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PAPER

Gamified Learning and Student Engagement in Blended Education: The Moderating Role of Chatbot Usability

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ABSTRACT

Student engagement plays an important role in blended learning. But it is not easy to keep students active over time. Students need clear learning tasks, useful feedback, and simple digital support. This study explores how gamification strategies (GS) affect student engagement in a blended learning course. It also examines whether chatbot usability strengthens this effect. The study focuses on four gamification strategies: triggers, actions, variable rewards, and investment. It draws on self-determination Theory, the Hook Model, and the Technology Acceptance Model. Data were collected from 600 undergraduate students who took a blended Chinese history course. Structural equation modeling (SEM) and hierarchical regression were used to test the proposed relationships. The results show that gamification strategies have a positive effect on student engagement ($\beta = 0.86$, $p < 0.01$). Among the four strategies, investment makes the strongest contribution. The results also show that chatbot usability is positively related to student engagement ($\beta = 0.26$, $p < 0.01$). In addition, chatbot usability moderates the relationship between gamification strategies and student engagement (interaction $\beta = 0.05$, $p < 0.05$). This means that gamification strategies are more effective when students find the chatbot easy and useful to use. These results suggest that gamified learning design should work together with usable chatbot support. Clear tasks, meaningful rewards, and simple chatbot interaction can help students take part more actively in blended learning.

KEYWORDS

gamification strategies (GS), chatbot usability (CU), student engagement, sustainable education

1 INTRODUCTION

In recent years, digital technologies have developed quickly. AI and natural language processing have also become more widely used in education. Because of this, chatbots have become an important tool in teaching and learning [1]. These intelligent assistants can give students quick feedback, learning suggestions, and interactive support. They are also changing traditional teaching models. Compared with many traditional online learning tools, chatbots can support students in a more direct and

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flexible way. This may help improve student engagement and learning outcomes. Also, the use of chatbots with gamification strategies (GS) may further increase students' learning motivation and engagement [2, 3]. Gamification strategies include elements such as points, rewards, and leaderboards. These elements can encourage students' motivation and make learning more active and interesting [4, 5]. But several research gaps remain. Existing studies have shown that gamification strategies can improve student engagement. But there is still limited research on specific gamification elements, such as immediate feedback and challenge settings [6]. Also, few studies have clearly examined how chatbot usability may moderate the relationship between gamification strategies and student engagement [2]. Therefore, this study examines the effects of gamification strategies on student engagement in blended learning contexts. It focuses on two research questions: (1) How do different gamification elements, including triggers, actions, variable rewards, and investment, affect student engagement? (2) Does chatbot usability moderate the relationship between these gamification strategies and student engagement?

Therefore, this study investigates whether chatbot usability strengthens the relationship between gamification strategies and student engagement in blended learning. Gamification strategies refer to game design elements used to increase learning motivation and engagement. Chatbot usability refers to students' perceived ease of use, satisfaction, efficiency, and interaction quality when using chatbots [7, 8].

2 LITERATURE REVIEW

2.1 Gamification strategies and student engagement

Blended learning combines face-to-face teaching with online learning activities. It has become common in higher education. In this study, blended learning refers to a network-supported teaching approach. It combines classroom teaching, online resources, and learning technologies to improve learning outcomes. But it is still difficult to keep students engaged in blended learning. This problem is more obvious when online activities do not provide timely feedback, interaction, or motivational support [9–13]. Student engagement refers to students' active participation and mental involvement in learning activities. It is shown through behavioral, cognitive, affective, and social dimensions [14, 15]. In technology-supported and gamified learning contexts, engagement can be seen in task completion, interaction frequency, participation quality, and students' self-reported involvement [4–16]. Many studies have examined the positive effect of gamification strategies on student engagement, especially in online and blended learning environments [2]. For example, gamification designs with immediate feedback and reward mechanisms can improve students' motivation. They can also help students stay engaged during learning [9]. Also, gamification can support students' active participation in learning tasks and improve their efficiency and accuracy in task completion [17].

This relationship can be explained by SDT, flow theory, and the Hook Model. SDT suggests that students are more motivated when learning supports their needs for autonomy, competence, and relatedness [18]. Gamification strategies may support these needs through task variety, immediate feedback, badges, leaderboards, and challenges [2, 19]. Flow Theory also suggests that clear goals, timely feedback, and suitable challenges can help students focus more deeply and become more engaged in learning [20, 21]. The Hook Model provides another useful way to explain sustained engagement. It includes four components: triggers, actions, variable rewards, and investment. These components match the gamification dimensions used in this study [22]. Gamification strategies may prompt students to take learning actions. They may also maintain students' interest through variable rewards. Over time, they may encourage students to invest more effort in blended learning.

Therefore, this study proposes the following hypothesis:

Hypothesis 1: Gamification strategies positively correlate with student engagement in blended learning environments.

