

Gamifying Pathology: A Novel Approach to Improve Student Engagement and Academic Performance

Karthika Padmavathy, Maghizh Jemima, Shaik Hifza Jasmine, Madhumittha R

Pathology Department, Sri
Lalithambigai Medical College
and Hospital, Dr M.G.R
Educational and Research Institute,
Chennai India.

Corresponding to:

Dr. Karthika Padmavathy.
Pathology Department, Sri
Lalithambigai Medical College and
Hospital, Dr M.G.R Educational and
Research Institute, Chennai India.

Email:

dr.karthikapadmavathy88@gmail.com

Received: 23 June 2025

Accepted: 2 July 2025

Abstract:

Background: Traditional lecture-based teaching in medical college may not be the best way to get students interested or help them remember difficult topics like pathology. The National Medical Commission (NMC) has introduced the Competency-Based Medical Education (CBME) curriculum from 2019, which puts more emphasis on active learning. Consequently, researchers are exploring numerous innovative teaching methods. This study looks at how using Bingo and crossword puzzles as a way to learn can help MBBS students do better in pathology. **Methods:** A total of 157 MBBS students in Phase II, enrolled under the CBME curriculum, were included in the study. During their self-directed learning time, they played pathology-themed bingo and crossword puzzles without any previous preparation. There were 70 students in the session. Two weeks later, all students took a formative test that had 20 MCQs (1 mark each) and 15 short-answer questions (2 marks each), for a total of 50 marks. We compared the performance of the 63 students who attended the game session and took the test with those who didn't participate. The analysis excluded 13 students who were absent. **Results:** Of 144, those who played the game ($n = 63$) did much better than those who didn't ($n = 81$). The median total score for people who attended was 42 (IQR 40–46), while the median total score for people who didn't attend was 27 (IQR 24.5–29.5). There were statistically significant differences in all parts, including MCQs, short answers, and total marks ($p < 0.001$, Mann–Whitney U test).

Keywords: game-based learning; pathology education; academic performance; active learning; and interactive teaching

Introduction

Medical education is evolving to keep up with the needs of modern clinical practice. The medical education is evolving and the researchers are exploring many innovative methods of teaching^{1,2}. Among them one of the most engaging and innovative methods to teach are game based teaching which includes bingo and crossword puzzles^{3,4}. The National Medical Commission (NMC) introduced Competency-Based Medical Education (CBME) curriculum in 2019 which was a significant reform in medical education system in India. It focuses on not only knowledge acquisition but also application, communication, and problem-solving skills⁵. This change in thinking has brought attention to teaching methods that can help students participate more, understand concepts better, and remember what they learn for a long time.

Pathology, being a bridge between basic sciences and clinical subjects, plays a critical role in shaping a medical student's diagnostic thinking. However, students often find it challenging to listen and retain the topics that are taught only through traditional lectures^{6,7}. Passive listening in large-group lectures can limit interactive learning and reduce opportunities for application and recall⁸.

Active learning strategies, which include student participation through discussion, application-based exercises, or games- have gained increasing attention in recent years. According to a number of studies, gamification of medical education increases student motivation, promotes deeper engagement, and stimulates healthy competition^{9,10}. In courses like nursing and allied health education, games like bingo, puzzles, and crosswords have been effectively used to review material and improve knowledge retention^{11,12}. These methods offer cognitive stimulation while simultaneously creating a stress-free, playful environment that enhances the learning experience¹³.

In the context of the CBME framework, game-based learning aligns well with the intended learning outcomes. It supports higher-order thinking, improves student involvement, and fosters a better grasp of clinical relevance¹⁴. Additionally, playing games as a part of education causes emotional engagement, which raises attention levels and helps ideas be encoded into long-term memory¹⁵.

