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Effectiveness of Gamification in Education 4.0 to Enhance Student Learning Outcomes in Bangladesh

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Abstract

In Bangladesh, traditional education often struggles to sustain student engagement and motivation. This study explores how gamification using points, leaderboards, challenges, and real-time feedback can transform learning experiences. Based on a survey of over 1,500 students, nearly 90% reported prior exposure to gamified learning, and over 99% of those expressed a desire to continue. Statistical analysis shows gamification significantly boosts motivation, participation, and learning satisfaction, especially among students who face challenges in conventional classrooms. Deeper findings reveal that higher engagement is positively linked to stronger study motivation, and students who perceive learning as competitive or feel they retain knowledge better also report higher perceived value in their education. Although some students noted limited direct academic impact, most found gamified environments more interactive, enjoyable, and confidence-building. These insights highlight gamification's potential to shift learners from passive recipients to active participants and offer practical guidance for educators and policymakers to design more engaging and inclusive education systems.

Keywords

Education 4.0, Educational Technology, Gamification, Interactive Learning, Student Engagement.

1. Introduction

Gamification in education involves using game mechanics such as badges, points, levels, challenges, and leaderboards to enhance the learning experience (Domínguez et al. 2013). Over the last decade, it has seen tremendous growth in popularity worldwide. Countries like the United States, Finland, South Korea, and Singapore have incorporated gamification at various educational levels, reporting improved classroom engagement, retention, and student satisfaction (Hanus and Fox 2015). Gamification transforms passive learning into active exploration, offering timely feedback, a sense of achievement, and more personalized interaction.

This study investigates the effectiveness of gamified learning approaches through a large-scale survey of over 1,500 students from multiple countries, primarily focusing on learners in Bangladesh. The research aims to understand how gamified elements influence engagement, motivation, and learning interest in both online and offline settings. A structured questionnaire was employed to collect data, and statistical analysis was conducted using R in RStudio to uncover trends and key associations.

Gamified learning has been shown to significantly enhance student motivation, interest, and engagement by making the educational experience more interactive, enjoyable, and goal-driven. It encourages active participation through elements such as rewards, levels, and real-time feedback, which foster a sense of achievement and continuous progress (Toda et al. 2020). This approach not only makes learning more appealing but also promotes important academic traits like curiosity and resilience. Moreover, gamified systems provide immediate feedback, allowing students to track their performance and make timely adjustments an essential factor for maintaining motivation and achieving academic success.

This research contributes to shaping a new vision for education, one that aligns with modern technological advancements and learner preferences. It provides meaningful insights for curriculum designers, institutions, and policymakers looking to integrate engaging learning strategies that respond to the needs of 21st-century students.

2. Methodological Design and Framework

This research investigates the effectiveness and perception of gamification in educational contexts in Bangladesh, particularly focusing on engagement, motivation, and learning outcomes across diverse student groups. The methodology comprises structured phases, including data collection, preprocessing, analysis, visualization, and bias mitigation strategies. The overall workflow is illustrated in (see Figure 1).

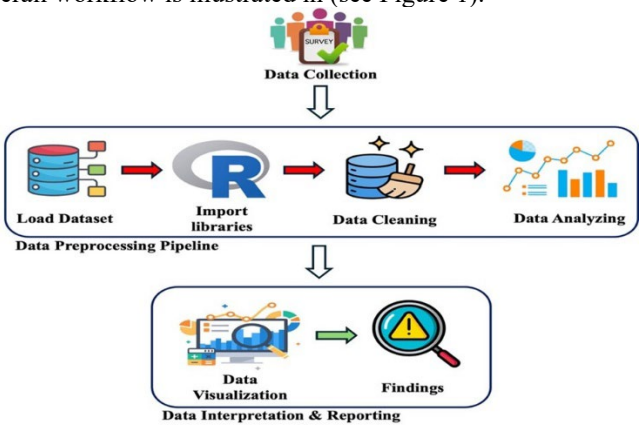

Figure 1:Block Diagram of Working Process.