2.2 Chatbot usability

Chatbot usability is an important factor in AI-supported education. It can affect students' learning experience and engagement. In this study, chatbot usability refers to students' perceived learnability, satisfaction, efficiency, and interaction quality when they use chatbots [23, 24]. These dimensions show whether students can use the chatbot easily. They also show whether students can get timely and accurate answers and have meaningful interaction during learning [25–28]. Previous studies have found that usable chatbots can give quick feedback, personalized learning support, and interactive dialogue. These functions can improve students' motivation and learning engagement [24–27]. GS may be useful, but their effects may depend on the usability of the educational technologies used to deliver them [2]. According to the technology acceptance model, students are more likely to accept and continue using tools when they find them easy to use, efficient, and satisfying [29–32]. Therefore, chatbot usability may strengthen the effect of GS on student engagement in blended learning environments [1].

Based on prior theoretical and empirical findings, the following hypothesis is put forward:

Hypothesis 2: Chatbot usability moderates the relationship between gamification strategies and student engagement.

To visually represent the proposed research relationships, Figure 1 presents the conceptual framework illustrating the direct effects of gamification strategies on student engagement and the moderating role of chatbot usability.

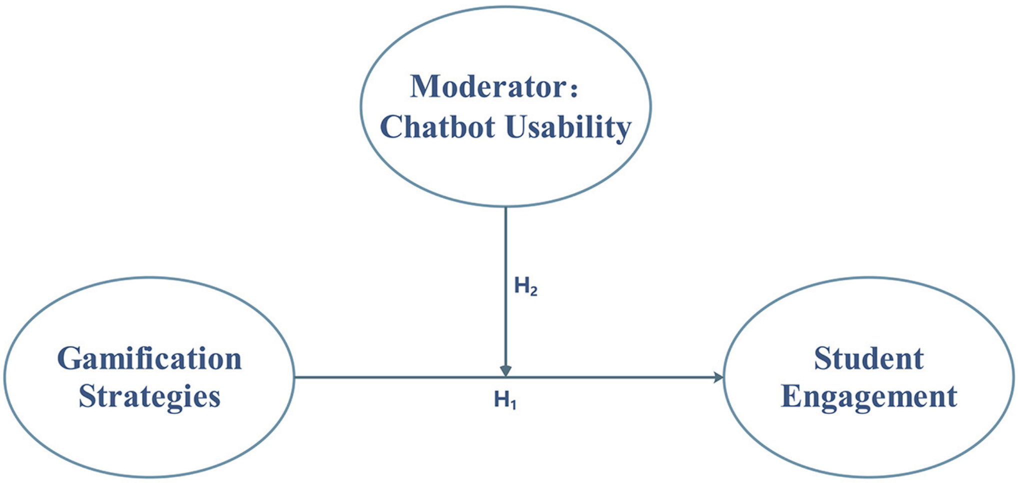

Fig. 1. Conceptual framework

3 METHODOLOGY

3.1 Participants

This study used a questionnaire survey. The participants were undergraduate students in blended learning courses at three comprehensive universities in Western Guangdong, China. The study used random sampling. Course administrators at the three universities provided class rosters. Students were then selected from these rosters. This process helped ensure that every student enrolled in the course had an equal chance of being selected. The selected course was a blended Chinese History course. A total of 645 questionnaires were distributed. Finally, 600 valid responses were collected during class breaks. The response rate was 93.02%. Students were told that participation was voluntary. They were also told that their responses would remain anonymous. All participants gave informed consent. Small incentives were provided to encourage students to complete the survey.

3.2 Context

The study was carried out in a blended Chinese History course. The course was delivered through a designated learning platform. It combined face-to-face classes with online modules. The online modules included video learning, primary source analysis, quizzes, discussions, and group tasks. The course also used several gamification strategies. These strategies included reminders, points, progress tracking, variable rewards, and investment-based activities. For example, students could unlock advanced learning content after completing certain tasks. An intelligent chatbot was also added to the platform. The chatbot provided learning guidance, instant answers, personalized suggestions, task reminders, and feedback support. These functions helped students understand learning tasks more clearly. They also supported students' autonomy and helped them stay engaged in blended learning activities.

3.3 Measures

The survey included three main instruments: (1) the Gamification Strategies Scale, (2) the Chatbot Usability Scale, and (3) the Student Engagement Scale. The GS Scale was adapted from the GAMEFULQUEST questionnaire developed by Kumari and Gujral [32]. It also included items from related studies [33–35]. This scale measured four dimensions: Trigger, Action, Variable Rewards, and Investment. The Chatbot Usability Scale was developed based on previous studies [36, 37]. It measured ease of use, satisfaction, efficiency, and interaction quality. The Student Engagement Scale used the Agentic Engagement Scale developed by Reeve [38]. It measured behavioral, cognitive, and affective engagement. All items used a 5-point Likert scale, from "strongly disagree" (1) to "strongly agree" (5). The questionnaires were distributed in two ways. Paper questionnaires were given during class. Online questionnaires were shared through the learning platform and class groups. The survey questions were written in a short and clear way. Small gifts or lottery opportunities were offered to increase the response rate and support data quality.

