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Designing an Advanced Gamified Collaborative Learning Model to Foster Student Engagement and Peer Interaction in Online Education

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Abstract - **The rise in the usage of online learning systems has posed many challenges for engaging students, collaborating, and interacting effectively through these digital learning platforms. An Advanced Gamified Collaborative Learning Model (AGCLM) is proposed in this study to enhance motivation, improve communication skills, enhance collaborative satisfaction, and promote learner engagement in online education settings. The quantitative management framework encompasses reward systems, achievement badges, collaborative missions, adaptive feedback systems, progress tracking, and peer interaction techniques within a single educational framework. A survey based on a five-point Likert scale was administered among 428 students from various higher educational institutions in Uzbekistan, who are enrolled in online learning programs. Structural Equation Modeling (SEM) and multiple regression analysis were used to test the interrelations between Gamified Learning Mechanisms (GLM), Learner Engagement, Peer Interaction Quality, Collaborative Learning Satisfaction, and Learning Outcomes. Validity and reliability results indicated excellent measurement consistency, with Cronbach's Alpha scores ranging between 0.84 and 0.93 and AVE (Average Variance Extracted) values surpassing 0.50 across all constructs. Statistical analysis showed that GLM had a strong effect on Student Engagement ($\beta = 0.79$, $p < 0.001$), whereas Collaborative Learning Satisfaction had the strongest positive influence on Learning Outcomes ($\beta = 0.82$, $p < 0.001$). The conceptual model was shown to meet the acceptable standards of model fit through the following indicators: CFI = 0.94, TLI=0.92, GFI=0.91, RMSEA = 0.051, and $\chi^2/df = 2.14$, indicating satisfactory structural adequacy. It should be highlighted that peer learning techniques, cooperative missions, and adaptive rewards significantly improved communication efficacy and engagement continuity, and learner satisfaction in virtual classrooms. Overall, the AGCLM framework proved to be an adequate solution in addressing collaboration and educational service quality problems associated with digital learning processes.**

Keywords: **Gamified Learning, Collaborative Online Education, Student Engagement, Peer Interaction, Structural Equation Modeling, Digital Learning Platforms, Educational Service Quality**

I. INTRODUCTION

Online learning has revolutionized the process of delivering academic material through the creation of flexible and technology-driven learning environments at various higher educational establishments. In spite of the numerous benefits brought about by accessibility and incorporation of technological resources, online learning tools still suffer from such problems as low student engagement, lack of peer interaction, poor collaborative involvement, and decreased motivation during online classes (Rivera & Garden, 2021). Conventional instructional methods used in online learning have been shown to lack learner attention and social interaction, which leads to ineffective learning results (Park & Kim, 2021). Thus, it becomes important to consider

learner-centric learning processes capable of improving collaboration among students (Leung et al., 2021).

The concept of gamification has gained attention as an innovative approach to teaching whereby elements of games are introduced in non-gaming learning spaces using features such as awards, scores, badges, competition, tracking progress, and team missions in order to make learners more motivated and engaged (Portela, 2022). Gamified techniques in the context of online educational systems have been found to have beneficial outcomes on learners' behavior and learning outcomes in terms of active behavioral and cognitive participation and cooperation (Estriegana et al., 2021). Additionally, it has been demonstrated that gamification increases social engagement in online learning environments (Bilro et al., 2021; An, 2021).

The increased importance of peer-mediated online education has resulted in the adoption of digital learning solutions that incorporate the use of engagement management techniques along with collaborative communication processes (Dustman et al., 2021). Nonetheless, gamified learning environments currently exist mostly to provide motivational rewards without sufficient connections made between collaborative learning processes and engagement analysis (Cheng et al., 2015). Thereby, there is a need for further research in order to create more management-oriented gamified learning systems where students can be engaged, collaborate successfully, and feel satisfied (Xiao & Hew, 2024).

In order to solve this problem, an Advanced Gamified Collaborative Learning Model (AGCLM) is recommended, which involves adaptive gamification techniques, collaboration and management of tasks, peer interaction monitoring, and instruction based on motivation through the integration of a quantitative approach. This study examines the efficiency of the AGCLM using statistical methods.

Research Objectives

RO1: For examining how gamified learning techniques affect students' participation in remote learning.

RO2: For examining how collaborative gamification affects the caliber of social interactions among students.

RO3: For examining the relationship between online learning satisfaction and gamified collaboration.

RO4: For investigating the relationship between student engagement and collaborative learning satisfaction.

RO5: For developing the Advanced Gamified Collaborative Learning Model.

Research Questions

RQ1: What effect do gamified teaching methods have on students' online learning engagement?

RQ2: How does collaborative gamification affect peer interaction?

RQ3: In what way does gamified collaborative learning influence learning satisfaction among students?

RQ4: What effect does student engagement have on collaborative learning satisfaction in virtual learning environments?

RQ5: How effective can the suggested AGCLM model be in enhancing collaborative online learning?

Hypotheses

H1: Gamification techniques improve students' participation in the virtual learning environment.

