escape room improved their clinical skills and facilitated learning.[41] While further modification in the instructional design can potentially mitigate the limitation of the escape room, no follow-up studies have been conducted to explore it. Overall, most of the studies indicate that students gain new knowledge and skills through participating in educational escape rooms.

Implication of Educational Escape Room: Engagement and Satisfaction

In addition to assessing the knowledge gained through educational escape rooms, understanding the participants' perceptions is equally crucial. Studies have explored factors such as students' engagement, satisfaction and problems encountered during the educational escape room experience (Table 4).

Cain developed an educational escape room activity tailored for the Pharmacy Management course.[52] 141 third-year pharmacy students were recruited, and findings showed that most of the students perceived higher problem-solving engagement and enjoyed the escape room, demonstrating agreement rates of 91 and 89 %, respectively. These findings suggest the gamified experience can significantly enhance student engagement which may be due to the incentivized nature of the educational escape room. Besides, 93% of the students agreed that they have good team collaboration in solving the challenges.[52] A positive collaborative environment is a crucial element for effective teamwork in real-world scenarios.

The results align with another study that developed an escape room for the Modular Organ Systems Therapeutics (MOST) course. They recruited 195 second-year professional students in which they reported that the participants were generally satisfied with the activity. Additionally, the sense of satisfaction remained for up to four weeks which indicates the retention of meaningful positive attitudes towards the subject. Participants were able to effectively review the topics and learn from their peers, demonstrating means of 4.21 and 4.30, respectively.[53] Hence, this shows that the immersive learning experiences helped in immediate engagement and appreciation of the subject, which is critically important to working scenarios.

Similarly, Gordon *et al*., also revealed the positive values of the educational escape room. 127 second- and third-year pharmacy students participated in the study, which used an escape room to evaluate team development. The findings demonstrated that 98% of participants felt their teammates supported, respected, and trusted them.[54] All statements showed significantly positive changes post-activity except for "I am an integral member of the team". This suggests that although the students generally appreciate the collaborative aspects of the activity, there may be still barriers to feeling fully integrated into the teams. Hence, further strategies will be needed to bolster students' confidence and engagement as team members.

Overall, the implementation of educational escape rooms has been shown to yield positive outcomes across various disciplines.

CONCLUSION

This review presents an overview of game-based learning focussing on the development and implications of educational escape rooms. Studies provide compelling evidence that educational escape room improves students' knowledge and enhance student perceptions of engagement and satisfaction in various educational contexts. However, several gaps remain in the literature. The long-term effects of educational escape rooms on students' academic achievement are still not well understood, necessitating longitudinal studies that track student performance over time. The integration of artificial intelligence into educational escape rooms is a promising yet unexplored revenue. Future research can explore the impact of artificial intelligence-driven learning systems and personalised challenges in improving the effectiveness of educational escape rooms. By addressing these gaps, future studies can provide a more comprehensive understanding of the role of educational escape rooms in student learning.

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ABBREVIATIONS

APPE: Advanced Pharmacy Practice Experiences; **GBA:** Game-based assessments; **MOST:** Modular Organ Systems Therapeutics; **PBA:** Performance-based assessment; **PBL:** Problem-Based Learning; **SRS:** Student Response Systems; **TBL:** Team-Based Learning

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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SUMMARY

The review discusses the advantages and disadvantages of conventional teaching approaches, particularly in efforts to engage with Generation Z students. It highlights the growing popularity of game-based learning techniques, with a particular focus on the development and implications of educational escape rooms. This review outlines their effectiveness in facilitating knowledge acquisition and enhancing student engagement. Studies showed that educational escape rooms offer immersive learning

experiences that significantly improve student understanding and academic performance. However, the long-term effects of game-based strategies warrant further investigation to fully implement across curricula.