SPSS 26.0 and AMOS 24.0 were used for data analysis. Firstly, the questionnaires were checked. Invalid responses were removed. Valid data were then entered for analysis. Descriptive statistics, including means and standard deviations, were used to summarize the data [39]. Confirmatory factor analysis (CFA) was used to test the construct validity of the measurement scales. Cronbach's α coefficients were calculated to test internal consistency reliability [40]. Structural equation modeling (SEM) was then conducted in AMOS 24.0. This analysis examined the proposed relationship between gamification strategies and student engagement. It also tested the moderating effect of chatbot usability [40]. Finally, hierarchical regression analysis was used to further test the moderating role of chatbot usability. Before the moderation model was built, all variables were mean-centered. This step was used to reduce multicollinearity and improve the stability of the analysis.

4 RESULTS

4.1 Descriptive statistics

Table 1 shows the demographic characteristics of the participants. The study included 600 valid respondents. Among them, 56.00% were female and 44.00% were male. Freshmen made up 63.00% of the sample, and sophomores made up 37.00%. Most participants were 18 or 19 years old. Also, most students reported occasional or frequent use of LMS. Most students were also somewhat familiar with chatbots. This shows that the sample had enough experience with blended learning and AI-supported learning tools.

Table 1. Descriptive participant statistics

	Variables	Number	Percent %
Gender	Male	264	44.00
	Female	336	56.00
Grade	Freshman	378	63.00
	Sophomore	222	37.00
Age	17	9	1.50
	18	302	50.33
	19	276	46.00
	20 and above	13	2.17
LMS Usage	Rarely Use	5	0.83
	Sometimes Use	405	67.50
	Frequently Use	190	31.67
Chatbots	Not Familiar	16	2.67
	Somewhat Familiar	517	86.17
	Very Familiar	67	11.17

4.2 Reliability analysis

As shown in Table 2, all constructs had high internal consistency. Cronbach's α values ranged from 0.923 to 0.977. The CITC values were also above the recommended level. This result shows that the items had good discrimination and reliability.

Table 2. Reliability test of factors

Construct	Number of Items	Cronbach's α	CITC Range
Triggers	6	0.947	0.808–0.864
Actions	4	0.923	0.783–0.852
Variable Rewards	6	0.953	0.829–0.890
Investment	10	0.971	0.836–0.890
Chatbot Usability	12	0.952	0.730–0.799
Student Engagement	15	0.977	0.824–0.878

4.3 Validity analysis

Confirmatory factor analysis was conducted to test convergent validity. All standardized factor loadings were higher than 0.6 and were statistically significant. This shows that the items had strong relationships with their related constructs. As shown in Table 3, average variance extracted (AVE) values for all four constructs were above 0.5. The composite reliability (CR) values were also above 0.7. These results show that the measurement model had good convergent validity.

Table 3. Convergent validity results

	AVE	C.R.
GS	0.771	0.989
CU	0.669	0.960
SE	0.754	0.979

Note: GS: Gamification strategies, CU: Chatbot Usability, SE: Student Engagement.

Discriminant validity was also tested by comparing the square root of AVE for each construct (refer Table 4). The square root of AVE for Gamification Strategies (GS) was 0.878. This value was higher than the largest correlation among the factors, which was 0.754. This result shows good discriminant validity [41]. The square root of AVE for Chatbot usability (CU) was 0.823. The value for SE was 0.869. Both values were higher than their related inter-factor correlations. These results show that the constructs were clearly different from each other.

Table 4. Validity assessment

	Gamification Strategies	Chatbot Usability	Student Engagement
Gamification Strategies	0.878		
Chatbot Usability	0.663**	0.823	
Student Engagement	0.754**	0.643**	0.869

Note: GS: Gamification Strategies, CU: Chatbot Usability, SE: Student Engagement.

