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ORIGINAL ARTICLE

Unlocking Engagement: The Power of Gamification in Anatomy Education

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ABSTRACT

Background: Although a foundational aspect of medical pedagogy, the teaching of anatomy is frequently regarded as tedious in traditional formats. An alternative potential method of improving engagement is the implementation of gamification, which utilizes various components of play, competition, and reward structures. This study evaluated the impact of gamified learning on knowledge acquisition, motivation, and satisfaction among first- and second-year MBBS students enrolled in anatomy courses.

Methodology: This research was conducted as a quasi-experimental study and was undertaken at Liaquat University of Medical and Health Sciences (LUMHS), Jamshoro, and Khairpur Medical College from January to July 2023. Two hundred MBBS students participated in the study. Anatomy was taught using three gamified modules which included pedagogical quizzes, puzzles, and interactive point systems which included a feedback mechanism, leaderboards, and gamification of feedback in real time. Knowledge was evaluated with pre and post-tests and a Likert scale questionnaire was used to assess the students' engagement, confidence, and satisfaction. Descriptive and inferential statistics were used to analyze the data with a confidence interval of 95% ($p < 0.05$).

Results: Gamification led to significant improvement in learning outcomes. The mean knowledge score increased from 54.1 ± 9.6 (pre-test) to 78.4 ± 8.3 (post-test) ($p < 0.001$). Confidence, engagement, and satisfaction scores also showed notable increases. No significant gender difference was observed in learning gains ($p = 0.412$). A strong positive correlation was noted between engagement and knowledge improvement ($r = 0.66$, $p < 0.001$). Overall, students demonstrated high satisfaction with gamified learning and reported increased motivation and enjoyment in anatomy sessions.

Conclusion: Incorporating aspects of gamification into the teaching of anatomy positively improved knowledge acquisition, motivation, and engagement of MBBS students. Adopting an interactive and enjoyable approach to what is often considered an unengaging and rote learning discipline showcases the potential of gamification to positively enhance students' participations and performance. The introduction of deliberate gamified elements into the medical undergraduate curriculum would provide the opportunity for more engaging and student-centered learning environments.

Keywords: Gamification; Anatomy Education; Medical Students; Learning Motivation; Educational Innovation; Engagement; Interactive Learning.

INTRODUCTION

Anatomy is the cornerstone of the health sciences curriculum and is key to students appreciating the form and function of the human body. The challenges students encounter in learning anatomy are due to the sophisticated memorization and the challenges of abstract spatial visualization the discipline demands. Anatomy is taught in a lecture-based style which is, informative, though, it does not capture students' interest and engagement leading to surface rather than profound learning[1-3].

Recent innovations in educational technologies regard gamification as an emerging approach to refresh the teaching of anatomy. Gamification is the use of game design elements like points, challenges, leaderboards, and rewards in learning environments that are not games. Its goal is to foster enjoyment, engagement, and mild competition. Combining play with purpose, gamification changes the learning of monotonous tasks into exhilarating exercises that entice the learner and facilitate retention[4-6].

The advantages of gamified learning in medicine and allied health professions education continue to accumulate in the literature. Numerous studies have shown that gamified learning approaches improve student motivation and engagement and overall academic success. In the case of anatomy, the use of digital games and interactive simulations has been shown to assist the learner in achieving better spatial comprehension and recall of intricate structures. Nevertheless, the degree to which gamification impacts cognitive and affective outcomes is still an area of increasing focus[7-9].

This study was therefore undertaken to evaluate the effect of gamification on anatomy learning outcomes among undergraduate medicine students. Specifically, it aimed to measure changes in knowledge, engagement, confidence, and satisfaction following a structured gamified intervention. The findings contribute to the expanding field of innovative teaching practices and support the integration of play-based strategies into medical education.

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METHODOLOGY

This study evaluated the effectiveness of gamification in anatomy teaching and learning using a quasi-experimental quantitative pre-test and post-test design. The study was conducted at Liaquat University of Medical & Health Sciences (LUMHS), Jamshoro and Khairpur Medical College, Khairpur Mir's, over a six-month period from January 2023 to July 2023. The purpose of the study was to determine the extent to which gamified teaching strategies influence medical students' knowledge acquisition, engagement, and motivation in anatomy learning. Ethical approval was obtained from the institutional review boards, and written informed consent was secured from all participants. Anonymity and confidentiality of the participants were ensured throughout the study.