H2: Gamification in collaboration positively impacts learner interaction.

H3: Gamification of collaboration positively impacts learning satisfaction.

H4: Student engagement positively impacts collaborative learning satisfaction.

H5: The proposed model AGCLM positively impacts the collaborative learning process in online learning environments.

Key Contributions

- The paper introduces a model known as the Advanced Gamified Collaborative Learning Model (AGCLM), which incorporates adaptive gamification, interaction mechanisms, and engagement analysis within one online educational framework.
- The effect of gamified learning methods with respect to collaboration, interaction among peers, satisfaction with collaboration, and learning achievements is tested quantitatively through SEM.
- The presented framework offers a management perspective for enhancing learner engagement, effective communication, and overall collaborative academic success at higher educational institutions.
- The paper makes a contribution to the field of quantitative educational service models, which can be applied to design digital learning policies and develop strategies for learner retention.

The remainder of the paper is organized as follows. The literature on online interactive education, gamified educational settings, and engagement concepts is reviewed in Section II. In Section III, the proposed approach is explained by discussing the study area, methodology, sampling technique, conceptual framework, SEM, and data analysis methods. Section IV provides an explanation of the model evaluation, experimental results, hypothesis testing outcomes, and management implications of the suggested

AGCLM framework. Finally, the paper concludes in Section V.

II. Literature Review

Recently, gamified learning environments have drawn a lot of interest in the context of higher education due to their potential to increase student engagement. Numerous gamification techniques, including the usage of badges, leaderboards, prizes, adaptive feedback systems, and cooperative missions, have already been the subject of research.

Studies on gamification in online learning revealed that engagement techniques through games helped improve learner participation and interactions in higher education settings (Huang et al., 2020). Motivational learning systems have been shown to provide positive impacts on persistence, focus, and collaboration among learners when learning activities were rewarded (Sailer & Homner, 2020). Personalization techniques used in adaptive gamified learning systems have been found to promote academic engagement and learner satisfaction (Zainuddin et al., 2020).

The impact of collaborative digital learning technologies on peer relationships and teamwork effectiveness has been the subject of numerous studies. The results showed that collaborative gamification led to interactions, cooperation, and knowledge sharing among peers (Zheng & Wang, 2023). Investigations done regarding collaborative tasks also highlighted the role of gamified peer learning environments as an effective way of facilitating communication skills and cooperation among groups in conducting academic assignments (Gyedu et al., 2026). Moreover, virtual collaborative learning systems backed up by gamification techniques contributed to improving learners' participation and minimizing their feelings of loneliness (Kyewski & Krämer, 2018).

The impact of gamified technology for education on educational results was the subject of several recent empirical research. The data supported gamification's beneficial effects on academic performance, learner retention, and e-learning course participation rates (Oliveira et al., 2023). Engagement analytics used in digital education proved to increase learning consistency and behavioral engagement as a result of using real-time feedback and achievement-tracking systems (Saleem et al., 2022). Moreover, some other empirical studies pointed out the role of gamification for the improvement of educational service quality (Subhash & Cudney, 2018).

Even while earlier studies have emphasized the benefits of gamification in the context of remote learning, there are still a number of unanswered questions. Previous models have tended to concentrate either on motivation rewards or collaboration systems separately, but have not explored the relationship between adaptation and collaboration sufficiently (Taesotikul et al., 2021). Also, a number of studies have not provided adequate quantified analysis of the impact of gamified collaboration and peer interactions, together with adaptation mechanisms.

According to the studied literature, gamification is crucial for boosting students' participation in their academics and promoting productive student interaction. Numerous studies have demonstrated the value of collaboration, reward systems, and adaptive feedback systems in inspiring students and enhancing the caliber of their interactions. Nonetheless, there is limited scholarly work that has explored the potential of adaptive gamification, peer interaction management, and collaborative engagement analysis within a quantitative framework. By creating a sophisticated model of gamified collaborative learning, the project seeks to close this gap.

III. Proposed Methodology

Study Area

This study was carried out among selected higher learning institutions situated in Tashkent, Samarkand, Bukhara, and Fergana areas in Uzbekistan, where both online and blended learning programs are fully operational at the undergraduate and graduate levels of education. The chosen institutions include government universities, management institutes, technological universities, and digital learning centers, which apply learning management systems for teaching and learning processes. The study concentrated on students majoring in such fields as business management, information systems, educational technology, and social sciences, as these academic domains extensively rely on collaborative online learning processes and digital communication platforms. The choice of the study area was dictated by the rising need for the effective management of learning activities in online educational settings among Uzbek universities.

The study was carried out from September 2025 to February 2026 during the academic year. The chosen universities created organized virtual classrooms, assignment collaboration, discussion among peers, an online testing system, and a learning process using games that created the proper environment required to conduct tests on the efficiency of the proposed Advanced Gamified Collaborative Learning Model (AGCLM). The learning environments utilized at these universities included learning management systems based on Moodle, Microsoft Teams classrooms, and the university's online learning sites that allowed gamification of peer discussions and participation monitoring.