4.4 Structural equation modeling analysis

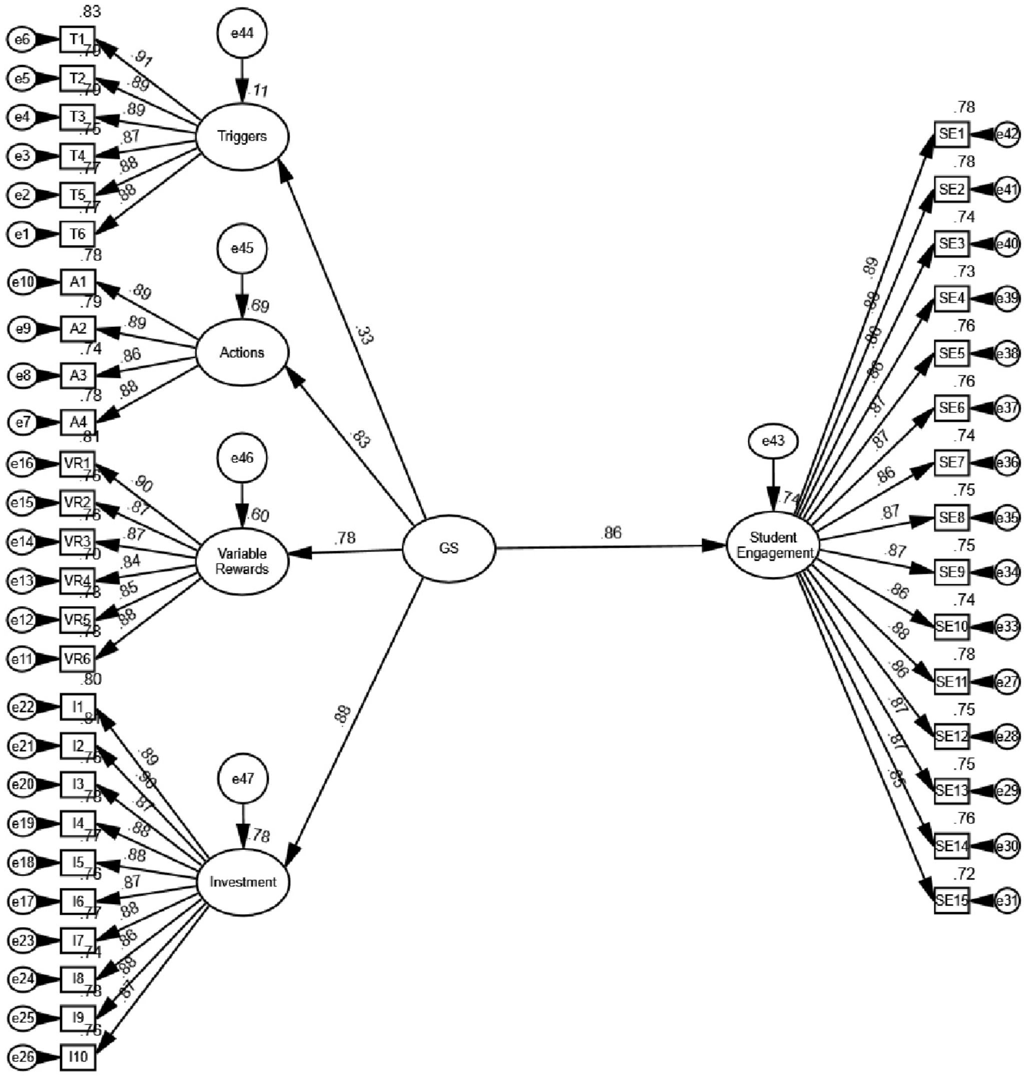

Fig. 2. Standardized estimates for hypothesized SEM models

Figure 2 shows the standardized estimates of the SEM model. The results showed a strong positive path from Gamification Strategies to Student Engagement ($\beta = 0.859$, $p < 0.01$). The model also showed an acceptable fit. The fit indices were $\chi^2/df = 2.743$, CFI = 0.953, NFI = 0.928, and RMSEA = 0.054, as shown in Table 5. Therefore, Hypothesis 1 was supported.

Table 5. Overall measurement model fit statistics

Measures	Measurement Model	Threshold Values
χ^2	2123.124	
df	774	
p-value	0.000	
χ^2/df	2.743	Less than 3
GFI	0.859	0.900 and above

(Continued)

Table 5. Overall measurement model fit statistics *(Continued)*

Measures	Measurement Model	Threshold Values
CFI	0.953	0.900 and above
NFI	0.928	0.900 and above
RMSEA	0.054	Less than 0.100

Path analysis supported Hypothesis 1 (H1). GS had a significant positive effect on SE. The standardized path coefficient was $\beta = 0.859$, with C.R. = 70.583 and $p < 0.01$ (see Table 6). Therefore, H1 was supported.

Table 6. Findings related to H1

X→Y	SE	C.R.	Path Coefffcients	Results	p
GS→T	–	–	0.333	Not supported	0.333
GS→A	0.359	70.531	0.832	Supported	0.832
GS→VR	0.312	70.451	0.776	Supported	0.776
GS→I	0.353	70.589	0.881	Supported	0.881
GS→SE	0.355	70.583	0.859	Supported	0.859

4.5 Moderating effect analysis

Hierarchical regression was used to test the moderating effect of chatbot usability. As shown in Table 7, Model 1 showed that gamification strategies significantly predicted student engagement ($\beta = 0.754$, $p < 0.01$, $R^2 = 0.569$). In Model 2, chatbot usability was added to the model. Gamification strategies remained significant ($\beta = 0.584$, $p < 0.01$). Chatbot usability was also a significant predictor ($\beta = 0.257$, $p < 0.01$). The explained variance increased to 60.6%. In Model 3, the interaction term was significant ($\beta = 0.053$, $p < 0.05$). This result shows that chatbot usability positively moderated the relationship between gamification strategies and student engagement.

