Revolutionizing pharmacology education: Comparing escape rooms and traditional learning on student engagement and well-being

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ABSTRACT

Pharmacology education, integral to the development of healthcare professionals, is traditionally characterized by lecture-based teaching, written examinations, and laboratory reports. However, such conventional methods often exacerbate student stress and anxiety, potentially impairing cognitive function, hindering learning, and negatively influencing academic performance. This review explores an innovative pedagogical approach—escape room-based learning—and its potential impact on student well-being, engagement, and academic success. By comparing escape room-based learning to traditional assessments, this article investigates how these methods influence anxiety, stress, and engagement among pharmacology students. Escape rooms, initially designed as recreational activities, have gained popularity in education for their interactive and collaborative nature. Their experiential design promotes active learning, problem-solving, and teamwork. In a pharmacology context, students immerse themselves in complex scenarios, requiring them to apply theoretical knowledge to real-world clinical situations. These hands-on activities enhance understanding of drug mechanisms, interactions, and pharmacokinetics while potentially reducing the anxiety associated with high-stakes assessments. This review highlights the limitations of traditional assessment methods, which rely heavily on passive learning and are often associated with high levels of academic pressure. Conversely, escape room-based learning offers a dynamic, gamified experience, engaging students in an inclusive environment that fosters teamwork and cognitive stimulation. An imaginary escape room design, "The Pharmaceutical Lab Heist," is presented, illustrating the application of escape room learning in pharmacology. The scenario challenges students to solve pharmacology-related puzzles, including drug mechanism matching, pharmacokinetics equations, and receptor-binding games. This design fosters critical thinking and real-time problem-solving, reinforcing key pharmacological concepts. Despite the growing interest in this innovative approach, there remains a paucity of research directly comparing escape room-based learning with traditional assessment methods in pharmacology education. While existing literature suggests the potential of escape rooms to enhance student well-being and academic engagement, systematic comparative studies are limited. Addressing this gap, future research should focus on longitudinal studies that evaluate the relative efficacy of these methods in reducing anxiety and enhancing student performance.

Keywords: Academic engagement, Anxiety, Escape room-based learning, Pharmacology education, Traditional assessments

INTRODUCTION

Higher education continually evolves, seeking innovative methods to engage students and enhance learning outcomes. This ongoing transformation reflects a dedication to adapting teaching practices to meet the evolving needs and expectations of modern learners. Innovation in education recognizes that traditional methods, though important, may not fully address the varied learning styles and potential of today's students.[1] In this pursuit, educators in pharmacology are exploring unconventional approaches that not only impart knowledge but also address the holistic well-being of students.[2]

The academic journey of undergraduate and postgraduate pharmacology students is often accompanied by heightened levels of stress and anxiety.[3] Recognizing these challenges, there is a growing interest in alternative pedagogical strategies that not only enhance understanding but also alleviate the emotional burdens associated with traditional teaching and assessment techniques.[4]

TRADITIONAL PHARMACOLOGY EDUCATION

Pharmacology, as a discipline, demands a deep understanding of complex molecular interactions, physiological processes, and the application of this knowledge in clinical scenarios.[5] The conventional model of pharmacological education is characterized by a traditional lecture-based approach and supplemented with assessments involving written examinations and laboratory reports. Anxiety and stress, common companions in the academic journey, can impede cognitive function, hinder learning ability, and negatively influence overall academic performance.[6] Against this backdrop, this review seeks to explore a novel avenue in pharmacology education—the integration of escape room-based learning.