Research Design

The study employed a quantitative explanatory research approach to evaluate the relationships between gamification learning processes, student engagement, peer interaction quality, satisfaction with collaborative learning, and learning performance in the context of online education settings. Because the study aimed to statistically verify the proposed model of AGCLM via construct testing as well as hypothesis testing methodologies, a quantitative approach was selected.

The study used a cross-sectional survey design, collecting data from students who participated in online collaborative learning.

In order to evaluate the effectiveness of gamified collaborative education platforms, this study used an integrated method that incorporated independent, mediating, and dependent factors. The concept of GLM was identified as an independent variable, whereas Student Engagement, Peer Interaction, and Collaborative Learning Satisfaction were mediating variables affecting Learning Outcomes. The technique of SEM was utilized to explore the associations between the variables.

Population and Sampling

Undergraduate and graduate students enrolled in hybrid or online courses at particular Uzbek institutions make up the study's target demographic. Accessible population refers to students who engage in collaborative learning in the form of group activities, interaction among peers, gamification tests, and online discussion forums in a virtual learning environment.

A stratified random sampling technique was used in order to maintain proportionality among the different subjects of study and education levels. Stratification of subjects was done according to institution, academic course, and education level before conducting the random sampling process. Sampling unit comprised of formally registered students from Tashkent State University of Economics, Samarkand State University, Bukhara State University, Fergana Polytechnic Institute, and associated digital learning institutions with collaborative online learning programs.

In total, 500 questionnaires were sent out using institutional academic portals and virtual learning classrooms. Out of the sent-out questionnaires, 446 responses were gathered, of which 428 responses were found to be complete and valid for final data analysis. The sample size used fulfilled the necessary conditions for the SEM sample size and exceeded the minimal sample size needed for multivariate statistical analysis.

The demographic characteristics of the respondent group involved students within the age group of 18 to 29 years, and the sample group comprised both males and females studying different subjects, such as management, technology, commerce, and social sciences.

Data Collection Procedure

A questionnaire that had been developed following the validation of gamification, along with online learning participation components, was used to collect data for primary research. The questionnaire was created using a five-point Likert scale with choices ranging from "Strongly Disagree" to "Strongly Agree." The questionnaire comprised five construct categories, which included Gamified Learning Constructs, Student Engagement, Quality of Peer Interaction, Collaboration, and Learning Outcomes.

In the GLM construct, the perceived notions among students on rewards, achievement badges, collaborative quests, challenges, progress measurement, and peer review were analyzed. Student Engagement consisted of the behavioral, cognitive, and emotional engagement constructs. Peer Interaction Quality is considered the communication, collaborative problem-solving, knowledge sharing, and peer support aspects. Collaborative Learning Satisfaction assessed the enjoyment, effectiveness, and satisfaction of the participants while collaborating. The Learning Outcomes considered learning outcomes such as participation, performance, learning, and retention.

Prior to administration, the questionnaire was tested through pilot studies on 35 learners from virtual learning environments. Changes were made to the questionnaire to increase its effectiveness through feedback obtained from respondents. After piloting, the completed questionnaire was delivered through an electronic platform such as Google Forms.

Fig. 1 shows the structure of the proposed Advanced Gamified Collaborative Learning Model that is intended to promote the levels of engagement and collaboration among peers in online educational environments. This structure utilizes gamified elements such as reward systems, badges of achievements, leaderboards, collaborative missions, challenges, progress tracking, and peer feedback tools within a centralized collaborative learning environment. The structure also considers the implementation of engagement analytics, behavior analysis systems, and supporting infrastructure provided by the institution to increase the levels of learner engagement and communications. Learner engagement and interaction serve as the primary elements of the proposed structure that integrates collaborative learning, gamification, peer interaction, and educational content management processes.