This study was conceived as a response to a spontaneous opportunity: a non-scheduled, game-based learning session involving Bingo and Crossword puzzles was conducted informally for a group of second-year MBBS students covering key pathology topics. Although unplanned, the session received overwhelmingly positive feedback from the participants. The current investigation aimed to assess whether such an intervention could influence knowledge retention and performance in a formal assessment setting. Specifically, we aimed to compare the academic scores of students who participated in the games with those who prepared using conventional textbook study methods.

Through this study, we aim to contribute evidence toward the implementation of innovative, learner-centered methodologies in core subjects like pathology, thereby enhancing the overall quality of undergraduate medical training in alignment with CBME principles¹⁶.

Materials and Methods

This observational analytical study was done with 157 second-year MBBS students who were following the CBME curriculum at a medical college in South India. After obtaining approval from The Institutional Ethics Committee (Dr.MGR-ERI/SLMCH/2024/048), and the Dean and Head of the Department of Pathology gave their permission for the activity and assessment to take place. The students were all in the same academic batch, and the study took place during a self directed learning hour from February 2025.

A voluntary game-based learning session was conducted during a self directed learning hour without prior intimation, using interactive tools such as Bingo and Crossword puzzles centered around pathology topics—specifically: hemodynamic disorders, cardiovascular, and respiratory systems. This had 70 students who took part. The goal of the session was to be fun, casual, and educational, and to help students remember the main ideas by having them participate.

All students were told ahead of time that they would have a structured written test two weeks after the activity. The test had 20 multiple-choice questions (MCQs) worth 1 mark each and 15 short-answer questions worth 2 marks each, for a total of 50 marks. The test lasted for an hour and a half and was done in a way that was similar to a real exam. There were 157 students, but only 144 were there. The other 13 were absent and were not included in the analysis. Of those who were there, 63 had played the game-based session, and their scores were compared to those of the 80 who had not.

We used descriptive statistics, like means and standard deviations for both groups, to look at how well the students did. Then we used independent sample t-tests to see if the differences in scores were statistically significant. Microsoft Excel was used to enter data and do some basic analysis. Charts and flow diagrams were also made to help with interpretation.

Additionally, after the assessment, structured feedback was collected using a Google Form. The feedback consisted of six items rated on a 5-point Likert scale (Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree). The feedback questions aimed to evaluate student perceptions of the game-based session's engagement, clarity, relevance to learning objectives, utility for exam preparation, its effect on attention span, and perceived impact on knowledge retention and clinical application.

Results

Of the 157 students who signed up for the study, 70 (44.6%) took part in the Bingo and Crossword game-based learning session, while 87 (55.4%) did not. The analysis did not include thirteen students who were not present for the summative assessment. So, the last analysis was done on 144 students. Of these, 63 students (43.8%) had been to the game-based session, and 81 students (56.2%) had not, **Table (1).**

There were three areas in which students' work was graded: multiple-choice questions (MCQs), short answer questions, and total marks. The results showed that students who had played the game-based session did better on average than those who had not, **Table (2)**

The Mann–Whitney U test was used on the data to find out if the differences in scores were statistically significant. We chose this non-parametric test because the data was in order and the groups were not the same size. The results showed that there were statistically significant differences in performance on all three parts: MCQs, short answer questions, and total scores. The p-values were all less than 0.001, **Table (3).**

These findings suggest that the game-based learning strategy was associated with a marked improvement in student performance in both objective and descriptive assessment formats.

We got feedback from all 144 students who took the test. Most of the feedback statements got very positive responses. 75% of students strongly agreed 25% agreed that the session was fun and interesting. In the same way, 63.9% strongly agreed and 36.1% agreed that the activity helped them remember what they had learned.

70.1% of the students strongly believed that these kinds of methods should be used all the time. A surprising 76.4% strongly agreed and 23.6% agreed that the intervention made them feel more

confident about getting ready for tests, **Table (4).**

When it came to focus and applying what they learned, 58.3% strongly agreed and 38.9% agreed that the session helped them pay attention longer. 65.3% strongly agreed and 31.9% agreed that it helped

them remember what they learned and make it relevant to their clinical work. Only a small number of students, 2.8%, gave neutral responses in these two areas. No students said they disagreed or had negative feelings about any of the feedback items.