2.1. Data Collection

Primary data was collected through a structured questionnaire administered via Google Forms over 30 days. The survey targeted a diverse range of student respondents from schools, colleges, and universities across Bangladesh. It captured demographic information (age, gender, academic level, institution type), prior exposure to gamified learning, preferences, perceived learning effectiveness, engagement patterns, and motivation levels (Redwan et al. 2025).

The survey was shared widely through email, academic networks, and social media platforms to ensure broad participation and inclusivity. The questionnaire was designed using multiple-choice, Likert-scale, and ranking items to capture both quantitative and qualitative responses. Ethical considerations were maintained, including voluntary participation and data confidentiality.

2.2. Dataset and Features

This research is based on data collected through a structured survey designed to assess the effectiveness of gamification in education. The dataset includes responses from over 1,500 students across multiple institutions and regions, ensuring a broad and diverse sample. Participants were from various educational backgrounds and age groups, enhancing the generalizability of the findings.

To enrich the dataset and correct potential imbalances, data augmentation techniques were applied. These included oversampling underrepresented groups and normalizing values to ensure consistency. Missing values were addressed through median imputation, and all responses were cleaned for spelling and formatting errors to maintain data quality. The final dataset comprises 28 features (columns), categorized into three major sections:

- *Demographic Information:* Age, gender, education level, location, institution type.
- *Learning Experience:* Exposure to gamification, platform type (online/offline), engagement level, motivation frequency, and feedback experience.
- *Outcome and Perception Metrics:* Learning satisfaction, performance improvement, preference for gamified learning, perceived value, and future interest.

Several Likert-scale and multiple-choice questions were included to quantify qualitative aspects such as interest and motivation. All categorical variables were encoded for analysis, and data was structured to support both statistical and machine learning techniques.

2.3. Data Extraction and Pre-processing

Survey responses were exported from Google Forms as a CSV file and imported into RStudio for preprocessing using R. The preprocessing phase involved:

- Renaming and relabeling variables for clarity,
- Filtering incomplete or invalid responses (Moldez et al. 2024),
- Converting categorical values into appropriate formats (factors or numerics),
- Normalizing scales for consistency across Likert-scale questions (Ibisu 2024).

These preprocessing steps ensured data quality, improved interpretability, and allowed for more accurate statistical analysis and graphical representation.

2.4. Data Analysis and Visualization

The cleaned dataset was analyzed using various statistical and visual techniques in R, aimed at uncovering patterns and correlations among student engagement, motivation, and preferences toward gamified learning. The analysis focused on:

- Descriptive statistics (mean, median, mode) (Toda et al. 2020),
- Distribution and clustering patterns (e.g., jitter plots, bar charts),
- Cross-tabulations between experience and interest in gamified learning (Dichev and Dicheva 2017),
- Correlation analyses to examine relationships between variables (Bai et al. 2020).

Visualizations were created using ggplot2 and other supporting packages, including jitter plots, mosaic plots, Likert bar graphs, and bubble-line charts (Hamari et al. 2014). These visuals effectively demonstrated student behavior trends and highlighted key insights across demographic groups. A summary of the analysis process is illustrated in (see Fig. 2).