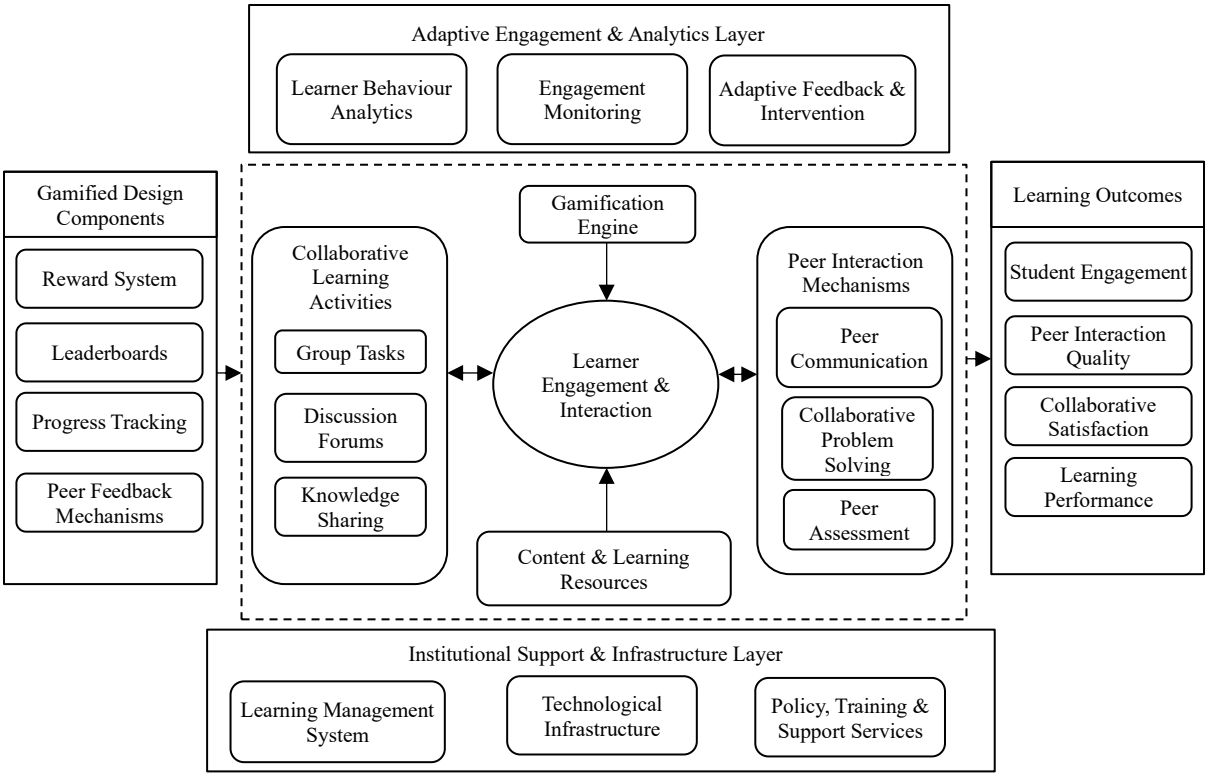

Fig. 1 Architecture of the Advanced Gamified Collaborative Learning Model

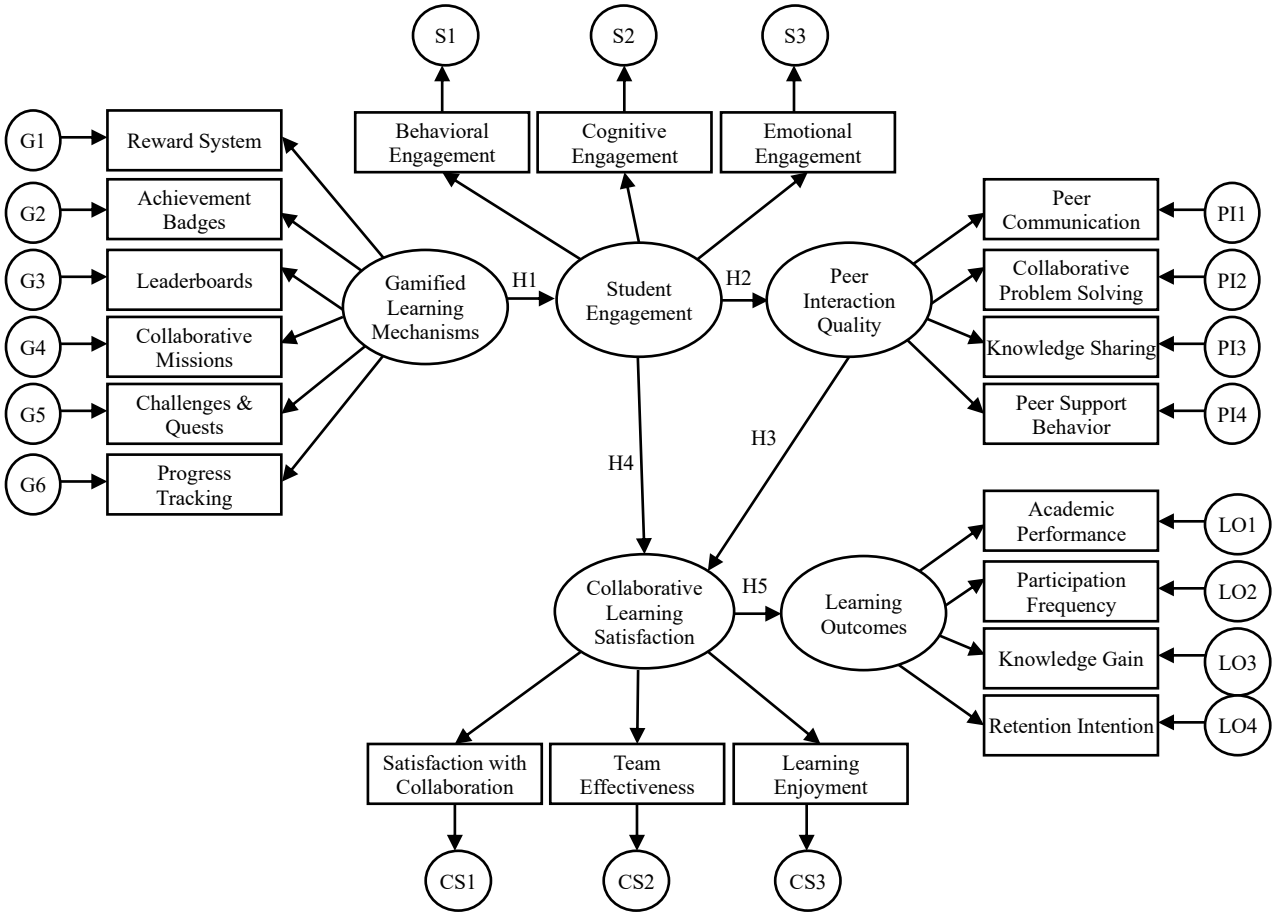

Fig. 2 Structural Equation Model of the Proposed Framework

Fig. 2 below shows the Structural Equation Model (SEM), which reflects the relationships that were hypothesized in the proposed AGCLM model involving all the main constructs considered. In the SEM diagram, there is an effect of the GLM on Student Engagement, as per hypothesis H1. On the other hand, Student Engagement exerts a positive effect on Peer Interaction Quality, as per hypothesis H2. Peer Interaction Quality then impacts Collaborative Learning Satisfaction, as per hypothesis H3. Moreover, Student Engagement also impacts Collaborative Learning Satisfaction, as per hypothesis H4. Lastly, Collaborative Learning Satisfaction Impacts Learning Outcomes, as per hypothesis H5.

Reliability and Validity Assessment

Reliability was tested with the help of Cronbach's alpha and Composite Reliability (CR) coefficients for assessing the consistency of constructs in the questionnaires. The achieved values of Cronbach's alpha coefficient varied from 0.84 to 0.93, reflecting high reliability in all measurements. Values of Composite Reliability were higher than the critical value of 0.70.

The construct validity was tested with Confirmatory Factor Analysis (CFA). Convergent validity was tested with the AVE measure, with all AVE values being greater than 0.50. Discriminant validity was assessed based on the Fornell-Larcker criterion and cross-loading test.

SEM Framework

The proposed SEM model considers the causality among the variables of gamified collaborative learning mechanisms and online educational performance. The dependent latent variable of Learning Outcomes is a function of Collaborative Learning Satisfaction, which itself is a function of Student Engagement and Quality of Peer Interaction. Student Engagement again is influenced by GLM in an online education context.

The generalized structural model is expressed as:

$$SE = \beta_1(GLM) + \varepsilon_1 \quad (1)$$

In equation (1), SE represents Student Engagement, GLM denotes Gamified Learning Mechanisms, β_1 represents the standardized path coefficient, and ε_1 represents the error term.

$$PIQ = \beta_2(SE) + \varepsilon_2 \quad (2)$$

In equation (2), PIQ denotes Peer Interaction Quality and β_2 represents the effect of Student Engagement on peer communication and collaborative interaction.

$$CLS = \beta_3(PIQ) + \beta_4(SE) + \varepsilon_3 \quad (3)$$