REFERENCES

1. Korayem GB, Alshaya OA, Kurdi SM, Alnajjar LI, Badr AF, Alfahed A, *et al.* Simulation-based education implementation in pharmacy curriculum: a review of the current status. Adv Med Educ Pract. 2022; 13: 649-60. doi: 10.2147/AMEP.S366724, PMID 35801134.
2. Badr AF. The geriatric virtual escape room in pharmacy education: female students escape significantly faster than male students. Pharmacy (Basel). 2022; 10(2): 36. doi: 10.3390/pharmacy10020036, PMID 35314617.
3. Oestreich JH, Guy JW. Game-based learning in pharmacy education. Pharmacy (Basel). 2022; 10(1): 11. doi: 10.3390/pharmacy10010011, PMID 35076609.
4. Caldas LM, Eukel HN, Matulewicz AT, Fernández EV, Donohoe KL. Applying educational gaming success to a nonsterile compounding escape room. Curr Pharm Teach Learn. 2019; 11(10): 1049-54. doi: 10.1016/j.cptl.2019.06.012, PMID 31685175.
5. Hope DL, Grant GD, Rogers GD, King MA. Gamification in pharmacy education: a systematic quantitative literature review. Int J Pharm Pract. 2023; 31(1): 15-31. doi: 10.1093/ijpp/riac099, PMID 36472962.
6. Taraldsen LH, Haara FO, Lysne MS, Jensen PR, Jenssen ES. A review on use of escape rooms in education–touching the void. Educ Inq. 2022; 13(2): 169-84. doi: 10.1080/20004508.2020.1860284.
7. Nicholson S. Peeking behind the locked door: A survey of escape room facilities; 2015. White Pap. p. 1-35. Available from: http://scottnicholson.com/pubs/erfacwhite.pdf.
8. Yousif MA, Eldalo AS, Abd Allah MA, Al-Sawat MA, Al-Wahaibi HM, Al-Osaimi AA, *et al.* Pharmacy education instruction: preference and practices, Saudi students' perception. Saudi Pharm J. 2014; 22(4): 309-14. doi: 10.1016/j.jsps.2013.06.005, PMID 25161374.
9. Almeman AA, Alrebish SA. Teaching strategies used in pharmacy. Elsevier Incorporated; 2018. doi: 10.1016/B978-0-12-811909-9.00010-1.
10. Islam MA, Khan SA, Talukder RM. Status of physiology education in US Doctor of Pharmacy programs. Adv Physiol Educ. 2016; 40(4): 501-8. doi: 10.1152/ADVAN.00073.2016, PMID 27780798.
11. Meng X, Yang L, Sun H, Du X, Yang B, Guo H. Using a novel student-centered teaching method to improve pharmacy student learning. Am J Pharm Educ. 2019; 83(2): 6505. doi: 10.5688/ajpe6505, PMID 30962633.
12. Nazar H, Obara I, Paterson A, Nazar Z, Portlock J, Husband A. A consensus approach to investigate undergraduate pharmacy students' experience of interprofessional education. Am J Pharm Educ. 2017; 81(2): 26. doi: 10.5688/ajpe81226, PMID 28381886.
13. Ilkiw JE, Nelson RW, Watson JL, Conley AJ, Raybould HE, Chigerwe M, *et al.* Curricular revision and reform: the process, what was important, and lessons learned. J Vet Med Educ. 2017; 44(3): 480-9. doi: 10.3138/jvme.0316-068R, PMID 28876993.
14. Shabanah S. Computer games for algorithm learning. In: Felicia P, editor. Handbook of research on improving learning and motivation through educational games: multidisciplinary approaches. Vol. I. IGI Global; 2011. p. 1036-63. doi: 10.4018/978-1-60960-495-0.ch048.
15. Vinall R, Kreys E. Use of end-of-class quizzes to promote pharmacy student self-reflection, motivate students to improve study habits, and to improve performance on summative examinations. Pharmacy (Basel). 2020; 8(3): 167. doi: 10.3390/pharmacy8030167, PMID 32927674.
16. Roediger HL, Karpicke JD. The power of testing memory: basic research and implications for educational practice. Perspect Psychol Sci. 2006; 1(3): 181-210. doi: 10.1111/j.1745-6916.2006.00012.x, PMID 26151629.
17. Calabrese J. A pilot study to compare lecture and active learning. J Occup Ther Educ. 2023; 7(2): 1-17. doi: 10.26681/jote.2023.070208.
18. Bleske BE, Remington TL, Wells TD, Klein KC, Guthrie SK, Tingen JM, *et al.* A randomized crossover comparison of team-based learning and lecture format on learning outcomes. Am J Pharm Educ. 2016; 80(7): 120. doi: 10.5688/ajpe807120, PMID 27756928.
19. Frame TR, Cailor SM, Gryka RJ, Chen AM, Kiersma ME, Sheppard L. Student perceptions of team-based learning vs traditional lecture-based learning. Am J Pharm Educ. 2015; 79(4): 51. doi: 10.5688/ajpe79451, PMID 26089560.
20. Zakaria MI, Maat SM, Khalid F. A systematic review of problem based learning in education. Creat Educ. 2019; 10(12): 2671-88. doi: 10.4236/ce.2019.1012194.
21. Ansari MT, Rahman SA, Badgujar VB, Sami F, Abdullah MS. Problem based learning (PBL): A novel and effective tool of teaching and learning. Indian J Pharm Educ Res. 2015; 49(4): 258-65. doi: 10.5530/ijper.49.4.3.
22. Smithson J, Bellingan M, Glass B, Mills J. Standardized patients in pharmacy education: an integrative literature review. Curr Pharm Teach Learn. 2015; 7(6): 851-63. doi: 10.1016/j.cptl.2015.08.002.
23. Young T, Rohwer A, Volmink J, Clarke M. What are the effects of teaching Evidence Based Health Care (EBHC)? Overview of systematic reviews. PLOS One. 2014; 9(1): e86706. doi: 10.1371/journal.pone.0086706, PMID 24489771.