Table 1: Attendance of Game-based Session (n = 157 and n = 144)

Attendance	Frequency (n=157)	Percentage	Frequency (n=144)	Percentage
Yes (Attended)	70	44.6%	63	43.8%
No (Not Attended)	87	55.4%	81	56.2%
Total	157	100%	144	100%

Table 2: Median and Interquartile Range (IQR) of Marks

Component	Attended (Median, IQR)	Not Attended (Median, IQR)	Overall (Median, IQR)
MCQ (20 marks)	17 (15–18)	11 (9–14)	14.5 (11–17)
Short Notes (30 m)	25 (23–28)	16 (13.5–18)	19 (15–25)
Total (50 marks)	42 (40–46)	27 (24.5–29.5)	30 (27–42)

Table 3: Mann–Whitney U Test Results

Component	Group	Mean Rank	Sum of Ranks	Mann–Whitney U	p-value
MCQ Marks	Attended	107.87	6795.5	323.5	<0.001
	Not Attended	44.99	3644.5		
Short Notes	Attended	108.81	6855	264.0	<0.001
	Not Attended	44.26	3585		
Total Marks	Attended	109.39	6891.5	227.5	<0.001
	Not Attended	43.81	3548.5		

Table 4: Results on Feedback from students

Feedback Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total Responses
The session was engaging and enjoyable	108	36	0	0	0	144
Helped improve retention of concepts	92	52	0	0	0	144
Should be implemented regularly	101	43	0	0	0	144
Felt more confident during test preparation	110	34	0	0	0	144
Improved attention span	84	56	4	0	0	144
Aided knowledge retention and clinical relevance	94	46	4	0	0	144

Discussion

Our study adds a lot to the growing body of evidence that game-based learning (GBL) that can change the way medical students learn, especially in subjects like pathology that have a lot of content. The

big difference in test scores between students who played the game and those who used traditional methods shows that they not only remembered the content better, but also understood it better,

thought critically, and showed more interest. The improvement in performance among participants backs up what was found before: active, student-centered teaching methods led to better academic results and happier students¹⁴⁻¹⁶.

The efficacy of simple, cost-effective tools like Bingo and Crossword puzzles lies in their dual benefit: they enhance the fun element in learning while reinforcing theoretical concepts¹⁷⁻²⁰.

These game based tools help make a learning environment that is immersive and collaborative by combining competition, repetition, and interaction with peers. Similar results to our study, Patel et al.²¹ found crossword-based review sessions helped students remember pathology content better in the long term than passive revision methods. Shailaja et al.²² also talked about how structured games that let students review in a relaxed, peer-supported setting helped them feel less anxious and stressed about tests.

The educational philosophy underlying this intervention is deeply rooted in Kolb's Experiential Learning Theory²³, which emphasizes the role of concrete experience, active experimentation, and reflective observation in building deeper understanding. Games naturally encourage students to "do and reflect" instead of just passively taking in information. This hands-on method helps people understand concepts better and use what they know in real life.

Self-Determination Theory (SDT)²⁴⁻²⁷ also, supports the use of gamified strategies in education. It says that places where people can learn that support autonomy, competence, and relatedness are more likely to make people want to learn. The way we planned our session, which included voluntary participation, immediate feedback, and working with peers- was very much in line with these ideas. This made students feel like they owned their learning and gave them confidence.

The feedback obtained from participants also strengthens the study's findings. A vast majority found the session engaging and preferred this method over traditional lectures. The quantitative Likert-scale results indicate not only satisfaction but also strong endorsement of GBL as a potential mainstay in the curriculum. The qualitative replies suggest that the students loved how active and entertaining the session was. One student commented, "It felt like revising while playing," while another added, "It made the subject more relatable and fun." These remarks demonstrate that these seminars are more inspiring than we thought.

