

COMPARATIVE ANALYSIS OF THE 'COMPLETE THE INCOMPLETE' GAME MODEL IN TEACHING PATHOLOGY TO UNDERGRADUATE MEDICAL STUDENTS

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Abstract

Background: Using games to get students' attention and get them involved in active learning isn't new. Due to the vastness of the medical educational system, and the fact that students are getting less proficient at reading, Interactive, collective, and competitive games tend to boost and encourage students to participate in reading and learning processes. One such game is using of 'Complete the Incomplete' game model to understand and retain the step wise pathways in pathology. The aim of the study is to analyze the effectiveness of "Complete the Incomplete" game model in understanding Pathology concepts. **Materials and Methods:** A Sample size of 150 second year undergraduate students was selected by using Random sampling method and G power analysis. Proper inclusion and exclusion criteria were applied. The sample population was grouped into two. Group A consists of 75 students, who were exposed to 'Complete the Incomplete' game model along with interactive lecture classes for 2 selected topics, Group B consists of 75 students who were not exposed to the game and only exposed to interactive lecture classes for the same. **Result:** Both the groups were made to take written tests on the topic and the results were obtained in an unbiased manner and fill out a feedback questionnaire. Both are statistically analysed, compared, and thus interpreted. Students who played 'Complete the Incomplete' games in conjunction with lectures would get significantly higher marks than those who only attended lectures and showed positive feedback towards the game model. **Conclusion:** The "Complete the Incomplete" game model demonstrated a significant improvement in students' performance and was positively received by the students.

INTRODUCTION

The field of medical education is undergoing a transformation, moving away from traditional lecture-based teaching towards more engaging and effective learning strategies. This shift is driven by a growing recognition that active learning approaches can significantly enhance students' comprehension and retention of complex medical concepts. While traditional lectures remain integral to medical curricula, educators are increasingly integrating innovative educational tools to enrich the learning experience. Active learning strategies encourage students to participate actively in the learning process, promoting critical thinking and application of knowledge. These methods include problem-based learning (PBL), case-based learning (CBL), flipped classrooms, and educational games. Each approach

aims to shift the focus from passive listening to active engagement, thereby deepening students' understanding and preparing them for real-world clinical challenges.

Educational games represent a promising innovation in medical education. These games are designed to simulate clinical scenarios, diagnostic challenges, or procedural skills in a virtual or simulated environment. By incorporating game mechanics such as competition, rewards, and immediate feedback, educational games motivate students and facilitate deeper learning. Research has shown that such gamified approaches not only enhance knowledge retention but also improve decision-making skills and teamwork among medical students.

Several studies have demonstrated the effectiveness of educational games in medical education. For example, a study by Chakaravarthy et al,^[1] found that

medical students who participated in a simulation game on emergency medicine showed significantly higher levels of knowledge retention and clinical reasoning compared to those who underwent traditional instruction alone. Similarly, one more review reported that a card-based educational game improved students' ability to diagnose rare diseases through repeated practice and interactive learning.^[2] While traditional lecture-based methods remain foundational in medical education, the integration of innovative approaches such as educational games offer significant benefits. These games not only make learning more interactive and enjoyable but also enhance students' understanding of complex medical concepts and prepare them for clinical practice. As medical education continues to evolve, leveraging technology and gamification could play a crucial role in shaping the future of how medical professionals are trained.^[3] One such innovative approach is the use of educational games, which have been shown to make learning more interactive and enjoyable. This study focuses on the "Complete the Incomplete" (C the I) game model, an educational tool aimed at improving the understanding of pathology concepts among undergraduate medical students. The C the I game model, specifically designed for pathology, helps students understand and memorize stepwise pathways by actively involving them in the learning process.

Pathology, as a branch of medical science, deals with the study of diseases, their causes, processes, development, and consequences. The complexity of pathology requires students to have a deep understanding of various mechanisms and pathways, which can be challenging to achieve through traditional teaching methods alone.^[4] The C the I game model addresses this challenge by transforming learning into a more engaging and interactive experience. Our study aimed to analyze the effectiveness of the "Complete the Incomplete" game model in understanding pathology concepts. The objectives of our study are, 1) To develop the "Complete the Incomplete" game model for two different topics in pathology, 2) To compare the game model with interactive lecture classes to assess its effectiveness and 3) To assess the feedback of the game model qualitatively using a questionnaire.