24. Sailer M, Homner L. The gamification of learning: a meta-analysis. Educ Psychol Rev. 2020; 32(1): 77-112. doi: 10.1007/s10648-019-09498-w.
25. Ferro LS, Walz SP, Greuter S. Gamicards – an alternative method for paper-prototyping the design of gamified systems. Vol. 8770. IFIP Int Fed. Inf Process; 2014. p. 11-8. doi: 10.1007/978-3-662-45212-7_2.
26. Manzano-León A, Camacho-Lazarraga P, Guerrero MA, Guerrero-Puerta L, Aguilar-Parra JM, Trigueros R, *et al.* Between level up and game over: A systematic literature review of gamification in education. Sustainability. 2021; 13(4): 1-14. doi: 10.3390/su13042247.
27. Wang AI, Lieberoth A. The effect of points and audio on concentration, engagement, enjoyment, learning, motivation, and classroom dynamics using Kahoot! Proceedings of the Eur conf games-based learn. October. 2016: 738-46.
28. Sauvé L, Renaud L, Kaufman D, Marquis JS. Distinguishing between games and simulations: A systematic review. Educ Technol Soc. 2007; 10(3): 247-56.
29. Omar NS, Foozy CF, Hamid IR, Hafit H, Arbain AF, Shamala P. Malware awareness tool for Internet safety using gamification techniques. J Phys Conf Ser. 2021; 1874(1): 1-9. doi: 10.1088/1742-6596/1874/1/012023.
30. Krath J, Schürmann L, von Korflesch HF. Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning. Comput Hum Behav. 2021; 125(August):1-33. doi: 10.1016/j.chb.2021.106963.
31. Putz LM, Hofbauer F, Treiblmaier H. Can gamification help to improve education? Findings from a longitudinal study. Comput Hum Behav. 2020; 110(April):10-1. doi: 10.1016/j.chb.2020.106392.
32. Murre JM, Dros J. Replication and analysis of Ebbinghaus' forgetting curve. PLOS One. 2015; 10(7): e0120644. doi: 10.1371/journal.pone.0120644, PMID 26148023.
33. Turan Z, Avinc Z, Kara K, Goktas Y. Gamification and education: achievements, cognitive loads, and views of students. Int J Emerg Technol Learn. 2016; 11(7): 64-9. doi: 10.3991/ijet.v11i07.5455.
34. Simões J, Redondo RD, Vilas AF. A social gamification framework for a K-6 social. Comput Hum Behav. 2013; 29(2): 1-6.
35. Lin DT, Ganapathy M, Kaur M. Kahoot! It: Gamification in higher education. Pertanika J Soc Sci Humanit. 2018; 26(1): 565-82.
36. Tan PM, Saucerman JJ. Enhancing learning and engagement through gamification of student response systems. Expo Conference proceedings. ASEE Annu Conf; June; 2017. p. 1-10. doi: 10.18260/1-2--28276.
37. Chans GM, Portuguez Castro M. Gamification as a strategy to increase motivation and engagement in higher education chemistry students. Computers. 2021; 10(10): 1-24. doi: 10.3390/computers10100132.
38. Mystakidis S, Cachafeiro E, Hatzilygeroudis I. Enter the serious E-scape room: A cost-effective serious game model for deep and meaningful e-learning. 10th Int Conf Information, Intell Syst Appl IISA (July); 2019. p. 1-6. doi: 10.1109/IISA.2019.8900673.
39. Gordillo A, Lopez-Fernandez D, López-Pernas S, Quemada J. Evaluating an educational escape room conducted remotely for teaching software engineering. IEEE Access. 2020; 8(December):225032-51. doi: 10.1109/ACCESS.2020.3044380.
40. López-Pernas S, Gordillo A, Barra E, Quemada J. Comparing face-to-face and remote educational escape rooms for learning programming. IEEE Access. 2021; 9: 59270-85. doi: 10.1109/ACCESS.2021.3073601.
41. Clauson A, Hahn L, Frame T, Hagan A, Bynum LA, Thompson ME, *et al.* An innovative escape room activity to assess student readiness for advanced pharmacy practice experiences (APPEs). Curr Pharm Teach Learn. 2019; 11(7): 723-8. doi: 10.1016/j.cptl.2019.03.011, PMID 31227096.
42. Borrego C, Fernández C, Blanes I, Robles S. Room escape at class: escape games activities to facilitate the motivation and learning in computer science. J Technol Sci Educ. 2017; 7(2): 162-71. doi: 10.3926/jotse.247.
43. Mohajan HK. Knowledge is an essential element at present world. Int J Publ Soc Stud. 2016; 1(1): 31-53. doi: 10.18488/journal.135/2016.1.1/135.1.31.53.
44. Latif E, Miles S. The impact of assignments and quizzes on exam grades: A difference-in-difference approach. J Stat Educ. 2020; 28(3): 289-94. doi: 10.1080/10691898.2020.1807429.
45. Gyamfi A, Langee P, Yeboah A, Adu IA. Performance-based assessment in contemporary classroom assessment: the forms and nature. ARJASS. 2023; 19(4): 1-7. doi: 10.9734/arjass/2023/v19i4431.
46. Koné K. Exploring the impact of performance-based assessment on Malian EFL learners' motivation. Adv Lang Lit Stud. 2021; 12(3): 51-64. doi: 10.7575/aiac.alls.v.12n.3.p.51.
47. Salma N, Prastikawati EF. Performance-based assessment in the English learning process: washback and barriers. Getsempena Engl Educ J. 2021; 8(1): 164-76. doi: 10.46244/geej.v8i1.1305.
48. Kim YJ, Almond RG, Shute VJ. Applying evidence-centered design for the development of game-based assessments in physics playground. Int J Test. 2016; 16(2): 142-63. doi: 10.1080/15305058.2015.1108322.
49. Zeng C. Computer based assessment: an innovation to language assessment. J Contemp Educ Res. 2020; 4(7): 1-4. doi: 10.26689/jcer.v4i7.1389.