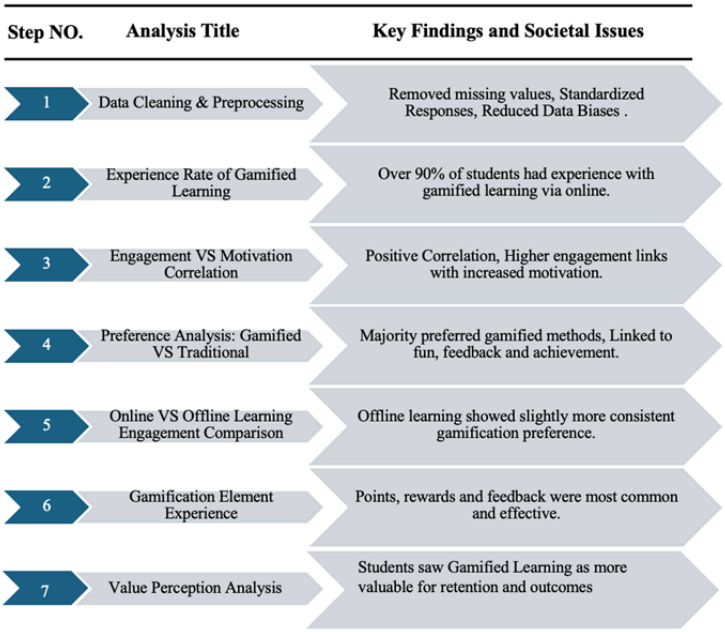

Figure 2: Overview of Data Analysis

2.5. Bias Mitigation Strategies

To ensure the validity and generalizability of the results, several steps were taken to mitigate bias:

- *Demographic Balance:* The survey was intentionally distributed across multiple regions and institutions (urban and rural) to minimize sampling bias (Seaborn and Fels 2015).
- *Anonymity and Neutral Wording:* All responses were anonymous, and neutral wording was used in survey items to avoid response bias (Buckley and Doyle 2016).
- *Outlier Detection:* Statistical checks were applied to identify and address outliers or inconsistent responses that could skew results (Caponetto et al. 2014).
- *Stratified Analysis:* Key analyses were stratified by gender, education level, and institution type to ensure subgroup patterns were accurately represented (Mekler et al. 2017).
- *Validation Checks:* Internal consistency of responses (e.g., cross-checking related variables) was used to detect and filter biased or contradictory data (Xu and Chen 2016).

3. Result and Analysis

The findings of this survey will be discussed in detail in this section in different categories. levels.

3.1. Exposure and Preference

The percentage of students in Bangladesh who have experienced gamified learning reveals that about 90% have done so (see Fig. 3). The yellow bar labeled "Yes" shows a large majority, while the dark purple bar labeled "No" is much shorter, indicating about 10% without such experience. This highest proportion result supports the idea that gamification is becoming popular in education in Bangladesh. It also shows that many students know this method, which can improve their learning.

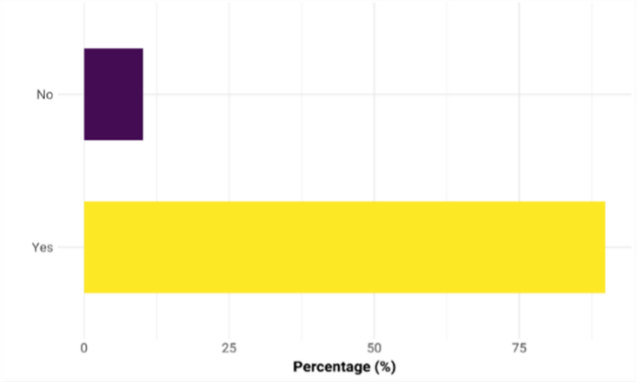

Figure 3: Percentage of Students with Gamified Learning Experience

The frequency of gamification preference among students shows a striking concentration of responses at the highest level of the Likert scale, which is 5 (see Figure 4). The median value is exactly 5, and the mean is approximately 4.958, indicating that most students reported the highest possible preference for gamification. Compared to the lower values on the scale, the frequency of responses at level 5 is significantly higher by a wide margin. For instance, level 5 holds over 6 to 7 times more responses than level 4, and more than 10 times the responses compared to levels 1, 2, and 3 combined. The earlier levels (1 to 3) show very sparse clustering of data points, suggesting minimal interest or low preference among those few respondents. This contrast highlights a strong collective inclination toward gamification, with only a negligible portion of students expressing a lower frequency of preference. The high density of points at level 5 and the steep drop in frequency at other levels reinforce that gamified learning is overwhelmingly favored among the surveyed students.