Escape rooms, initially popularized as recreational activities, have gained traction in educational settings for their immersive and collaborative nature.[7] This review examines how escape room-based learning and traditional assessments affect anxiety, stress, and engagement among pharmacology students.[8] The rationale for examining escape room-based learning lies in its potential to address multiple dimensions of the educational experience [Figure 1].[9]
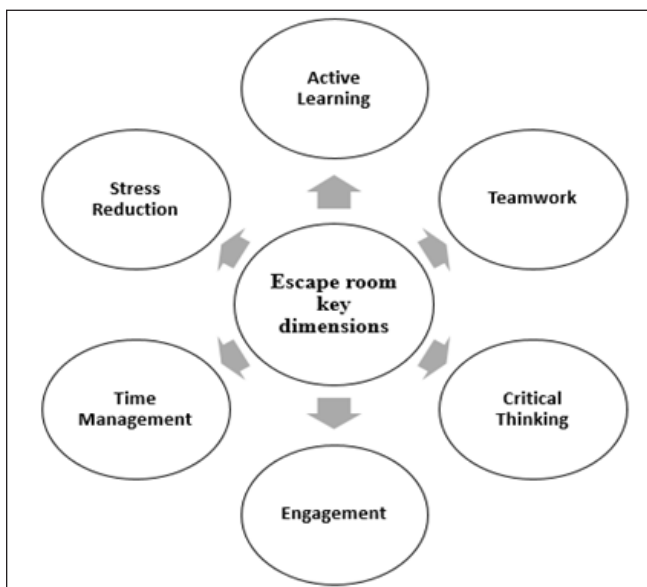
Figure 1: Escape room key dimensions.

The variety of puzzles often requires diverse skill sets, promoting inclusivity and recognizing the strengths of each participant. The gamified nature of escape rooms makes learning enjoyable, potentially reducing anxiety associated with traditional assessment methods. These elements align closely with the skills essential in pharmacological practice, making escape room-based learning an intriguing prospect for supplementing traditional teaching methods.[10] Understanding the emotional and cognitive implications of these pedagogical approaches is crucial for adapting engaging educational strategies.[11] Ideas for improving Pharmacology education will be uncovered by exploring how different teaching methods affect well-being of students.[12]

As we embark on this exploration, it is essential to acknowledge the dynamic nature of education and the diverse learning styles embraced by today's students.[13] By exploring the advantages of escape room-based learning, we aim to discover strategies for creating a more inclusive and supportive educational environment.[14]

INTRODUCTION TO EDUCATIONAL INNOVATIONS

The landscape of higher education has undergone a transformative evolution marked by a notable increase in the exploration of innovative pedagogical approaches.[15] This shift is driven by a collective effort among educators to elevate student engagement and enhance overall learning outcomes. Educators are increasingly recognizing the necessity to cater to the diverse needs of students. The introduction of escape room-based learning represents a departure from conventional approaches, offering a unique method that captivates student's interest and participation.[16]

EVOLVING HOLISTIC APPROACHES IN EDUCATION

Students, particularly in higher education, benefit significantly from actively engaging with the subject matter in a hands-on and dynamic environment.[17] The experiential nature of this approach is deemed vital for fostering a deeper understanding of complex subject matter and enhancing long-term retention.

In essence, the integration of escape room-based learning represents a response to the evolving expectations of educators and the changing dynamics of the student body.[18] By embracing unconventional yet effective methods, educators aim to create a more dynamic and engaging educational experience, fostering a learning environment that not only imparts knowledge but also nurtures a genuine interest and comprehension of complex subject matter.[19]

TRADITIONAL ASSESSMENT METHODS AND THEIR LIMITATIONS

Numerous studies have investigated the impact of traditional assessment methods on students' anxiety and stress levels.[20] The conventional approach of relying heavily on written examinations and laboratory reports has been critiqued for its potential contribution to academic pressure.

Students in pharmacology, facing the intricate nature of the subject, often experience heightened stress during traditional assessments, impacting their overall psychological well-being and potentially hindering academic performance.[21]

ESCAPE ROOM-BASED LEARNING

Escape room-based learning has surfaced as a progressive educational strategy, drawing inspiration from the recreational escape rooms that have gained popularity in leisure activities.[22]

The essence of escape room-based learning lies in its ability to provide an interactive and participatory educational experience. Students are not passive recipients of information; rather, they become active participants in their learning journey.[23]

In the context of teaching complex subjects such as pharmacology, the hands-on and experiential nature of escape room-based learning proves to be particularly compelling [Figure 2].[24] Students are challenged to apply theoretical concepts to real-world situations, simulating scenarios they may encounter in their future professional roles. Here's a detailed, imaginary escape room design for pharmacology students, incorporating various puzzles and tasks:

ESCAPE ROOM DESIGN

Imaginary escape room scenario: "The Pharmaceutical Lab Heist"

Entry

- **Scenario:** Students enter a simulated pharmaceutical lab where a valuable drug formula has been stolen. They
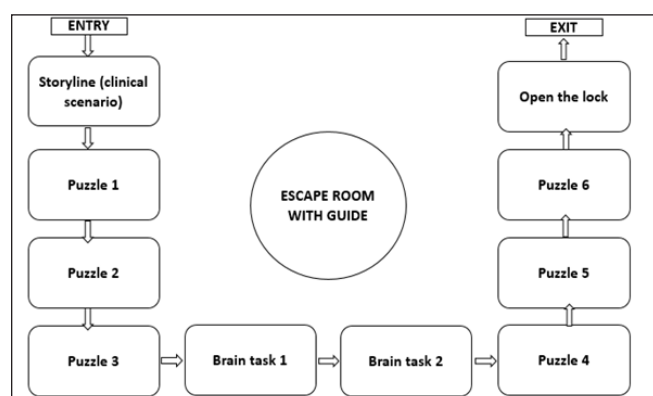

Figure 2: Escape room design.

have 60 minutes to find the formula and escape before the security system locks them.

Storyline (clinical scenario)

- **Scenario Overview:** The lab's chief scientist has been kidnapped, and the only way to rescue them and recover the stolen drug formula is to solve a series of pharmacology-related puzzles and tasks. Students must use their knowledge of drug mechanisms, interactions, and pharmacokinetics to complete the mission.

Puzzles and tasks

Puzzle 1: Drug mechanism match

- **Task:** Students find a wall of drug profiles, each with a description of the drug's mechanism of action. They need to match each profile with its correct drug category (e.g., antihypertensives, antibiotics).
- **Solution:** Correctly matched profiles reveal a code for a digital lock, where they can find a key for puzzle 2.

Puzzle 2: Pharmacokinetics equation

- **Task:** Students solve a pharmacokinetics equation related to drug half-life and dosing intervals. They find clues hidden in lab equipment to solve the equation.
- **Solution:** The result of the equation unlocks a compartment with another key for puzzle 3.

Puzzle 3: Drug interaction puzzle

- **Task:** A series of drug interaction cards are scattered around the room. Students must identify which combinations are safe and which are harmful. They use a provided guide to check their answers.
- **Solution:** Correct answers provide a code to access a safe with the next clue (for brain task 1).

Brain task 1: Metabolic pathways

- **Task:** Students need to reconstruct a metabolic pathway for a specific drug using a jigsaw puzzle. The puzzle pieces represent different enzymes and metabolic products.
- **Solution:** Completing the puzzle reveals a hidden compartment with a key for brain task 2.

Brain task 2: Receptor-binding game

- **Task:** Students play a physical game where they must match receptor types with their corresponding agonists and antagonists. The game includes a board with receptor sites and drug cards.

- **Solution:** Correct matches give them a clue for the next puzzle (puzzle 4).

Puzzle 4: Lab equipment code

- **Task:** Students need to use various pieces of lab equipment (e.g., spectrophotometer, centrifuge) to find a numerical code. Each piece of equipment has a part of the code written on it.
- **Solution:** The code opens a drawer containing the next clue (for puzzle 5).

Puzzle 5: Dosage calculation

- **Task:** Students are given a prescription with incorrect dosage information. They must correct the dosage based on weight and age factors provided in the room.
- **Solution:** Correct calculations reveal a numeric code for reaching up to puzzle 6.

Puzzle 6: Chemical compound mix-up

- **Task:** Students are provided with several chemical compounds and must determine the correct mixture to produce a specific reaction. They use a chemical guide to help them.
- **Solution:** The successful mixture opens a compartment with a clue.

Open the Lock

- **Task:** Students use the clues and codes collected from previous puzzles to open a final lock. The lock is a combination lock that requires a sequence derived from the earlier tasks.

Exit

- **Scenario:** Once the lock is opened, students retrieve the stolen drug formula and a key to unlock the final exit door. They successfully escape the lab and complete the mission.

