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A Study of Gamified Learning Behavior Based on the Hedonic-Motivation System Adoption Model

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Abstract. With the development of digital learning, increasing students' interest in learning and enhancing interactivity in the learning process have become central issues in educational research. By combining the hedonic-motivation system adoption model and the reward-penalty mechanism, this study analyzed learning behaviors in a gamified learning environment from the perspective of hedonic motivation. Correlation and regression analyses were employed to systematically explore the influence of multiple psychological factors, including perceived ease of use, perceived usefulness, curiosity, pleasure, and perceived control on the learning process, intention to use, and learning outcomes. The findings suggest that perceived ease of use and perceived usefulness significantly influence learner engagement and intention to use. Curiosity and a sense of pleasure promote continuous engagement and active learning. Perceived control enhances learners' sense of control over what they are learning, focus and immersion, and learning effectiveness. Meanwhile, the reward-penalty mechanism exerts a positive moderating effect on the relationship between perceived ease of use and the learning process, thereby fostering learning motivations and promoting the continuity and depth of learning behaviors. The study demonstrates that the joint effects of psychological factors and the reward-penalty mechanism have significant implications for optimizing learning environments and enhancing learning outcomes.

Keywords: gamified learning, Hedonic-motivation system adoption model, learning behavior, reward-penalty mechanism

1 Introduction

The rapid development of the internet and digital technology has revolutionized the integration of education and technology. Furthermore, the widespread application of technologies such as artificial intelligence, virtual reality, and 5G communications has amplified interactions among teachers, students, learning environments, and educational resources [1]. Within such contexts, collaborative interaction among learners in online learning communities has been argued to foster meaningful learning and improve engagement and active participation [2]. Consequently, optimizing learning outcomes by increasing students' learning interest and promoting their engagement have become central issues in educational research. Although conventional technology-enhanced learning can create a certain degree of interaction in the learning environment, it remains insufficient to consistently inspire learning motivations and improve learning performance.

As a novel teaching strategy, gamified learning stimulates students' learning initiative through features such as point systems, levels, badges, tasks, and challenges. Studies have shown that gamified learning promotes students' independent learning ability, classroom engagement, teamwork skills, and cognitive and practical abilities [3–9]. Additionally, it utilizes tools such as digital badges and rankings to promote learners' confidence and initiative, further boosting their learning motivation and engagement [10–12]. In gamified learning, reward and penalty systems are used to moderate behavior. Studies indicate that rewards significantly improve students' learning outcomes and engagement, while reasonable penalties can reinforce learning behaviors [13–15]. Meanwhile, the effects of rewards and penalties are influenced by multiple factors, including the type of reward, the timing of rewards, the purpose of rewarding, and competitive environments [16–18].

However, researchers have mainly explored the practical application of gamified learning, and systematic analyses of learners' psychological mechanisms, motivation development, and behavioral intentions remain scarce. To address this research gap, this study applied the hedonic-motivation system adoption model

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(HMSAM), which advances the exploration of users' intrinsic motivation, emotional experience, and sense of pleasure based on the technology acceptance model (TAM) [19–21]. By combining the HMSAM with the reward-penalty mechanism, this study analyzed the influence of multiple psychological factors, including perceived ease of use, perceived usefulness, curiosity, pleasure, and perceived control, on students' learning processes, intention to use, and learning outcomes from the perspective of hedonic motivation. Additionally, it verified the moderating effect of the reward-penalty mechanism between perceived ease of use and the learning process.

2 Literature Review

2.1 The Application of Rewards and Penalties in A Gamified Learning Environment

In gamified learning, the reward-penalty mechanism plays a key role. Zhang [13] argued that rewards and penalties are more than educational means; they are an art that should be carefully designed and implemented by teachers to exert maximum effectiveness. The reward-penalty mechanism is crucial for enhancing students' learning motivation and independent learning ability. Research has demonstrated that, while both rewards and penalties can promote learning, rewards have more significant effects [14, 21, 22]. These effects are influenced by multiple factors, including the type of reward, the timing of rewards, the purpose of rewards, and competitive environments [16–18]. A well-designed reward-penalty system combines playfulness with educational content, stimulating students' interest and enhancing their classroom engagement, teamwork skills, and practical skills [3, 4, 5]. Additionally, such a system creates an immersive learning environment that promotes deep learning and contributes to the development of critical thinking and problem-solving skills [8, 9]. Moreover, education is enhanced by rewards and penalties. Reasonable use of rewards and penalties integrated with an evaluation system can improve students' all-round development [15]. The seamless combination of game elements and teaching content enables students to build knowledge and develop skills in a playful and educational environment [8, 9, 23, 24]. However, in the field of blended learning, very few empirical studies have explored student motivation in gamified learning, and studies combining the HMSAM with the reward-penalty mechanism are even fewer. Therefore, this study employed the HMSAM to analyze the influence of rewards and penalties on learners' intention to use, providing theoretical support for optimizing learning behaviors.