Table 7. Results of hierarchical regression models 1–3

	Model 1				Model 2				Model 3			
	β	SE	t	p	β	SE	t	p	β	SE	t	p
Constant	–	0.030	102.960	0.000**	–	0.028	107.578	0.000**	–	0.035	85.982	0.000**
GS	0.754	0.033	28.077	0.000**	0.584	0.042	17.011	0.000**	0.567	0.043	16.077	0.000**
CU					0.257	0.035	7.473	0.000**	0.273	0.036	7.750	0.000**
GS*CU									0.053	0.032	1.989	0.047*
R^2	0.569				0.606				0.608			
Adjusted R^2	0.568				0.604				0.606			
F	F = 788.313				F = 458.231				F = 308.319			
p	0.000				0.000				0.000			
ΔR^2	0.569				0.037				0.003			
ΔF	F = 788.313				F = 55.847				F = 3.956			
p	0.000				0.000				0.000			

4.6 Simple slope analysis

Simple slope analysis further confirmed the moderating effect of chatbot usability. As shown in Table 8, the effect of gamification strategies on student engagement was strongest when chatbot usability was high. The effect was moderate when chatbot usability was average. The effect was weakest when chatbot usability was low. These results support Hypothesis 2.

Table 8. Simple slope analysis across models 1, 2 and 3

Moderate Variable Level	Regression Coefficients	Std. Error	t	p	95% CI	
Average CU	0.695	0.043	16.077	0.000	0.610	0.779
High CU	0.763	0.048	15.766	0.000	0.668	0.858
Low CU	0.626	0.061	10.183	0.000	0.505	0.746

Note: CU: Chatbot Usability.

5 DISCUSSION

This study found that gamification strategies significantly improved student engagement in a blended learning environment. This finding is consistent with previous studies. Gamified elements can support students' motivation and participation by offering clear tasks, timely feedback, rewards, and chances for continued involvement. Among the gamification dimensions, investment had the strongest effect. This result shows that sustained effort, accumulated progress, and meaningful task involvement are important for keeping students engaged [42–44].

This study also examined the moderating role of chatbot usability. The findings provide empirical support for gamified learning. They also offer useful guidance for teachers, course designers, and educational technology developers. The results showed that gamification strategies had a significant positive effect on student engagement. Investment showed the strongest contribution among all dimensions. This finding is in line with previous research. It suggests that students' psychological investment in learning tasks can strongly affect their motivation and engagement [45]. Therefore, instructional designers should pay more attention to students' sense of investment. They can do this through challenging tasks, clear goals, and timely feedback [46]. These strategies can help students stay focused and feel a stronger sense of achievement. Students should also have some autonomy when completing tasks. This can further improve their intrinsic motivation and active participation.

Moreover, the dimensions of action and variable rewards had a significant effect on student engagement. This result shows the importance of clear task structures and flexible reward systems in improving students' learning experiences [47]. Educators should design learning tasks in a step-by-step way. They should also use different reward mechanisms, such as badges, points, and leaderboards, to encourage active participation. For example, immediate feedback can help students receive timely recognition after they complete tasks. This can support motivation to learn, engagement, and task completion.

Another important finding was that chatbot usability positively moderated the relationship between gamification strategies and student engagement. In other words, gamification strategies were more effective when chatbot usability was high. This result shows that chatbots can do more than provide quick feedback in gamified learning environments. They can also improve the overall learning experience. When students find the chatbot easy and useful to use, they may be more willing to take part in gamified tasks. For educational technology developers, this finding suggests that user experience should receive more attention [48]. Developers should improve conversational naturalness, system intelligence, and personalized learning support. For example, high usability chatbots should provide personalized suggestions based on students' learning progress. They should also offer timely help when students face problems. Technologies such as speech recognition and sentiment analysis may also make chatbot interaction smoother and more natural. This can help students participate more actively in learning.

6 CONCLUSION

This study examined how gamification strategies affected student engagement in a blended Chinese History course. It also tested the moderating role of chatbot usability. The results showed that gamification strategies significantly improved student engagement. Among the four dimensions, investment had the strongest effect. Chatbot usability also positively moderates this relationship. This means that gamified learning design worked better when students found the chatbot easy and useful to use. This study also offers theoretical and practical value. In theory, it extends the use of SDT, TAM, and the Hook Model in AI-supported blended learning. In practice, the findings suggest that teachers and educational technology developers should design meaningful gamified tasks. They should also improve chatbot usability through clearer interaction, timely feedback, and personalized learning support. Future studies can examine other disciplines. They can also use longitudinal designs and test the separate moderating effects of different chatbot usability dimensions.