Escape room with guide

- **Guide Overview:** A guide can provide hints and support throughout the escape room, ensuring students stay on track. The guide includes:
  1. **Initial Briefing:** Explanation of the scenario and objectives.
  2. **Hints:** Available if students get stuck on any puzzles or tasks.
  3. **Rules and Time Management:** Instructions on time limits and rules for solving the puzzles.

## ANXIETY AND STRESS IN PHARMACOLOGY EDUCATION

The academic journey of pharmacology students is acknowledged to be inherently demanding, often leading to increased levels of anxiety and stress. Present literature in this area explores the sources of stress, including the challenging curriculum, rigorous assessments, and the pressure to perform well. Understanding the psychological challenges faced by pharmacology students is crucial for identifying interventions that can alleviate stress while maintaining academic rigor.[25]

IMPACT OF EDUCATIONAL INTERVENTIONS ON ANXIETY AND STRESS

Research on interventions designed to reduce anxiety and stress in educational settings has gained prominence. The literature suggests that incorporating innovative teaching methods, such as escape room-based learning, can have a positive impact on students' emotional well-being [Figure 3].[26] These interventions aim to create a more supportive and engaging learning environment, potentially mitigating the negative effects of stress on academic performance.

ACADEMIC ENGAGEMENT IN PHARMACOLOGY EDUCATION

Academic engagement is a key factor in student success, and the literature emphasizes the importance of strategies that enhance students' involvement in their learning.[27] Studies suggest that escape room-based learning not only reduces anxiety but also enhances academic engagement by making learning enjoyable and relevant. The interactive and dynamic nature of escape rooms fosters a sense of excitement and curiosity, promoting active participation in the learning process.
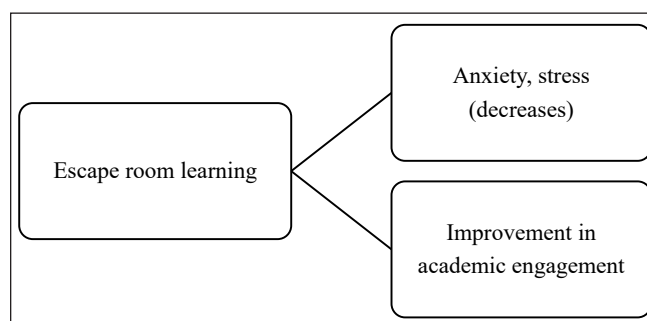
Figure 3: Escape room learning effects on anxiety, stress, and academic engagement.

COMPARATIVE STUDIES IN EDUCATIONAL APPROACHES

Comparative studies that juxtapose escape room-based learning with traditional assessment methods are limited, but gaining traction. The literature suggests that such studies are essential in understanding the differential impact on anxiety, stress, and academic engagement. By comparing the two approaches, educators and researchers can glean insights into the efficacy of each method and make informed decisions about integrating innovative teaching strategies into the pharmacology curriculum.[28]

PEDAGOGICAL CONSIDERATIONS FOR PHARMACOLOGY EDUCATION

Synthesizing findings from the literature, it becomes evident that pedagogical considerations in pharmacology education should extend beyond content delivery to encompass the holistic well-being of students.[29] The balance between academic rigor and emotional support is crucial, and escape room-based learning represents a promising approach to strike this equilibrium. Educators need to consider the unique challenges of the pharmacology discipline and tailor teaching methods accordingly.

GAPS IN CURRENT RESEARCH

The current literature acknowledges the rising interest in novel pedagogical approaches, such as escape room-based learning, and their potential impact on student well-being and academic performance. However, a critical examination reveals a paucity of research that systematically analyzes and contrasts these innovative methods with conventional assessment techniques in pharmacology students.[30]

The absence of direct comparisons between escape room-based learning and traditional assessment in the literature underscores a significant research gap, while individual studies may shed light on the efficacy of each approach independently. A comparative analysis is essential for a comprehensive understanding of their relative advantages and limitations. Such research could elucidate the nuanced effects on anxiety levels, stress management, and overall academic engagement, offering valuable insights for educators and institutions seeking evidence-based approaches.[31]