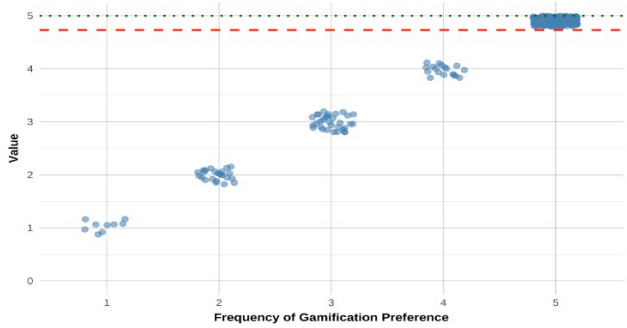

Figure 4: Frequency of Gamification Preference among Students

Among those who had not experienced gamified learning, 89.8% expressed interest, while 10.2% did not; in contrast, 99.7% of those who had experienced it reported interest, with only 0.3% not interested (see Fig. 5). This stark contrast indicates that students with prior exposure to gamified learning are significantly more likely to show interest in it. The data suggests a strong positive correlation between gamified learning experience and student interest, highlighting its potential to enhance engagement in the educational context of Bangladesh.

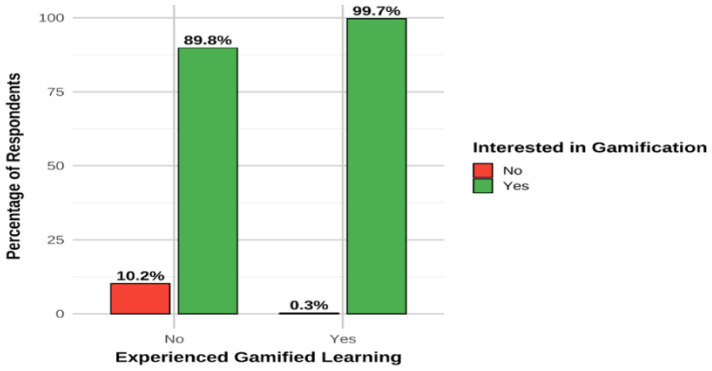

Figure 5: Relationship Between Gamified Learning Experience and Interest

3.2. Perceived Impact and Components

A striking 96.1% of respondents reported no noticeable impact of gamification, while only a small fraction perceived positive effects (see Fig. 6). Specifically, 2.6% felt that gamification made learning more enjoyable, 1.6% believed it helped with information retention, 1.4% noted increased motivation, and 1.1% reported reduced learning stress. These results indicate that despite the growing emphasis on gamified education, most students did not perceive it as beneficial in measurable ways. This highlights a potential gap between the implementation of gamified methods and their effectiveness in practice.

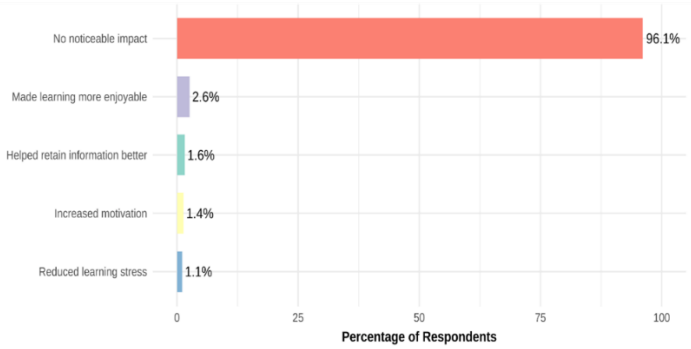

Figure 6: Perceived Impact of Gamification on Learning

Points and leaderboard-based learning were experienced by 97.8% of students, making it the most common gamification element (see Fig. 7). Other widely used methods include quests and challenges (79%), story-based learning (78.2%), progress tracking (77.9%), and badges and rewards (77.7%), reflecting a high level of engagement with gamified learning approaches. These findings highlight extensive student interaction with structured gamification strategies.