2.2 Hedonic-Motivation System Adoption Model

Although the TAM [6] can explain user behavior through the constructs of perceived usefulness and perceived ease of use, it remains limited in its ability to reveal users' intrinsic motivations and emotional experiences when using technology. To address this gap, Lowry et al. [19] proposed the HMSAM, which emphasizes users' emotions, sense of pleasure, and immersive experience when using technology. This model is particularly applicable to digital systems characterized by high levels of interaction, such as online games, virtual worlds, social networks, and gamified learning. An extension of the hedonic system adoption model, the HMSAM helps to understand learners' attitudes toward digital learning systems by analyzing their intention for continuous use and immersive experience characterized by concentration, intrinsic motivation, and a sense of pleasure [20, 25, 26]. In a gamified learning environment, the HMSAM can effectively explain learners' behavioral motivations. Research shows that a pleasant and intuitive interface can enhance students' immersive experience, which positively affects their learning attitudes and behavioral intentions [27–29]. Furthermore, Kong and Lin [30] posited that students' immersive experience mediates their attitude and intentions toward programming, while perceived teacher support plays a mediating role in the relationship between student attitude and immersive experience. Thus, the HMSAM not only reveals learners' intrinsic motivations and emotional experiences in a gamified learning environment but can also help educators design learning systems and supportive strategies that are more aligned with students' needs. This can promote learners' continuous engagement and boost active behaviors. Studies have shown that the HMSAM exhibits stronger explanatory power in research on gamified systems and digital technology adoption [20, 31, 32]. However, very few studies have attempted to integrate the model with the reward-penalty mechanism, particularly in the context of blended learning, where the developmental trajectories and acceptance mechanisms of student motivation remain underexplored. This gap highlights the need for further theoretical and practical investigations.

The constructs of the HMSAM are defined in Fig. 1 as follows:

When using technology for learning purposes, individuals are motivated by attitudes, subjective norms, and perceptions, which are closely related to immersive experiences. The independently constructed key factors are presented below:

Perceived usefulness: Users believe that technology adoption will enhance their learning outcomes.

Perceived ease of use: Users believe that the technology is easy to use.

Curiosity: The technology inspires users' cognitive curiosity, driving them to engage more deeply in the learning process.

Pleasure: Users find learning using the technology to be a pleasant experience.

Perceived control: Users perceive that they can easily master and use the technology for learning.

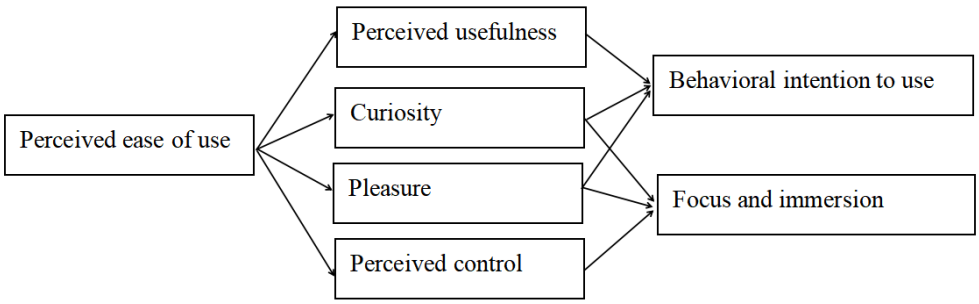

Fig. 1. The HMSAM

2.3 Gamified Learning Environments

Gamified learning environments can be created in various classroom settings and apply to many subject areas. They support activities ranging from guided tasks to nuanced comprehension of complex concepts [33]. In the American pedagogical community, "gamification" refers to the application of game design elements in a non-game context, while Taiwanese scholars emphasize solving real-life problems by using game elements and mechanisms to influence learner behavior [34]. Empirical research demonstrates that gamified learning significantly enhances students' academic performance, learning enthusiasm, and sense of achievement. The mechanisms through which gamified learning exerts its influence can be explained using the theory of conditioned reflex. Specifically, gamification renders the process of learning more appealing by leveraging goal-pursuit, self-regulation, and self-value expectancy [35, 36]. Game elements such as digital badges, point systems, leaderboards, and challenges raise learners' confidence and initiative, thereby enhancing their learning motivation and engagement [10–12]. Gamified course design utilizes mechanisms such as tasks, rewards, feedback, competition, and teamwork to satisfy learners' psychological needs for independence, a sense of competence, and a sense of belonging. It ultimately arouses their intrinsic motivations and promotes the internalization of knowledge and skills [11, 12]. Despite numerous studies on gamified learning, empirical research combining the HMSAM with the reward-penalty mechanism remains scarce. Few studies have systematically examined the development of motivation and engagement among students in a blended or gamified learning environment. Thus, this study integrated the HMSAM and the reward-penalty mechanism to explore students' attitudes, immersive experiences, and behavioral intentions in a gamified learning environment, thereby providing theoretical evidence for optimizing course design and enhancing learning outcomes.

This study addressed the following research questions:

What are the relationships among perceived ease of use, perceived usefulness, pleasure, curiosity, perceived control, and rewards/penalties in a gamified learning environment?