In equation (3), CLS represents Collaborative Learning Satisfaction, while β_3 and β_4 represent the influence of Peer Interaction Quality and Student Engagement, respectively.

$$LO = \beta_5(CLS) + \varepsilon_4 \quad (4)$$

In equation (4), LO denotes Learning Outcomes including academic participation, knowledge gain, and retention intention.

Statistical Analysis

The gathered data were analyzed using SEM, confirmatory factor analysis, reliability testing, and descriptive statistics using SPSS and AMOS software. The descriptive statistics, such as mean, standard deviation, skewness, and kurtosis, were used to analyze the patterns in respondents' responses. SEM-based path analysis was used in testing the hypothesis and model fit.

The indices applied in testing SEM validation included χ^2/df ratio, Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Goodness-of-Fit Index (GFI). The threshold levels for the indices considered as an adequate fit included $\chi^2/df < 3.0$, CFI>0.90, TLI>0.90, RMSEA<0.08, and GFI>0.90.

IV. Results and Discussion

Sample Details

The last dataset comprised 428 valid responses obtained from students studying through either the blended or online learning method in select higher educational institutions in Uzbekistan. In the data screening process, all responses that were not complete or inconsistent were eliminated before carrying out statistical analysis. According to the demographic analysis, 54.2% of the respondents were male, and 45.8% were female students. Of the whole sample population, 31.5% were postgraduate students and 68.5% were undergraduates. 57.9% of the responders, or a sizable share, were between the ages of 20 and 24. The majority of respondents were from the management/business disciplines, comprising 34.6% of the sample.

TABLE I DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

Variable	Category	Frequency	Percentage (%)
Gender	Male	232	54.2
	Female	196	45.8
Academic Level	Undergraduate	293	68.5
	Postgraduate	135	31.5
Age Group	18–20 Years	91	21.3
	21–24 Years	248	57.9
	25–29 Years	89	20.8
Discipline	Management & Business	148	34.6
	Information Technology	121	28.3
	Social Sciences	93	21.7
	Others	66	15.4

It was noted that the participants consistently engaged in online learning activities like group tasks, discussions,

gaming exercises, and socialization exercises. The data collected allowed for enough variability for conducting SEM and multivariate analysis. The responses in table I are evenly distributed by gender, educational attainment, and discipline, which improves the validity and dependability of the study findings.