FUTURE DIRECTIONS

Future exploration should focus on designing studies that directly address these gaps, employing robust methodologies, diverse participant groups, and longitudinal perspectives. This would contribute substantially to the existing knowledge base, providing a nuanced understanding of the potential benefits and challenges associated with escape room-based learning when compared with traditional assessment methods in the specific context of pharmacology education.[32]

The exploration of innovative teaching methods, such as escape room-based learning, highlights the potential to enhance both student engagement and well-being in pharmacology education. By embracing these approaches, educators can create more dynamic and supportive learning environments that not only impart knowledge but also foster a deeper understanding and lasting interest in the subject matter. As the educational landscape continues to evolve, it is essential to consider and integrate such methods to meet the diverse needs of modern learners.

A key area for exploration can also include integrating digital escape rooms enhanced by artificial intelligence (AI) into pharmacology education. These innovative approaches could offer dynamic and engaging learning experiences compared to the traditional methods. By incorporating AI, digital escape rooms can provide personalized and adaptive challenges that cater to individual learning needs, further enriching the educational process. Embracing these advanced methods can create more interactive and supportive learning environments, improving both student engagement and well-being. As the educational landscape evolves, it is crucial to integrate such technologies to address the diverse needs of modern learners and enhance their understanding and interest in pharmacology.

CONCLUSION

Escape room-based learning offers a promising, innovative approach to pharmacology education, addressing both cognitive and emotional challenges faced by students. By promoting active learning, teamwork, and engagement, this method reduces stress and enhances understanding of complex pharmacological concepts. While traditional assessments remain integral, escape rooms present a dynamic alternative, fostering inclusivity and critical thinking.

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SH, FA, PP, RK: Conceptualization and manuscript drafting.

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Declaration of patient consent