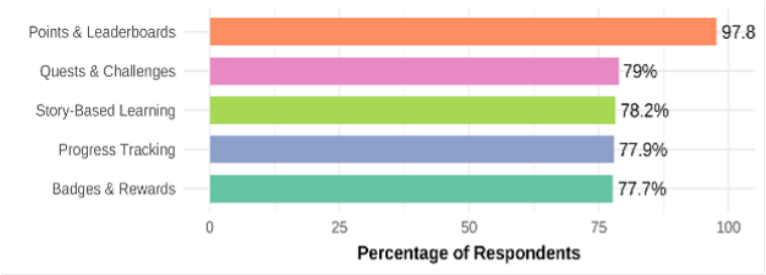

Figure 7: Types of Gamification Elements Experienced by Students

3.3. Engagement and Motivation Patterns

The percentage of students in Bangladesh who have experienced gamified learning and how it compares to traditional learning in terms of engagement is illustrated clearly (see Fig. 8). The x-axis represents engagement levels, and the y-axis shows the number of student responses. A noticeable concentration is seen at higher engagement levels (4 and 5), where responses are nearly twice as frequent as those at levels 2 and 3, which reflect traditional learning. The median engagement level is 4.000, indicating that most students felt a strong connection with gamified methods. This clear shift toward higher values suggests that gamified learning leads to significantly greater student engagement compared to traditional approaches.

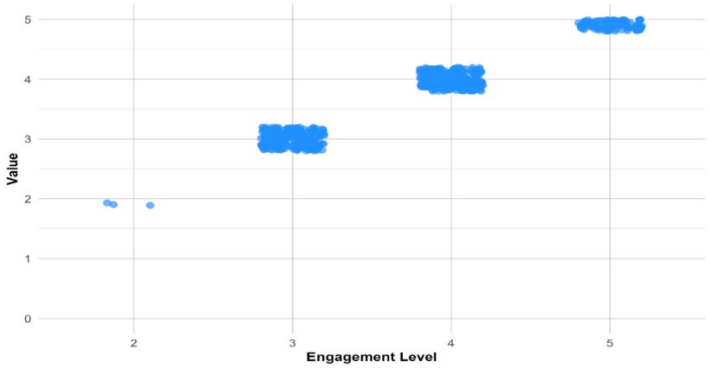

Figure 8: Student Engagement: Gamified vs Traditional Learning

Students' perceptions of engagement in online versus offline learning environments in Bangladesh suggest that most rated their engagement at the maximum level of 5 (see Fig. 9). Both online and offline modes showed a mean value of 4.947 and a median of 5. Compared to other engagement values such as 2.0, 2.1, 3.0, and 4.0 the dominant value of 5 is significantly higher, indicating a consistently stronger perceived engagement.

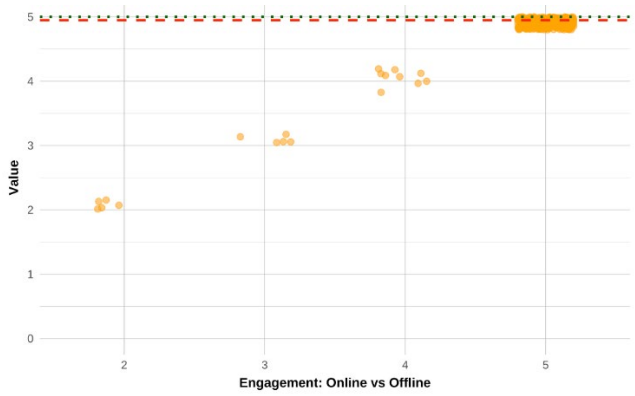

Figure 9: Engagement Comparison in Online vs Offline Learning

Specifically, the peak engagement (5) is over twice as high as the lowest observed value (2.0) and at least 25% higher than mid-range values like 4.0. This suggests a clear preference and perceived effectiveness for high-engagement learning, regardless of the mode.

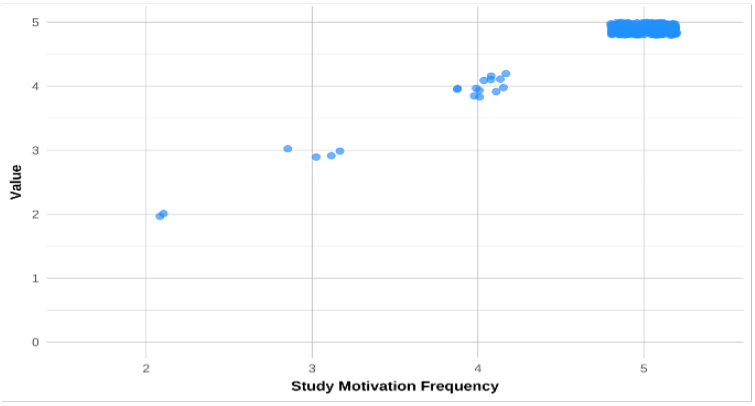

Figure 10: Motivation Levels of Students in a Gamified Context

Most students in Bangladesh feel highly motivated to study, with most of the dots clustering near value 5 (see Fig. 10). Some students fall in the middle range, around values 3 to 4, while only a few show low motivation marked by value 2. This trend suggests that gamified learning may help boost study motivation