7 REFERENCES

[1] M. de la Roca, M. M. Chan, A. Garcia-Cabot, E. Garcia-Lopez, and H. Amado-Salvatierra, "The impact of a chatbot working as an assistant in a course for supporting student learning and engagement," *Computer Applications in Engineering Education*, vol. 32, p. e22750, 2024. https://doi.org/10.1002/cae.22750

[2] C.-C. Liu, Y.-Y. Lin, F.-Y. Lo, C.-H. Chang, and H.-M. Lin, "From readers to players: Exploring student engagement in a gamified metaverse and its effect on reading interest," *Education and Information Technologies*, vol. 30, no. 1, pp. 421–447, 2025. https://doi.org/10.1007/s10639-024-13068-1

[3] O. Nozhovnik, T. Harbuza, N. Teslenko, O. Okhrimenko, V. Zalizniuk, and A. Durdas, "Chatbot gamified and automated management of L2 learning process using Smart Sender platform," *International Journal of Educational Methodology*, vol. 9, no. 3, pp. 603–618, 2023. https://doi.org/10.12973/ijem.9.3.603

[4] A. Christopoulos and S. Mystakidis, "Gamification in education," *Encyclopedia*, vol. 3, pp. 1223–1243, 2023. https://doi.org/10.3390/encyclopedia3040089

[5] W. Majid, F. Zain, and S. Ismail, "Gamified flipped classroom in education: A systematic review," *International Journal of Evaluation and Research in Education*, vol. 13, no. 3, p. 1610, 2024. https://doi.org/10.11591/ijere.v13i3.26721

[6] A. Khaldi, R. Bouzidi, and F. Nader, "Gamification of e-learning in higher education: A systematic literature review," *Smart Learning Environments*, vol. 10, no. 1, p. 10, 2023. https://doi.org/10.1186/s40561-023-00227-z

[7] O. M. Schei, A. Møgelvang, and K. Ludvigsen, “Perceptions and use of AI chatbots among students in higher education: A scoping review of empirical studies,” *Education Sciences*, vol. 14, no. 8, p. 922, 2024. https://doi.org/10.3390/educsci14080922

[8] A. Saihi, M. Ben-Daya, and M. Hariga, “The moderating role of technology proficiency and academic discipline in AI-chatbot adoption within higher education: Insights from a PLS-SEM analysis,” *Education and Information Technologies*, vol. 30, no. 5, pp. 5843–5881, 2024. https://doi.org/10.1007/s10639-024-13023-0

[9] B. Nguyen-Viet and H. D. N. Minh, “How gamification enhances learning effectiveness through blended learning and intrinsic motivation: The moderating effects of self-regulation,” *SAGE Open*, vol. 15, no. 4, 2025. https://doi.org/10.1177/21582440251385846

[10] A. S. Ghai, Z. Altinay, F. Altinay, S. Jasola, G. Dagli, and B. Yikici, “Exploring the impact of interactive technologies on student engagement in blended learning environments at higher education institutions,” *International Journal of Interactive Mobile Technologies*, vol. 19, no. 5, pp. 233–257, 2025. https://doi.org/10.3991/ijim.v19i05.52039

[11] Z. Zhang and X. Huang, “Exploring the impact of the adaptive gamified assessment on learners in blended learning,” *Education and Information Technologies*, vol. 29, no. 16, pp. 21869–21889, 2024. https://doi.org/10.1007/s10639-024-12708-w

[12] H. L. Núñez, C. Guevara, V. B. Núñez, and D. V. Pérez, “Analysis of gamification in b-learning in university higher education: A systematic review of the literature,” *Journal of Higher Education Theory and Practice*, vol. 23, no. 19, pp. 29–38, 2023. https://doi.org/10.33423/jhetp.v23i19.6674

[13] B. Means and J. Neisler, “Bridging theory and measurement of student engagement: A practical approach,” *Online Learning Journal*, vol. 27, no. 4, pp. 26–47, 2023. https://doi.org/10.24059/olj.v27i4.4034

[14] G. A. Akinpelu, S. A. Akinpelu, M. S. Folorunsho, K. S. Ameen, S. R. Adebayo, and C. Y. Daramola, “Impact of mastery learning instructional scheme on post-basic school students’ engagement levels in mathematics in Osogbo, Nigeria,” *Discover Education*, vol. 4, no. 1, p. 127, 2025. https://doi.org/10.1007/s44217-025-00535-1