Reliability and Validity Analysis

The internal reliability analysis has been carried out by measuring Cronbach's Alpha and CR. The constructions have good reliability because the computed outcomes have exceeded the minimum criterion of 0.70. For the assessment of the convergent validity, the AVE measure has been used, and all the results have exceeded 0.50.

The outcomes displayed in table II demonstrate that the created AGCLM model has adequate validity and reliability for SEM.

TABLE II RELIABILITY AND CONVERGENT VALIDITY ASSESSMENT

Construct	Cronbach's Alpha	Composite Reliability	AVE
GLM	0.91	0.93	0.71
Student Engagement	0.89	0.91	0.68
Peer Interaction Quality	0.87	0.90	0.66
Collaborative Learning Satisfaction	0.90	0.92	0.70
Learning Outcomes	0.84	0.88	0.63

Hypothesis-Based Structural Analysis

SEM was performed to test the formulated research hypotheses and establish causality among the constructs. Standardized coefficients, t-values, and significance levels of each variable can be seen in table III below.

TABLE III HYPOTHESIS TESTING RESULTS

Hypothesis	Relationship	Path Coefficient (β)	t-value	p-value	Result
H1	GLM→ Student Engagement	0.79	13.84	<0.001	Supported
H2	Student Engagement → Peer Interaction Quality	0.74	12.62	<0.001	Supported
H3	Peer Interaction Quality → Collaborative Learning Satisfaction	0.71	11.57	<0.001	Supported
H4	Student Engagement → Collaborative Learning Satisfaction	0.67	10.49	<0.001	Supported
H5	Collaborative Learning Satisfaction → Learning Outcomes	0.82	15.16	<0.001	Supported

According to the study, GLM has significantly increased student engagement (β = 0.79). Moreover, the study reveals that students who were more engaged had better peer communication and collaboration skills. Peer Interaction Quality had a positive impact on Collaborative Learning Satisfaction, which means that collaborative learning made students happy and more effective in working together. The best correlation was found between Collaborative Learning Satisfaction and Learning Outcomes.

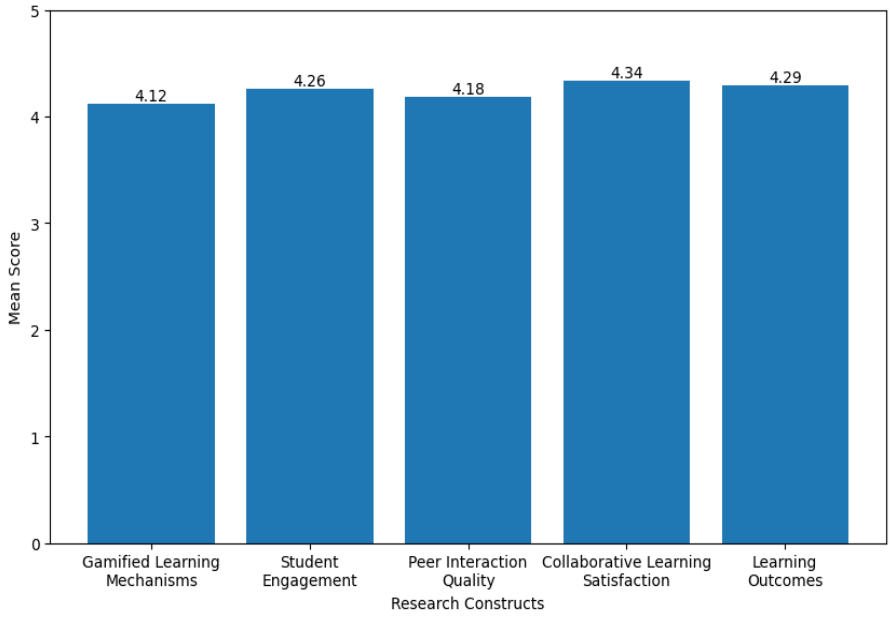

Fig. 3 Comparative Analysis of AGCLM Construct Mean Scores

In fig. 3, the mean scores of the most important constructs under the AGCLM framework are depicted. As seen from this figure, it can be stated that the scores for Collaborative Learning Satisfaction and Learning Outcomes are higher than others, revealing effective results obtained by gamified collaborative educational methods.

Model Evaluation

Model fit statistics provided evidence of acceptable model fit to the theoretical construct based on statistical standards of measurement.

TABLE IV STRUCTURAL EQUATION MODEL FITNESS INDICES

Fit Index	Obtained Value	Recommended Threshold
χ^2/df	2.14	< 3.0
CFI	0.94	> 0.90
TLI	0.92	> 0.90
RMSEA	0.051	< 0.08
GFI	0.91	> 0.90

The results displayed in table IV below demonstrate that the AGCLM model is both statistically valid and structurally sufficient for describing the results of interactive online learning.