A total of 200 MBBS students participated in the study. Participants were selected using convenience sampling and included only first- and second-year MBBS students, as anatomy is taught during these years.. Students who previously completed advanced anatomy modules or who did not consent to participate were excluded to ensure uniformity in baseline knowledge.

At baseline, students completed a structured pre-test consisting of 25 multiple-choice questions (MCQs) covering key concepts of gross anatomy to assess prior knowledge. The focus remained on quantitative assessment only.

Gamified instructional strategies were then introduced, including anatomy quiz competitions, interactive digital activities, puzzles, point-based learning, badges, leaderboards, and instant feedback. Both individual and team-based gamified tasks were used to enhance engagement and promote active participation in the learning process.

Following the intervention, students completed a post-test with the same structure as the pre-test to measure knowledge

gains. A Likert-scale questionnaire was also administered to assess engagement, motivation, and satisfaction levels.. The tools used were designed based on validated educational instruments.

Data analysis was performed using SPSS version 26.0. Demographic characteristics were summarized using descriptive statistics, including mean, standard deviation, and percentages. A paired t-test was applied to compare pre- and post-test scores, while an independent t-test assessed gender-based differences in learning gains. Pearson's correlation coefficient was used to examine relationships between engagement, satisfaction, and knowledge improvement. A significance level of $p < 0.05$ was considered statistically significant.

RESULTS

A total of 200 MBBS students participated in the study, with an average age of 20.9 years (SD = 1.3). Of the participants, 52% were female and 48% were male. Equal numbers of first-year (50%) and second-year (50%) students were enrolled. All participants had prior exposure to traditional anatomy teaching, but only 32% had previous experience with gamified learning approaches. This ensured that the majority were introduced to structured gamification for the first time in this study.

Table 1: Demographic Characteristics of Participants (n = 200)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	Mean ± SD	20.9 ± 1.3	—
Gender	Male	96	48.0
	Female	104	52.0
Year of Study	First Year MBBS	100	50.0
	Second Year MBBS	100	50.0
Prior Anatomy Knowledge	Yes	200	100
Prior Gamified Learning Exposure	Yes	64	32.0
	No	136	68.0

A significant improvement was noted across all measured learning outcomes following the gamified anatomy learning intervention. The mean knowledge score increased from 54.1 ± 9.6 before the intervention to 78.4 ± 8.3 after the intervention ($p < 0.001$). Confidence, engagement, and satisfaction levels also showed statistically significant improvements, highlighting the positive impact of gamification on student learning and motivation.

Table 2: Comparison of Pre-Test and Post-Test Scores After Gamification

Variable	Pre-Test Mean ± SD	Post-Test Mean ± SD	Mean Difference	p-value
Knowledge Score	54.1 ± 9.6	78.4 ± 8.3	+24.3	< 0.001
Confidence	2.9 ± 0.8	4.2 ± 0.7	+1.3	< 0.001
Engagement	3.1 ± 0.7	4.6 ± 0.5	+1.5	< 0.001
Satisfaction	3.3 ± 0.7	4.7 ± 0.4	+1.4	< 0.001

When comparing knowledge gain between genders, no significant difference was observed. Male students improved by an average of 23.8 ± 7.9 points while female students improved by 24.6 ± 7.4 points ($p = 0.412$), showing that gamification was equally effective among male and female medical students.

Table 3: Gender-wise Comparison of Knowledge Gain

Gender	Mean Knowledge Gain ± SD	p-value
Male	23.8 ± 7.9	0.412
Female	24.6 ± 7.4	—

A strong positive correlation was found between student engagement and knowledge gain ($r = 0.66$, $p < 0.001$). Satisfaction also demonstrated a moderate positive correlation with knowledge improvement ($r = 0.59$, $p < 0.001$). This indicates that students who were more engaged and satisfied with gamified activities achieved greater academic improvement.

Students' feedback was overwhelmingly positive. Most participants reported increased enjoyment, motivation, and understanding through gamified learning. Additionally, 92.5% expressed interest in adopting similar methods in other medical subjects.