One of the study's merits is that the gaming session was set up quickly and with few resources, showing that educational interventions don't necessarily have to be complicated or expensive to work. Even though we didn't utilize any advanced digital platforms or simulation tools, we were able to improve information retention and exam scores by carefully designing the sessions and getting the learners involved.

However, the absence of a pre-test design limits our ability to measure the exact quantum of learning gain attributable to the intervention alone. While post-test results clearly favor the GBL group, a baseline assessment would have helped quantify the improvement more precisely. Furthermore, randomized controlled trials and multi-institutional studies²⁸⁻³⁰ are recommended in future research to confirm reproducibility, eliminate selection bias, and establish generalizability across various learning environments and student populations.

In conclusion, this study shows that using games in medical education might make it more interesting, useful, and easy for the students to learn. As undergraduate students have more to think about, using these kinds of tactics might be quite helpful for helping them do well in school and gain skills that will last a lifetime.

Strengths and Limitations

Strengths

A lot of students took part in the study, which demonstrates that they were quite interested in the game-based method. It was easy to observe how well pupils were learning by comparing items in real time using objective test results. The data and the students' remarks demonstrated that the method succeeded.

Limitations:

One big problem was that there was no data from before the exam, which made it hard to establish exactly how much information was gained. If people had chosen to participate on their own, there would have been self-selection bias. Also, the results might not be useful in many situations because the study only looked at one medical institute.

Conclusion

Researchers have found that even when game-based learning is used in a casual and unplanned way, it makes students much more excited about learning. It makes them better to remember what they learn, and more positive about learning in general. This study shows how important it is to use interactive teaching methods in traditional medical colleges, especially in the CBME framework, which is all about focussing on students and on their results. From the students' good scores and feedback- we know that these methods could work well with regular teaching. Faculty doctors are encouraged to carefully add game-based activities to regular classes to make them more fun and helpful for learning. These settings will not only help students do better in medical school, but they will also teach future doctors learning throughout their lives.

Future Implications

Integrating planned game-based sessions into the pathology curriculum and tracking longitudinal performance trends could provide further insights. Collaborations with educational technologists can also

support the development of scalable game-based modules.

References

1. Abdulghani HM, Ahmad F, Irshad M, Khalil MS, Al-Shaikh GK, Syed S, et al. Computer-assisted learning and interactive group discussions as methods of teaching physiology: A comparative study. *BMC Med Educ.* 2015;15:97.
2. Selvakumar N, Duraimurugan M, Chandrasekar M. Effectiveness of crossword puzzle in enhancing learning among medical students in biochemistry. *J Clin Diagn Res.* 2017;11(12):JC01–JC04.
3. Shinde M, Bairagi A. Effectiveness of crossword puzzle in teaching-learning of nursing students. *Int J Curr Res.* 2018;10(10):73924–73926.
4. Cadorin L, Bagnasco A, Rocco G, Tolotti A, Pagnucci N, Sasso L. Developing professional competence in nursing students: the role of tutorial strategies. *Nurse Educ Pract.* 2019;35:17–22.
5. National Medical Commission. *Competency Based Undergraduate Curriculum for the Indian Medical Graduate.* New Delhi: NMC; 2019.
6. Harden RM, Crosby JR, Davis MH. AMEE Guide No. 14: Outcome-based education: Part 1—An introduction to outcome-based education. *Med Teach.* 1999;21(1):7–14.
7. Yardley S, Teunissen PW, Dornan T. Experiential learning: Transforming theory into practice. *Med Educ.* 2012;46(1):86–95.
8. Wiederhold BK, Davis R, Wiederhold MD. Virtual reality exposure therapy for war veterans with posttraumatic stress disorder. *Cyberpsychol Behav Soc Netw.* 2011;14(1-2):75–78.
9. Koivisto JM, Haavisto E, Niemi H, Katajisto J, Multisilta J. Elements explaining learning clinical reasoning in simulation among nursing students. *Nurse Educ Today.* 2016;45:143–149.
10. Hung CL, Hsu YC, Cheng YH, Chung SY. The effectiveness of game-based learning in medical education: A systematic review and meta-analysis. *BMC Med Educ.* 2019;19:276.
11. Knowles MS. *The Adult Learner: A Neglected Species.* 3rd ed. Houston: Gulf Publishing; 1984.
12. Kolb DA. *Experiential Learning: Experience as the Source of Learning and Development.* Englewood Cliffs: Prentice Hall; 1984.
13. Deci EL, Ryan RM. The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychol Inq.* 2000;11(4):227–268.