50. Shute VJ, Wang L, Greiff S, Zhao W, Moore G. Measuring problem solving skills via stealth assessment in an engaging video game. Comput Hum Behav. 2016; 63: 106-17. doi: 10.1016/j.chb.2016.05.047.
51. Eukel HN, Frenzel JE, Cernusca D. Educational gaming for pharmacy students – Design and evaluation of a diabetes-themed escape room. Am J Pharm Educ. 2017; 81(7): 6265. doi: 10.5688/ajpe8176265, PMID 29109566.
52. Cain J. Exploratory implementation of a blended format escape room in a large enrollment pharmacy management class. Curr Pharm Teach Learn. 2019; 11(1): 44-50. doi: 10.1016/j.cptl.2018.09.010, PMID 30527875.
53. Plakogiannis R, Stefanidis A, Hernandez N, Nogid A. A heart failure themed escape room approach to enhance pharmacy student learning. Curr Pharm Teach Learn. 2020; 12(8): 940-4. doi: 10.1016/j.cptl.2020.04.014, PMID 32564996.
54. Gordon SK, Trovinger S, DeLellis T. Escape from the usual: development and implementation of an 'escape room' activity to assess team dynamics. Curr Pharm Teach Learn. 2019; 11(8): 818-24. doi: 10.1016/j.cptl.2019.04.013, PMID 31227197.
55. Veldkamp A, van de Grint L, Knippels MC, van Joolingen WR. Escape education: A systematic review on escape rooms in education. Educ Res Rev. 2020; 31(January):1-18. doi: 10.1016/j.edurev.2020.100364.

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