Table 4: Correlation Between Engagement, Satisfaction and Knowledge Gain

Variable Pair	Pearson's r	p-value
Engagement vs Knowledge Gain	0.66	< 0.001
Satisfaction vs Knowledge Gain	0.59	< 0.001

Table 5: Student Perceptions Toward Gamified Learning (n = 200)

Statement	Mean ± SD	Agreement (%)
Gamification made learning enjoyable	4.8 ± 0.4	95.0
Improved understanding of anatomy	4.6 ± 0.5	93.5
Increased motivation to learn	4.6 ± 0.5	90.8
Prefer gamification in other medical subjects	4.7 ± 0.4	92.5

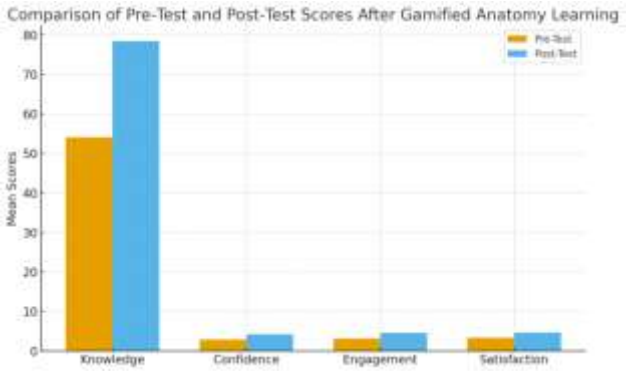

Figure 1: graph illustrating the comparison of pre-test and post-test mean scores after gamified anatomy learning. It clearly shows marked improvements across all measured areas knowledge, confidence, engagement, and satisfaction following the gamified intervention.

DISCUSSION

Incorporating gamification within the teaching of anatomy has been shown to considerably improve learners' knowledge, confidence, involvement, and satisfaction. The improvement in post-test scores compared to pre-test scores in this study indicates the effectiveness of gamification as a modern instructional strategy to enhance traditional teaching. The use of structured game-based learning in three anatomy modules for first- and second-year MBBS students led to significant cognitive and motivational gains, demonstrating that gamified learning provides an engaging alternative to passive lecture-based formats. Elements such as competition, immediate feedback, badges, and point systems contributed to a stimulating and interactive learning environment that promoted sustained interest.

These results are in accordance with previous studies that have reported positive outcomes of gamified learning in medical and allied health education. Research found that students exposed to gamified anatomy tools showed higher retention and engagement compared with those taught through lectures alone[10,11]. Similar to earlier literature, our study found that medical students responded favorably to gamified quizzes, leaderboards, and interactive tasks, reinforcing the role of gamification in enhancing participation and conceptual understanding[12-14]. This supports the growing consensus that gamified learning strategies can enrich anatomy education, which is traditionally perceived as memorization-heavy and challenging.

The absence of a significant gender difference in learning gains suggests that gamification is beneficial regardless of gender. The equal improvement among male and female MBBS students implies that gamification supports diverse learning preferences,

including visual, competitive, and collaborative modes, thereby ensuring inclusivity and equitable learning outcomes[15,16].

Furthermore, the positive correlation between engagement, satisfaction, and knowledge improvement in this cohort highlights the importance of emotional and motivational components in academic performance. When educational activities are enjoyable and perceived as meaningful, students are more likely to actively participate and retain knowledge. These findings are consistent with literature emphasizing that motivation and sustained interest are key drivers of learning effectiveness in gamified environments[17,18].

From a practical standpoint, this study demonstrates that integrating gamification into large MBBS anatomy classes can enhance student attention, interaction, and comprehension, especially in challenging content areas. Gamified methods should be viewed as intentional pedagogical tools not entertainment designed to support deeper processing and retention of complex anatomical concept[19,20].

While this study benefitted from a larger sample of 200 medical students, it was still limited to first- and second-year MBBS students from two institutions. Future research could explore multi-center studies, longitudinal retention effects, and the integration of advanced gamified platforms such as 3D interactive anatomy systems. Additionally, future work could incorporate student reflections to further understand motivation and learning behavior, although the current study focused strictly on quantitative outcomes.

CONCLUSION

This study confirms that gamification positively influences anatomy learning by enhancing knowledge acquisition, engagement, and student satisfaction. The gamified intervention applied to first- and second-year MBBS students resulted in substantial improvement in learning outcomes and learner motivation. The strategy helped sustain interest, encouraged active participation, and created an enjoyable learning atmosphere conducive to academic success.

The findings support the integration of structured gamified approaches into MBBS anatomy curricula as an effective and student-centered teaching method. When executed with clear learning objectives, gamification can transform traditional teaching practices into dynamic experiences that promote deeper understanding, confidence, and long-term retention of anatomical knowledge. Continued research and innovation in this area will further strengthen its role in modern medical education.

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