MATERIALS AND METHODS

This study was designed as a cross-sectional analysis and was approved by the Institutional Human Ethics Committee (IHEC) (MMCRI/IEC/2023/024). The study involved a sample size of 150 second-year undergraduate medical students, determined through G-power analysis. Inclusion Criteria of the study are second-year undergraduate medical students who had not been previously exposed to the topics under study and who were willing to participate. Students who were unwilling to participate are excluded from the study.

The "Complete the Incomplete" game model was developed specifically for two pathology topics. The selection of topics was based on their complexity and the common challenges students face in understanding them. The topics chosen for this study were Leukemia morphology. Specific portions related to Leukemia morphology were selected from the standard textbook, ROBBINS Pathology, 10th edition. The images from the textbook was grabbed and the salient points for the morphology of leukemia were hidden with a white text box using Microsoft PowerPoint application. The modified content was converted into PDF format and printed for use in the game. The game model underwent a validation process involving two subject matter experts. The validation was conducted using the kappa agreement method, achieving an agreement level of over 95%, ensuring the reliability and accuracy of the content used in the game.

The study involved 150 participants who were divided into two groups. The first group, consisting of 75 students, engaged with the "Complete the Incomplete" (C the I) game model in addition to a prior interactive lecture session on leukemia integrated into their regular class schedule. After the lecture, these students formed small groups of four. Each group received printed game materials and was allowed to refer to their textbooks to complete the hidden portions of the printed concepts. They were given 15 minutes to complete the task. Upon finishing, the groups submitted their completed materials, which facilitators then checked and corrected immediately. The second group, also comprising 75 students, received traditional interactive lecture classes without the incorporation of the C the I game model. The effectiveness of the game model was assessed using multiple-choice questions (MCQs) designed to evaluate the students' understanding of the pathology concepts taught. The assessment comprised 15 MCQs, with a total possible score of 15 marks. In addition to the quantitative assessment through MCQs, feedback was collected using a structured questionnaire. The questionnaire aimed to gather students' perceptions of the game model, including its engaging nature, ease of use, and perceived impact on their learning. The data collected from the assessments were analyzed using statistical methods. After the data collection the students were allowed to cross over. An independent t-test was employed to compare the performance of the two groups. Descriptive analysis was conducted to summarize the feedback from the students.

RESULTS

The results of the MCQ assessments revealed a significant difference in the performance of students who used the C the I game model compared to those who received traditional interactive lecture alone. The mean scores of the group using the game model were notably higher, indicating a better

understanding and retention of the pathology concepts.

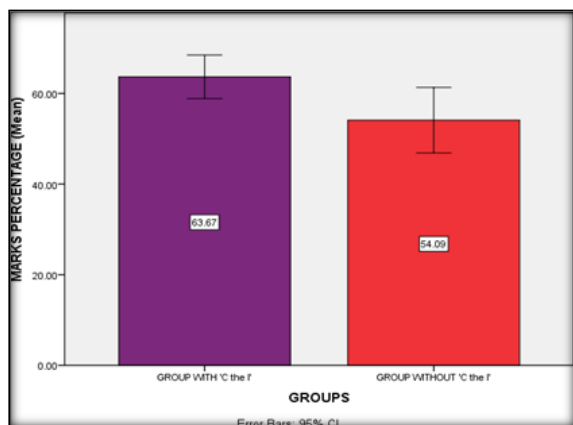


Figure 1: Mean score obtained by the study population. Purple indicates the mean score of the group with “C the I” game and the Red indicates the mean score of the group without exposed to the game.

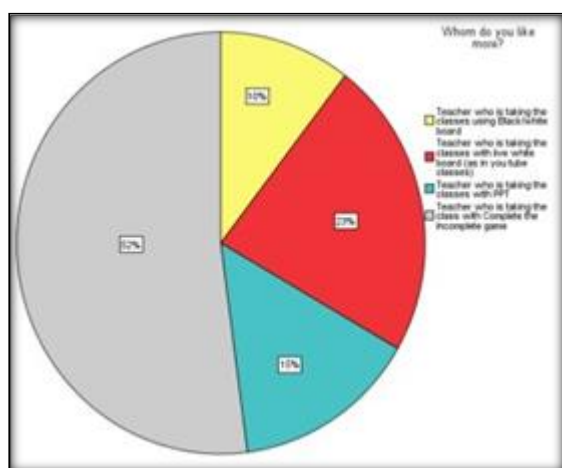


Figure 2: Feedback analysis regarding the preferences for facilitators/teachers among the study population.