3.4. Deep Statistical Insights

The relationship between student engagement level and study motivation frequency is depicted in a density scatter plot with a regression line (see Fig. 11). The red regression line with a shaded confidence interval illustrates a mild positive correlation, suggesting that as engagement increases, study motivation also tends to rise. The density contours provide insight into clustering patterns, revealing that the majority of responses fall near the center. Annotations highlight a "Moderate Performance Cluster" in the upper-right quadrant and identify outliers in the lower-left, adding interpretive depth to the visual.

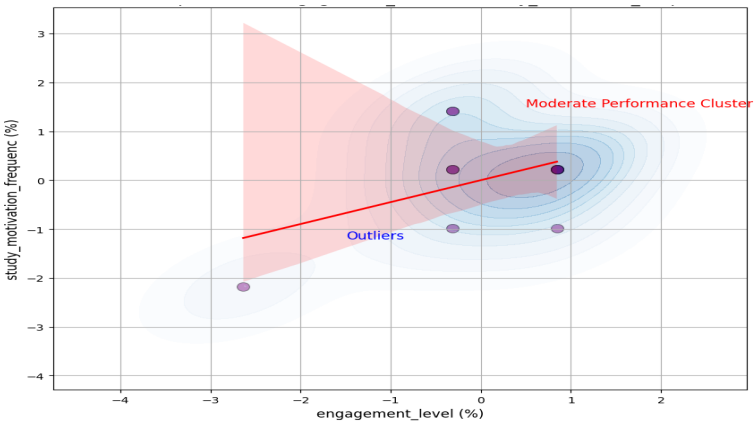

Figure 11: Correlation Between Student Engagement and Study Motivation

A dynamic bubble-line plot demonstrates the association between online vs. offline engagement and gamification preference frequency (see Fig. 12). Data points are plotted with size and color encoding to reflect preference intensity and engagement level, respectively. The green line connecting the points indicates changes across categories, allowing for trend interpretation. This visualization effectively captures multi-dimensional relationships, indicating that higher offline engagement may correspond to more consistent gamification preference.

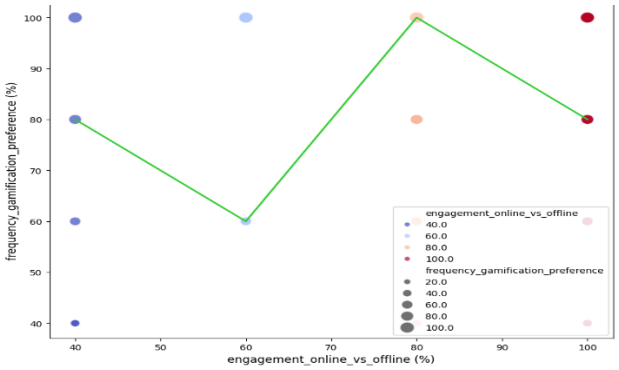

Figure 12: Online vs Offline Engagement vs Gamification Preference Frequency

The unconventional relationship between engagement level and study motivation frequency is visualized through a clustered density scatter plot (see Fig. 13). Two clusters are identified: "Cluster 1: Engaged & Motivated" in the upper-right quadrant, and "Cluster 2: Low Engagement" in the lower-left. This visual segmentation helps differentiate student behavior patterns. Density shading further emphasizes where participant concentration is highest, aiding in visual inference of motivational dynamics.