[15] J. Zare, A. Derakhshan, and F. R. Madiseh, “Self-efficacy and engagement in L2 writing: A structural equation modelling perspective,” *European Journal of Education*, vol. 60, no. 4, p. e70255, 2025. https://doi.org/10.1111/ejed.70255

[16] C. K. Lo, K. F. Hew, and M. S.-Y. Jong, “The influence of ChatGPT on student engagement: A systematic review and future research agenda,” *Computers & Education*, vol. 219, p. 105100, 2024. https://doi.org/10.1016/j.compedu.2024.105100

[17] I. A. Alshalabi, T. Alrawashdeh, A. AbuKaraki, and M. Z. Alksasbeh, “A mobile-enabled adaptive gamification framework for programming education,” *International Journal of Interactive Mobile Technologies*, vol. 19, no. 8, pp. 42–69, 2025. https://doi.org/10.3991/ijim.v19i08.52823

[18] J. Li *et al.*, “Analyzing the network structure of students’ motivation to learn AI: A self-determination theory perspective,” *Npj Science of Learning*, vol. 10, no. 1, 2025. https://doi.org/10.1038/s41539-025-00339-w

[19] L. Li, K. F. Hew, and J. Du, “Gamification enhances student intrinsic motivation, perceptions of autonomy and relatedness, but minimal impact on competency: A meta-analysis and systematic review,” *Educational Technology Research and Development*, vol. 72, pp. 765–796, 2024. https://doi.org/10.1007/s11423-023-10337-7

[20] J. R. Chapman, T. B. Kohler, P. J. Rich, and A. Trego, “Maybe we’ve got it wrong. An experimental evaluation of self-determination and Flow Theory in gamification,” *Journal of Research on Technology in Education*, vol. 57, no. 2, pp. 417–436, 2025. https://doi.org/10.1080/15391523.2023.2242981

[21] L. Zhong and J. Zhou, "Personalized games for computer science education in higher education: The effect of personalization feature on students' engagement and flow state," *Journal of Computing in Higher Education*, vol. 38, no. 1, pp. 77–104, 2024. https://doi.org/10.1007/s12528-024-09427-z

[22] N. Eyal, *Hooked: How to Build Habit-Forming Products*. London, UK: Penguin, 2014.

[23] M. Veras, J.-O. Dyer, M. Rooney, P. G. B. Silva, D. Rutherford, and D. Kairy, "Usability and efficacy of artificial intelligence chatbots (ChatGPT) for health sciences students: Protocol for a crossover randomized controlled trial," *JMIR Research Protocols*, vol. 12, p. e51873, 2023. https://doi.org/10.2196/51873

[24] J. Yin, T. T. Goh, and Y. Hu, "Interactions with educational chatbots: The impact of induced emotions and students' learning motivation," *International Journal of Educational Technology in Higher Education*, vol. 21, no. 1, 2024. https://doi.org/10.1186/s41239-024-00480-3

[25] S. Shaikh, S. Y. Yayilgan, B. Klimova, and M. Pikhart, "Assessing the usability of ChatGPT for formal English language learning," *European Journal of Investigation in Health, Psychology and Education*, vol. 13, pp. 1937–1960, 2023. https://doi.org/10.3390/ejihpe13090140

[26] B. Kayalı, M. Yavuz, Ş. Balat, and M. Çalışan, "Investigation of student experiences with ChatGPT-supported online learning applications in higher education," *Australasian Journal of Educational Technology*, vol. 39, pp. 20–39, 2023. https://doi.org/10.14742/ajet.8915

[27] M. A. Kuhail, N. Alturki, S. Alramlawi, and K. Alhejori, "Interacting with educational chatbots: A systematic review," *Education and Information Technologies*, vol. 28, pp. 973–1018, 2023. https://doi.org/10.1007/s10639-022-11177-3

[28] Y. Chen, S. Jensen, L. J. Albert, S. Gupta, and T. Lee, "Artificial intelligence (AI) student assistants in the classroom: Designing chatbots to support student success," *Information Systems Frontiers*, vol. 25, pp. 161–182, 2023. https://doi.org/10.1007/s10796-022-10291-4

[29] N. A. Dahri, W. M. Al-Rahmi, K. A. Alhashmi, and F. Bashir, "Enhancing mobile learning with AI-powered chatbots: Investigating ChatGPT's impact on student engagement and academic performance," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 19, no. 11, pp. 17–38, 2025. https://doi.org/10.3991/ijim.v19i11.54643

[30] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly*, vol. 13, pp. 319–340, 1989. https://doi.org/10.2307/249008

[31] V. Venkatesh and F. D. Davis, "A theoretical extension of the technology acceptance model: Four longitudinal field studies," *Management Science*, vol. 46, no. 2, pp. 186–204, 2000. https://doi.org/10.1287/mnsc.46.2.186.11926

[32] H. Gujral and Kumari, "A study of gamification and its effect on consumer behaviour," *International Journal of Advanced Research in Computer Science*, vol. 14, no. 4, pp. 1–16, 2023. https://doi.org/10.26483/ijarcs.v14i4.7011

[33] L. C. Lucas, "Using Gamification in the Teaching and Learning of Euclidean Geometry," Master's thesis, University of Johannesburg, Johannesburg, South Africa, 2021.