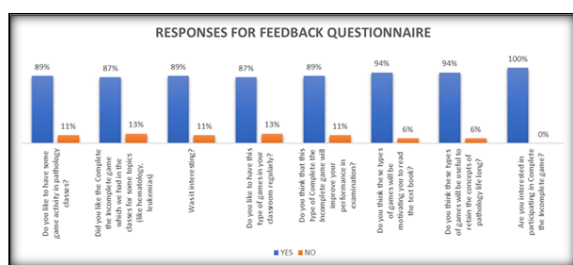


Figure 3: Feedback analysis of the “C the I” game based learning.

The results of the study indicate that the group utilizing the "Complete the Incomplete" (C the I) game model achieved significantly higher performance compared to the group without exposure to the game as shown in the figure 1. Specifically, the group with the C the I intervention obtained a high mean score of 63.67 (± 20.9), whereas the group without the C the I intervention had a mean score of 54.09 (± 31.46). The analysis yielded a P-value of <0.001 , indicating that the difference between the

two groups was statistically significant. These findings suggest that the students who participated in the C the I game performed better, demonstrating the effectiveness of the gaming model in enhancing academic performance among the study population. The significant improvement in scores for the group exposed to the game underscores the potential of interactive and engaging learning tools in medical education, supporting the hypothesis that active learning strategies can lead to better educational outcomes.

The pie chart in figure 2 illustrates student preferences for different types of facilitators or teachers based on their teaching methods. The largest segment, representing 52% of the respondents, shows a strong preference for teachers who incorporate the "Complete the Incomplete" (C the I) game into their classes. This indicates that more than half of the students find this interactive and engaging method highly effective and enjoyable. Following this, 29% of students prefer teachers who use PowerPoint presentations (PPT) for their lectures, underscoring the importance of visual aids in enhancing understanding and retention of material. Additionally, 15% of students prefer teachers who utilize live whiteboard sessions, like those found in YouTube classes, highlighting the appeal of real-time, visual explanations and demonstrations. The smallest segment, making up 10% of the chart, reflects a preference for traditional blackboard or whiteboard teaching methods, indicating that while less popular, this approach still holds value for a subset of students. The data reveals a clear preference for interactive and visually engaging teaching methods among students, with the C the I game model being the most favoured.

The feedback from students provided additional insights into the effectiveness of the game model. The feedback questionnaire results, as depicted in the accompanying bar chart, indicate strong positive responses from students regarding the "Complete the Incomplete" game model used in pathology classes (Figure 3). A substantial majority, 89%, expressed a preference for incorporating game activities into pathology classes. Similarly, 87% of students reported enjoying the Complete the Incomplete game. When asked if the game sessions should be included in classes for specific topics like haematology and leukemia, 89% responded affirmatively, highlighting the game's perceived relevance and interest. Furthermore, 87% of students favored having such game sessions regularly in their classrooms. Most respondents, 89%, found the game engaging, while 94% believed it helped improve their performance in examinations. Additionally, 94% agreed that such types of games motivated them to read more from textbooks and helped them retain pathology concepts for life. Notably, all students (100%) expressed interest in participating in the Complete the Incomplete game, demonstrating its universal appeal and potential for wider application in medical education.

The feedback was overwhelmingly positive, with students highlighting several key benefits of the C the I game model. The "Complete the Incomplete" game model significantly enhanced student engagement, making the learning process more enjoyable and interesting compared to traditional lectures. The interactive nature of the game promoted active participation, which facilitated better understanding and retention of the material. Students found the game format easy to follow and appreciated the opportunity to refer to textbooks to complete the incomplete points. Moreover, many students reported that the game improved their retention of concepts, as the process of actively finding and filling in the missing information reinforced their learning.