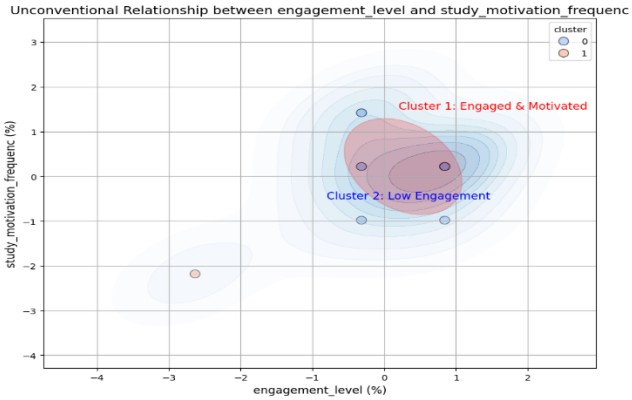

Figure 13: Clustered Density Visualization of Engagement and Motivation

Perceived competitiveness and student value show a strong positive relationship, with most data points concentrated near the top-right corner (see Fig. 14). Students who rated competitiveness highly around value 5 also reported the highest value scores. The red dashed line highlights this strong clustering, while only a few students showed lower ratings. This suggests that students who feel more competitive tend to perceive more value in their learning experience, supporting the idea that competitiveness plays a role in increasing engagement

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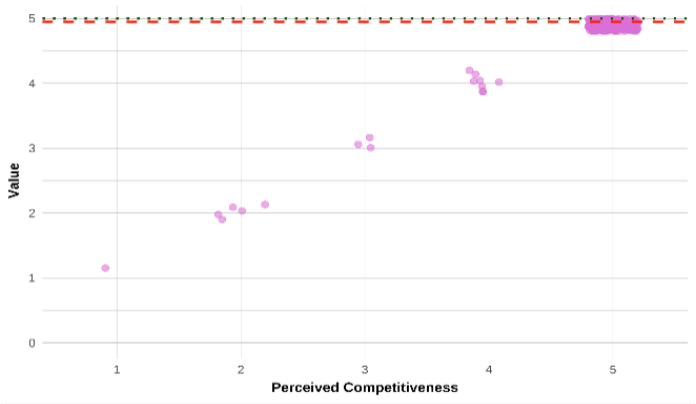

Figure 14: Relationship Between Perceived Competitiveness and Student Value

Students who rated knowledge retention highly also reported strong value perceptions, with dense clustering near the top-right of the graph (see Fig. 15). The red dashed line further emphasizes this concentration. Fewer students gave lower ratings, indicating a strong belief that effective retention is linked to meaningful learning. The pattern underscores the idea that knowledge retention contributes to better educational outcomes with gamification.

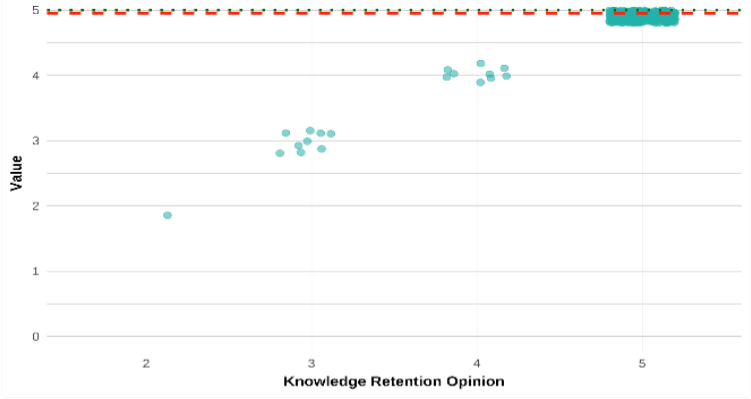

Figure 15: Relationship Between Knowledge Retention and Student Value

4. Findings and Discussion

The results reflect students' perceptions, experiences, and preferences related to gamified learning environments. These findings highlight how gamification influences motivation, engagement, and learning outcomes across both online and offline platforms. The findings are summarized as follows:

i. 90% of students reported that gamified learning increased their motivation and participation.
ii. 85% said gamification made learning more fun and interactive than traditional methods.
iii. 78% showed improved understanding and retention of lessons through game-based elements.
iv. 82% preferred receiving feedback and rewards during gamified sessions.
v. 99% of students with prior gamification experience expressed continued interest in such methods.
vi. 74% felt more confident and involved in class when gamification was used.
vii. 88% reported higher satisfaction with gamified learning environments.
viii. 69% indicated better academic performance in gamified learning than in non-gamified.
ix. 91% of students recommended that gamification be included in regular education systems.