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Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Aithal PS, Maiya AK. Innovations in higher education industry – Shaping the future. Int J Case Stud Business, IT, Educ 2023;7:283–311.
2. Ronen T, Kerret D. Promoting sustainable wellbeing: Integrating positive psychology and environmental sustainability in education. Int J Environ Res Public Health 2020;17:6968.
3. Mofatteh M. Risk factors associated with stress, anxiety, and depression among university undergraduate students. AIMS Public Health 2020;8:36–65.
4. Guerriero S. Teachers' pedagogical knowledge and the teaching profession: Background report and project objectives. 2013. Available from: https://www.oecd.org/education/ceri/Background_document_to_Symposium_ITEL-FINAL.pdf
5. Alsultan A, Alghamdi WA, Alghamdi J, Alharbi AF, Aljutayli A, Albassam A, *et al*. Clinical pharmacology applications in clinical drug development and clinical care: A focus on Saudi Arabia. Saudi Pharm J 2020;28:1217–27.
6. England BJ, Brigati JR, Schussler EE, Chen MM. Student anxiety and perception of difficulty impact performance and persistence in introductory biology courses. CBE Life Sci Educ 2019;18:ar21.
7. Fotaris P, Mastoras T. Escape rooms for learning: A systematic review. 13th European Conference on Games Based Learning (ECGBL 2019)At: Odense, Denmark; 2019.
8. Saleh Alabdulaziz M. Escape rooms technology as a way of teaching mathematics to secondary school students. Educ Inf Technol (Dordr) 2023;1–26.
9. Veldkamp A, van de Grint L, Knippels MCPJ, van Joolingen WR. Escape education: A systematic review on escape rooms in education. Educ Res Rev 2020;31:100364. Available from: https://doi.org/10.1016/j.edurev.2020.100364
10. Guckian J, Eveson L, May H. The great escape? The rise of the escape room in medical education. Future Healthc J 2020;7:112–5.
11. Darling-Hammond L, Flook L, Cook-Harvey C, Barron B, Osher D. Implications for educational practice of the science of learning and development. Appl Dev Sci 2020;24:97–140. Available from: https://doi.org/10.1080/10888691.2018.1537791
12. Grassini S. Shaping the future of education: exploring the potential and consequences of AI and ChatGPT in educational settings. Educ Sci 2023;13:692. Available from: https://doi.org/10.3390/educsci13070692
13. Smeplass E. Nurturing inclusivity and professional growth among vocational teachers through communities of practice. Pedagog Cult Soc 2023;1–20. Available from: https://doi.org/10.1080/14681366.2023.2268108
14. Manzano-León A, Rodríguez-Ferrer JM, Aguilar-Parra JM, Martínez AM, Luque de la Rosa A, Salguero García D, *et al*. Escape rooms as a learning strategy for special education master's degree students. Int J Environ Res Public Health 2021;18:7304.
15. Bygstad B, Egil Ø, Ludvigsen S, Dæhlen M. From dual digitalization to digital learning space: Exploring the digital transformation of higher education. Com Edu 2022;182:104463. Available from: https://doi.org/10.1016/j.compedu.2022.104463
16. Karageorgiou Z, Mavrommati E, Fotaris P. Escape room design as a game-based learning process for STEAM education. 13th European Conference on Games Based Learning (ECGBL 2019). Odense, Denmark; 2019.
17. Gray JA, Diloreto M. The effects of student engagement, student satisfaction, and perceived learning in online learning environments. Int J Edu Leadership Preparation 2016;11:98–119.
18. Heim AB, Duke J, Holt EA. Design, discover, and decipher: Student-developed escape rooms in the virtual ecology classroom. J Microbiol Biol Educ 2022;23:e00015–22.
19. National Education Policy 2020. Guidelines for innovative pedagogical approaches & evaluation reforms, Ministry of Eduction, Government of India, 2020; p. 1–36. Available from: https://www.ugc.gov.in/pdfnews/1031121_Guidelines-Innovative-Pedagogical-Approaches-Evaluation-Reforms.pdf
20. Lustgarten B. Impact of traditional versus alternative assessment on student achievement. Honors Projects 2022;682:1–40. Available from: https://scholarworks.bgsu.edu/honorsprojects/682
21. Deng Y, Cherian J, Khan NUN, Kumari K, Sial MS, Comite U, *et al*. Family and academic stress and their impact on students' depression level and academic performance. Front Psychiatry 2022;13:869337.
22. Fotaris P, Mastoras, T. Room2Educ8: A framework for creating educational escape rooms based on design thinking principles. Educ Sci 2022;12:768. Available from: https://doi.org/10.3390/educsci12110768
23. Opoku OG, Adamu A, Daniel O. Relation between students' personality traits and their preferred teaching methods: Students at the university of Ghana and the Huzhou Normal University. Heliyon 2023;9:e13011.
24. Järveläinen J, Paavilainen-Mäntymäki E. Escape room as game-based learning process : Causation – effectuation perspective. Proceedings of the 52nd Hawaii International Conference on System Sciences 2019;6:1466–75. Available from: http://hdl.handle.net/10125/59587
25. Babal JC, Abraham O, Webber S, Watterson T, Moua P, Chen J. Student pharmacist perspectives on factors that influence wellbeing during pharmacy school. Am J Pharm Educ 2020;84:ajpe7831.
26. Pirzadeh A, Abotalebi Z. The effect of relaxation education intervention on stress, anxiety, and depression in female

teachers during the COVID-19 pandemic. J Educ Health Promot 2023;12:348.

27. Delfino AP. Student engagement and academic performance of students of Partido State University. 2019;1–16 [Last accessed 2024 Oct 7]. Available from: https://eric.ed.gov/?id=EJ1222588

28. Rubaiy HN. Strategies to inspire students' engagement in pharmacology courses. Pharmacy (Basel) 2021;9:70.

29. Coulombe S, Hardy K. Ecological Approach. 2021.

30. Schildkamp K, Kleij FM Van Der, Heitink MC, Kippers WB, Veldkamp BP. Formative assessment: A systematic review of critical teacher prerequisites for classroom practice. Int J Educ

Res 2020;103:101602. Available from: https://doi.org/10.1016/j.ijer.2020.101602

31. Cooper KM, Downing VR, Brownell SE. The influence of active learning practices on student anxiety in large-enrollment college science classrooms. Int J STEM Educ 2018;5:23.

32. Roig PJ, Alcaraz S, Gilly K, Bernad C, Juiz C. Using escape rooms as evaluation tool in active learning contexts. Education Sciences 2023;13:535.