[34] A. I. Alzahrani, "A Conceptual Framework for Gamified e-Learning Systems Acceptance by Students in Saudi Arabian Universities," Ph.D. dissertation, University of Southampton, Southampton, UK, 2019.

[35] A. W. Brown, "ClassDojo and the Effects of Gamification on Student Engagement Within the Third-Grade Art Classroom: An Action Research Study," Doctoral dissertation, University of South Carolina, Columbia, SC, USA, 2021.

[36] S. Borsci, M. Schmettow, A. Malizia, A. Chamberlain, and F. van der Velde, "A confirmatory factorial analysis of the Chatbot usability scale: A multilanguage validation," *Personal and Ubiquitous Computing*, vol. 27, pp. 317–330, 2023. https://doi.org/10.1007/s00779-022-01690-0

[37] A. Alabbas and K. Alomar, "A weighted composite metric for evaluating user experience in educational chatbots: Balancing usability, engagement, and effectiveness," *Future Internet*, vol. 17, no. 2, p. 64, 2025. https://doi.org/10.3390/fi17020064

[38] M. Maričić and Z. Lavicza, "Enhancing student engagement through emerging technology integration in STEAM learning environments," *Education and Information Technologies*, vol. 29, no. 17, pp. 23361–23389, 2024. https://doi.org/10.1007/s10639-024-12710-2

[39] A. Bekele, W. Melese, and T. Sime, "The effect of blended learning approach on students' learning engagement at Jimma Teachers' College, Ethiopia," *Discover Education*, vol. 4, no. 1, p. 327, 2025. https://doi.org/10.1007/s44217-025-00564-w

[40] B. B. Wiyono, A. Komariah, H. Hidayat, and D. E. Kusumaningrum, "The structural effects of evaluation types in the implementation process of the independent learning program in higher education," *Discover Sustainability*, vol. 6, no. 1, pp. 1–17, 2025. https://doi.org/10.1007/s43621-025-01171-3

[41] N. H. Mohd Dzin and Y. F. Lay, "Validity and reliability of adapted self-efficacy scales in Malaysian context using PLS-SEM approach," *Education Sciences*, vol. 11, no. 11, p. 676, 2021. https://doi.org/10.3390/educsci11110676

[42] Y. Yang, J. Chen, and X. Zhuang, "Self-determination theory and the influence of social support, self-regulated learning, and flow experience on student learning engagement in self-directed e-learning," *Frontiers in Psychology*, vol. 16, p. 1545980, 2025. https://doi.org/10.3389/fpsyg.2025.1545980

[43] Y. Yousaf, M. Shoaib, M. A. Hassan, and U. Habiba, "An intelligent content provider based on students learning style to increase their engagement level and performance," *Interactive Learning Environments*, vol. 31, p. 27372750, 2023. https://doi.org/10.1080/10494820.2021.1900875

[44] E. Dejonckheere *et al.*, "Real-time incentivizing survey completion with game-based rewards in experience sampling research may increase data quantity, but reduces data quality," *Computers in Human Behavior*, vol. 160, p. 108360, 2024. https://doi.org/10.1016/j.chb.2024.108360

[45] H. Liu, Y. Wang, and H. Wang, "Exploring the mediating roles of motivation and boredom in basic psychological needs and behavioural engagement in English learning: A self-determination theory perspective," *BMC Psychology*, vol. 13, no. 1, p. 179, 2025. https://doi.org/10.1186/s40359-025-02524-3

[46] G. T. Brown, C. Andersson, M. Winberg, B. Palmberg, and T. Palm, "Teacher conceptions of assessment and feedback predicting formative feedback practices: Helping students to not ignore improvement-oriented feedback," *Scandinavian Journal of Educational Research*, vol. 70, no. 2, pp. 266–284, 2025. https://doi.org/10.1080/00313831.2025.2468183

[47] P. Montero-Benavides, G. Albort-Morant, and I. C. Masero-Moreno, "Evaluating a gamified assessment model to enhance performance and engagement in finance education: A quasi-experimental study," *The International Journal of Management Education*, vol. 23, no. 3, p. 101266, 2025. https://doi.org/10.1016/j.ijme.2025.101266

[48] M. Al-Shafei, "Navigating human-chatbot interactions: An investigation into factors influencing user satisfaction and engagement," *International Journal of Human–Computer Interaction*, vol. 41, pp. 411–428, 2025. https://doi.org/10.1080/10447318.2023.2301252

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