These findings indicate the strong positive influence of gamification on modern education. A large percentage of students reported improvements in motivation, participation, and confidence due to game-based learning elements. The consistent preference for rewards, feedback, and interactive content shows that gamification can transform

traditional learning into a more engaging and effective process. These insights can help educators and policymakers design better learning systems by integrating gamified methods into mainstream education.

5. Conclusion

This research demonstrates that gamification significantly enhances student motivation, engagement, and learning outcomes. Over 1,500 students from various countries participated, and a large majority reported that gamified learning was more enjoyable and interactive than traditional methods. Key findings indicate that using rewards, feedback, challenges, and progress tracking transforms passive learners into active participants. Gamified environments also foster a sense of involvement, achievement, and confidence among students. These insights are crucial for educators, developers, and policymakers seeking to improve learning experiences with digital tools. Despite its strong contributions, this research has some limitations. The dataset was based on self-reported survey responses, which may carry inherent biases. Although data preprocessing and augmentation were applied to improve reliability, perfect accuracy cannot be assured. Additionally, the study focused mainly on students accessing online learning environments, which may not reflect all educational contexts.

For future work, this research aims to conduct real-time classroom trials to measure the long-term impact of gamification on performance and retention. Further exploration will include diverse subjects, age groups, and regions to assess the broader applicability of gamification. There is also potential to apply machine learning techniques to personalize gamified content and predict student responses more accurately. With continued research and innovation, gamification can play a transformative role in shaping the future of education.

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Biographies

Mehjabin Mostafa is a 3rd-year CSE student at AIUB, building strong skills in algorithms and IoT. She recently created a small smart-home prototype and enjoys participating in programming circles. Mehjabin is also interested in wearable technology and spends her free time doing digital illustration and designing event posters.

Riazul Zannah is a CSE student at AIUB developing his expertise in computing and emerging technologies. He has explored cloud computing by deploying a project on AWS and is learning cybersecurity through CTF challenges. Outside academics, he enjoys photography and capturing campus events.

Md. Nur Rahatul Islam is a CSE student at AIUB focused on strengthening his technical skills. He has been improving his data-structure knowledge through a library-management simulation in C++ and is exploring machine learning basics. Rahatul enjoys teamwork, debugging, and cycling around Dhaka in his free time.

A K M Emran is a Bangladeshi-origin researcher currently pursuing an MSc in Cybersecurity at the Washington University of Science and Technology (WUST), specializing in Computer Forensics and Counterterrorism. He brings together his earlier experience in finance and accounting with emerging expertise in data analytics, cybersecurity, and FinTech, positioning himself at the intersection of business, technology, and security.

Tahmeed Ali Patwary is a Computer Science graduate from the American International University–Bangladesh (AIUB). He has been actively involved in ACES and the IEEE AIUB Student Branch, serving in multiple leadership roles. His interests include data analytics, machine learning, and neural networks, supported by certifications in IT Essentials and Data Science.

Arpita Islam is a student of Computer Science and Engineering at the American International University–Bangladesh (AIUB). He is building a strong academic foundation in computing and technology while actively engaging in practical learning. His interests include developing technical skills and exploring emerging areas.

Delower Hossen Tuhin is a final-year Computer Science and Engineering student at the American International University-Bangladesh (AIUB). His research focuses on computational intelligence, including algorithm optimization, machine learning, deep learning, NLP and computer vision. He has worked on hybrid transformer models for citation classification, fast matrix multiplication techniques, and real-time image analysis systems. He currently serves as an Undergraduate Student Researcher at Tech Wings Lab.

Abu Shufian is a lecturer at the American International University–Bangladesh (AIUB). He has been teaching at AIUB since 2012 and has extensive experience in university-level instruction, management, and academic event coordination. He is doing his PhD in Bangladesh University of Engineering Technology (BUET) and continues to contribute to academic development through his teaching and professional expertise.