Metrics Formulae Used for Analysis

Cronbach's Alpha was calculated using equation (5):

$$\alpha = \frac{k}{k-1}\left(1-\frac{\sum\sigma_i^2}{\sigma_t^2}\right) \quad (5)$$

Where k represents the number of items, σ_i^2 represents item variance, and σ_t^2 represents total variance.

CR was computed using equation (6):

$$CR = \frac{(\sum\lambda_i)^2}{(\sum\lambda_i)^2 + \sum\theta_i} \quad (6)$$

Where λ_i denotes factor loading and θ_i denotes measurement error variance.

AVE was calculated using equation (7):

$$AVE = \frac{\sum\lambda_i^2}{n} \quad (7)$$

Where $n$represents the number of observed indicators.

The coefficient of determination for learning outcomes was estimated using equation (8):

$$R^2 = 1 - \frac{SS_{res}}{SS_{tot}} \quad (8)$$

Where SS_{res} represents residual variance and SS_{tot} represents total variance.

Discussion

The study's findings demonstrate that gamifying collaborative learning greatly raises student online engagement, facilitates peer communication, and boosts collaborative satisfaction in higher education settings. The beneficial impact of GLM on student engagement demonstrates the importance of gamification components like prizes, accomplishment badges, group missions, and progress tracking in raising student motivation and active participation in the learning process.

Students who are actively involved in their studies participate more actively in discussion board sessions, according to the association between student engagement and peer interaction quality, peer collaboration activities, and knowledge-sharing processes among peers. The findings demonstrate that learning outcomes are significantly influenced by collaborative satisfaction, making social interaction a crucial component of online learning initiatives.

However, the AGCLM approach has managed to integrate aspects such as adaptive gamification, participation management, and engagement analytics in one platform, which can help learners improve retention and performance. The analysis shows that the AGCLM framework is indeed viable in terms of implementation for higher education institutions.

Recommendations and Implications

Educational organizations must employ adaptive gamification techniques in Learning Management Systems to enhance the participation and quality of interaction among learners within their virtual learning environments. Universities should adopt collaborative missions, reward systems for participation, peer recognition programs, and engagement tracking systems to maintain student motivation and effective communication.

The managers of the institutions should consider implementing training sessions for teachers aimed at designing gamified activities that facilitate the engagement of learners within the course activities. Incorporation of engagement metrics into e-learning platforms can help identify disengaged learners early enough.

In addition to this, the suggested AGCLM framework has some practical applications for the purpose of enhancing the quality of digital learning services and collaborative academic performances at a higher education level.

Suggestions for Future Research

By utilizing artificial intelligence to develop an adaptive learning system with a personalized recommendation technique in a game-based learning environment, future research can expand on the proposed AGCLM framework. Research conducted using a comparative analysis method and involving various nations may enhance the overall generalizability of the framework. Another aspect to be examined is longitudinal behavior and academic retention.

V. Conclusion

This paper formulated and tested the Advanced Gamified Collaborative Learning Model (AGCLM), which aims to increase engagement, collaborative quality, satisfaction with collaboration, and learning in virtual higher education settings. This research aimed to address some significant issues related to learner disengagement, ineffective communication among learners, and ineffective engagement in the digital education system. For this purpose, the quantitative explanatory research method was adopted to analyze data collected from 428 students of undergraduate and postgraduate levels in higher educational institutions in Uzbekistan through SEM and multivariate analysis methods. Indeed, the results obtained from the statistics indicated that the GLM was highly effective in promoting Student Engagement, with a strong standardized path coefficient of $\beta = 0.79$ and $p < 0.001$. In addition, Student Engagement was shown to have a positive impact on the quality of Peer Interactions ($\beta = 0.74$), which was found to be positively related to Collaborative Learning Satisfaction ($\beta = 0.71$). The highest path coefficient was associated with Collaborative Learning Satisfaction, which was related to Learning Outcomes ($\beta = 0.82$). This shows that collaborative learning satisfaction plays an important role in facilitating participation, knowledge acquisition, and intention to retain information by online students. Furthermore, the SEM model had high levels of goodness-of-fit indices, CFI = 0.94, GFI=0.91, TLI = 0.92, RMSEA = 0.051, and $\chi^2/df = 2.14$. From the findings presented, it is evident that rewards, collaboration, tracking, and learning processes through peers can greatly enhance communication efficiency and continuous learning among students in online classes. The suggested AGCLM model brings about several managerial insights for educational institutions that wish to improve learning service quality, increase retention levels of learners, and enhance collaborative learning. Furthermore, the research contributes towards building a scientifically valid base for the development of intelligent gamified learning and adaptive collaborative educational environments.