DISCUSSION

The findings from this study suggest that the "Complete the Incomplete" game model is an effective educational tool for teaching pathology concepts to undergraduate medical students. The significant improvement in MCQ scores among students who used the game model indicates that this interactive approach enhances understanding and retention of complex medical information. The results of this study are consistent with existing literature on the benefits of game-based learning in medical education. The feedback was overwhelmingly positive, with students highlighting several key benefits of the C the I game model. The "Complete the Incomplete" game model significantly enhanced student engagement, making the learning process more enjoyable and interesting compared to traditional lectures. The interactive nature of the game promoted active participation, which facilitated better understanding and retention of the material. Students found the game format easy to follow and appreciated the opportunity to refer to textbooks to complete the incomplete points. Moreover, many students reported that the game improved their retention of concepts, as the process of actively finding and filling in the missing information reinforced their learning.

The C the I game model adds to this body of evidence by providing a practical example of how game-based learning can be implemented in pathology education. The "Complete the Incomplete" game model offers several advantages in the context of medical education. By transforming the learning process into an interactive game, it significantly enhances student engagement and motivation to learn. The game's structure requires students to actively find and fill in missing information, which promotes deeper learning and comprehension of the material. Additionally, the game provides immediate feedback, enabling students to correct their mistakes and reinforce their understanding promptly. Moreover, the game can be effectively used in group settings, fostering collaborative learning and encouraging discussion

among students, thereby enriching the educational experience.

Previous studies have demonstrated that educational games can improve student engagement, motivation, and learning outcomes.^[5-7] Game-based learning has been increasingly recognized as an effective pedagogical approach in medical education, particularly in fields such as pathology. Studies have shown that digital games can significantly enhance the quality of medical education by making the learning process more engaging and interactive. For instance, a systematic review and meta-analysis found that digital game-based learning methods improve student engagement and knowledge retention, which are crucial for effective medical training.^[8]

One study that utilized the Kahoot! platform for gamified formative assessment in pathology education demonstrated positive outcomes. The study highlighted improved student perceptions and academic performance, suggesting that game-based tools can be seamlessly integrated into pathology curricula to foster a more engaging learning environment. In addition to engagement and retention, game-based learning also prepares students for clinical experiences. A randomized controlled trial showed that using video games helped nursing and medical students become more prepared for their first visits to the operating theatre. This method reduced anxiety and improved their readiness for real-world clinical tasks.^[9]

Withal, the use of serious games has been shown to be more effective than traditional e-modules in teaching patient safety, according to a comparative study. The findings suggest that serious games can provide a more interactive and impactful learning experience, thereby enhancing students' understanding and awareness of patient safety protocols.^[10] Another notable example is the use of InsuOnline, an educational game designed for teaching insulin therapy. A randomized controlled trial with primary care physicians revealed that this game significantly improved their knowledge and skills in managing diabetes, showcasing the potential of game-based learning to enhance practical medical skills.^[11]

These studies collectively underscore the benefits of incorporating game-based learning into medical education. By making learning more interactive and engaging, game-based methods not only improve knowledge retention but also better prepare students for practical, real-world applications. This aligns well with the findings of our study, which demonstrated the effectiveness of the "Complete the Incomplete" (C the I) game model in enhancing student performance and engagement in pathology education.

While the study demonstrates the effectiveness of the "Complete the Incomplete" (C the I) game model, there are some limitations to consider. Firstly, the study was conducted with a relatively small sample size of 150 students, which may limit the

generalizability of the findings. Secondly, the assessment was conducted shortly after the learning sessions, so long-term retention was not evaluated. Thirdly, the study was conducted at a single institution, which may limit the applicability of the results to other educational settings. Future research could address these limitations by conducting studies with larger and more diverse student populations, as well as evaluating the long-term impact of the game model on knowledge retention. Additionally, exploring the application of the C the I game model to other medical subjects and integrating it with other active learning strategies could further enhance its effectiveness.

CONCLUSION

The "Complete the Incomplete" game model is a valuable educational tool for teaching pathology concepts to undergraduate medical students. It promotes active learning, enhances engagement, and improves understanding and retention of complex information. The positive feedback from students further supports the utility of this game model as an innovative teaching strategy in medical education. Future research should continue to explore and refine this approach to maximize its benefits across various medical disciplines.

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