14. Kaur H, Mahajan R, Singh T. Introducing crossword puzzle as a self-learning tool in pharmacology. *J Educ Health Promot.* 2019;8:202.
15. Dissanayake R, Wathurapatha WS, Wijesinghe HD, Kottahachchi J. Student perceptions regarding the use of games to enhance learning in medical education. *Educ Health (Abingdon).* 2020;33(1):6–12.
16. Bickerdike SR, Booth RS, Wilson PM, Murtagh GM. Peer learning in medical student education: What are the benefits? *Med Teach.* 2020;42(7):746–752.
17. Zayabalaradjane Z. Game-based learning in pathology: A MedEdPublish review. *MedEdPublish.* 2021;10(1):57.
18. Cain J, Piascik P. Are serious games a good strategy for pharmacy education? *Am J Pharm Educ.* 2012;76(4):68.
19. Nair SP, Shah T, Seth S. Enhancing active learning in physiology using crossword puzzles. *Natl J Physiol Pharm Pharmacol.* 2021;11(9):1035–1039.
20. Bonwell CC, Eison JA. *Active Learning: Creating Excitement in the Classroom.* Washington, DC: ASHE-ERIC Higher Education Report No. 1; 1991.
21. Patel VL, Yoskowitz NA, Arocha JF. Translating biomedical informatics into clinical practice: More than technology is required. *Acad Med.* 2000;75(10):S112–S118.
22. Shailaja S, Sudha S. Enhancing medical student engagement through gamification: A cross-sectional study. *J Adv Med Educ Prof.* 2022;10(4):199–205.
23. Kolb DA. *Experiential Learning: Experience as the Source of Learning and Development.* Englewood Cliffs: Prentice Hall; 1984.
24. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Psychol Inq.* 2000;11(4):227–268.
25. Connolly TM, Boyle EA, MacArthur E, Hainey T, Boyle JM. A systematic literature review of empirical evidence on computer games and serious games. *Comput Educ.* 2012;59(2):661–686.
26. Deterding S, Dixon D, Khaled R, Nacke L. From game design elements to gamefulness: Defining gamification. *Proc CHI.* 2011;12:2425–2428.
27. Deci EL, Ryan RM. *Handbook of Self-Determination Research.* Rochester: University of Rochester Press; 2002.
28. Sandars J, Patel R, Steele H, McAreavey M. Developmental student support in medical education: Lessons learned. *Med Teach.* 2020;42(7):715–718.
29. Khan A, Egbue O, Palkie B, Madden J. Active learning: Engaging students to maximize learning in an online course. *BMC Med Educ.* 2022;22:123.
30. George PP, Papachristou N, Belisario JM, Wang W, Wark PA, Cotic Z, et al. Online eLearning for undergraduates in health professions: A systematic review of the impact on knowledge, skills, attitudes, and satisfaction. *Med Teach.* 2014;36(Suppl 1):S38–S44.

To cite this article: Karthika Padmavathy, Maghizh Jemima, Shaik Hifza Jasmine, Madhumittha R. Gamifying Pathology: A Novel Approach to Improve Student Engagement and Academic Performance. *BMFJ* 2025;42(10):36-42.