References

[1] An, Y. (2021). A qualitative investigation of team-based gamified learning in an online environment. *Educational Process: International Journal (EDUPIJ)*, *10*(4), 73-91. https://doi.org/10.22521/edupij.2021.104.5

[2] Bilro, R. G., Loureiro, S. M. C., & Angelino, F. J. D. A. (2021). The role of creative communications and gamification in student engagement in higher education: A sentiment analysis approach. *Journal of Creative Communications*, *17*(1), 7-21. https://doi.org/10.1177/0973258621992644

[3] Cheng, M. T., She, H. C., & Annetta, L. A. (2015). Game immersion experience: its hierarchical structure and impact on game-based science learning. *Journal of computer assisted learning*, *31*(3), 232-253. https://doi.org/10.1111/jcal.12066

[4] Dustman, W. A., King-Keller, S., & Marquez, R. J. (2021). Development of gamified, interactive, low-cost, flexible virtual microbiology labs that promote higher-order thinking during pandemic instruction. *Journal of microbiology & biology education*, *22*(1), 10-1128. https://doi.org/10.1128/jmbe.v22i1.2439

[5] Estriegana, R., Medina-Merodio, J. A., Robina-Ramírez, R., & Barchino, R. (2021). Analysis of cooperative skills development through relational coordination in a gamified online learning environment. *Electronics*, *10*(16), 2032. https://doi.org/10.3390/electronics10162032

[6] Gyedu, F. O., Partey, P. A., Boafo, F. A., & Agbo, D. D. (2026). Gamification effect: Enhancing student learning outcomes in higher education: A meta-analysis and policy implications. *Sage Open*, *16*(1), 21582440261421375. https://doi.org/10.1177/21582440261421375

[7] Huang, R., Ritzhaupt, A. D., Sommer, M., Zhu, J., Stephen, A., Valle, N., ... & Li, J. (2020). The impact of gamification in educational settings on student learning outcomes: A meta-analysis. *Educational Technology Research and Development*, *68*(4), 1875-1901. https://doi.org/10.1007/s11423-020-09807-z

[8] Kyewski, E., & Krämer, N. C. (2018). To gamify or not to gamify? An experimental field study of the influence of badges on motivation, activity, and performance in an online learning course. *Computers & Education*, *118*, 25-37. https://doi.org/10.1016/j.compedu.2017.11.006

[9] Leung, F. Y., Lau, M., Wan, K., Law, L., Kwong, T., & Wong, E. Y. (2021, September). Promoting Students' Global Perspectives Through a Gamified e-Learning Platform. In *Frontiers in Education* (Vol. 6, p. 617680). Frontiers Media SA. https://doi.org/10.3389/feduc.2021.617680

[10] Oliveira, W., Hamari, J., Shi, L., Toda, A. M., Rodrigues, L., Palomino, P. T., & Isotani, S. (2023). Tailored gamification in education: A literature review and future agenda. *Education and information technologies*, *28*(1), 373-406. https://doi.org/10.1007/s10639-022-11122-4

[11] Park, S., & Kim, S. (2021). Is sustainable online learning possible with gamification?—The effect of gamified online learning on student learning. *Sustainability*, *13*(8), 4267. https://doi.org/10.3390/su13084267

[12] Portela, F. (2022). Towards an engaging and gamified online learning environment—A real CaseStudy. *Information*, *13*(2), 80. https://doi.org/10.3390/info13020080

[13] Rivera, E. S., & Garden, C. L. P. (2021). Gamification for student engagement: a framework. *Journal of further and higher education*, *45*(7), 999-1012. https://doi.org/10.1080/0309877X.2021.1875201

[14] Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational psychology review*, *32*(1), 77-112. https://doi.org/10.1007/s10648-019-09498-w

[15] Saleem, A. N., Noori, N. M., & Ozdamli, F. (2022). Gamification applications in E-learning: A literature review. *Technology, Knowledge and Learning*, *27*(1), 139-159. https://doi.org/10.1007/s10758-020-09487-x

[16] Subhash, S., & Cudney, E. A. (2018). Gamified learning in higher education: A systematic review of the literature. *Computers in human behavior*, *87*, 192-206. https://doi.org/10.1016/j.chb.2018.05.028

[17] Taesotikul, T., Chinpaisal, C., & Nawanopparatsakul, S. (2021, May). Kahoot! gamification improves learning outcomes in problem-based learning classroom. In *2021 3rd International Conference on Modern Educational Technology* (pp. 125-129). https://doi.org/10.1145/3468978.3468999

[18] Xiao, Y., & Hew, K. F. (2024). Personalised gamification enhances student participation but produces mixed effects on emotional and cognitive engagements: a systematic review. *Interactive Learning Environments*, *32*(10), 7014-7040. https://doi.org/10.1080/10494820.2023.2299977

[19] Zainuddin, Z., Chu, S. K. W., Shujahat, M., & Perera, C. J. (2020). The impact of gamification on learning and instruction: A systematic review of empirical evidence. *Educational research review*, *30*, 100326. https://doi.org/10.1016/j.edurev.2020.100326

[20] Zheng, E., & Wang, Q. (2023). Effectiveness of Online Collaborative Learning in Gamified Environments. *International Journal of Emerging Technologies in Learning*, *18*(17). https://doi.org/10.3991/ijet.v18i17.42851