What are the specific influences of hedonic motivation on gamified learning?

The following 10 hypotheses on the relationships among the HMSAM constructs are proposed:

H1: Perceived ease of use has a significant positive influence on the learning process.

H2: Perceived usefulness has a significant influence on intention to use.

H3: Curiosity has a significant influence on intention to use.

H4: Curiosity has a significant influence on learners' sense of focus and immersion.
H5: Pleasure has a significant influence on intention to use.
H6: Pleasure has a significant influence on learners' sense of focus and immersion.
H7: Perceived control has a significant influence on learners' sense of focus and immersion.
H8: Behavioral intention to use has a significant positive influence on learning outcomes.
H9: Sense of focus and immersion has a significant positive influence on learning outcomes.
H10: Rewards/penalties have a positive moderating effect on the relationship between perceived ease of use and the learning process.

3 Research Methods

This study employed quantitative research and collected data through a questionnaire survey, which made it possible to quantify the motivational factors in students' intention to use in a reward-penalty-based gamified learning environment.

3.1 Participants

The participants were students from the School of Art Design of Shanghai Technical Institute of Electronics & Information College. In the class, they received training via interactive animations in a gamified learning environment. This teaching approach evaluated students' learning outcomes through gamified tests; required them to preview before class, learn during class, and review after class; and motivated them using a points system and a reward-penalty system. Over a four-week period, students were presented with interactive animation-based mini-games in the classroom and provided with selective tests and corresponding guidance. The course aimed to increase students' learning interest and encourage them to actively engage with the gamified learning environment. Real-life workplace problems were incorporated into the games to stimulate students' critical thinking and teamwork skills.

Students received rewards and points after testing in each phase. Rankings were determined based on the scores obtained after completing the tasks and reflected their accuracy rates.

During the four weeks, the research team explained the research purposes to each participant and explicitly informed the students of their right to withdraw from the study at any time.

Participants were required to answer questionnaire items based on a 5-point Likert scale ranging from 1 to 5, with 1 meaning "strongly disagree" and 5 meaning "strongly agree."

3.2 Research Framework

The research framework, developed based on the research purpose, is illustrated in Fig. 2. SPSS software was utilized for statistical analysis.

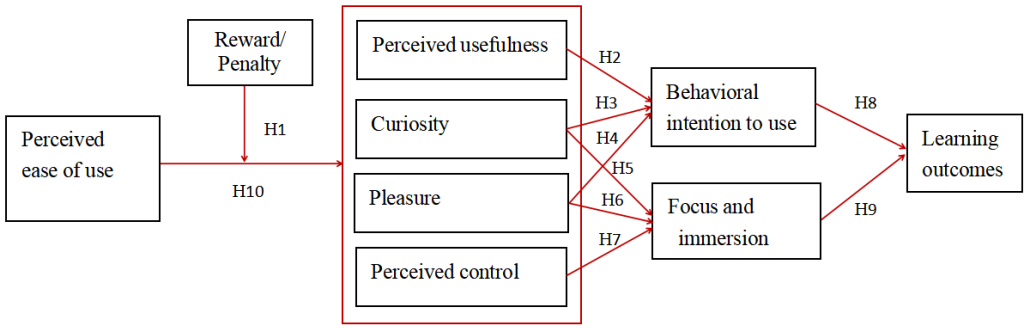

Fig. 2. Research framework

3.3 Experimental Procedures

Pretest sampling was conducted. Wu [37] argued that the pretest sample size should be 3- to 5-times the number of items in the subscale with the most items in the scale. Thus, the sample needed to include 90 to 150 participants.

This study employed two scales, one for basic information and one on the factors influencing students' learning intention in a digital gamified learning environment. Basic information was gathered on gender, age, and grade, and the scale on influencing factors measured variables including perceived ease of use, perceived usefulness, curiosity, perceived control, pleasure, sense of focus and immersion, and reward/penalty.

Perceived ease of use was measured based on the usability and interface friendliness of the interactive animation software in the gamified learning environment. Perceived usefulness was measured from the aspects of learning efficiency and learning outcomes. Curiosity was measured from two perspectives: the level of student curiosity when engaging with the gamified learning environment and the curiosity stimulated by the course content. Pleasure was also measured from two perspectives: the sense of pleasure generated from learning in the gamified learning environment and the sense of pleasure generated from exchanging learning experiences. Perceived control was measured around the course content, course arrangement, and learning rules in the gamified learning environment. Immersive experience was measured from two perspectives: experience in the gamified learning environment and the sense of time passing. Reward/penalty was measured by the point system, rankings, and sense of honor. The corresponding measurement scales are presented in Table 1.

Data were collected through an online questionnaire survey. The pretest survey used students from the School of Art Design as participants; a total of 260 questionnaires were distributed. After deleting invalid responses, a total of 247 valid responses were obtained, giving a valid response rate of 88%. Following content validation of the pretest questionnaire by experts, as well as item and reliability analyses based on the data collected from the pretest, the main questionnaire was developed.

Table 1. Measurement scale for students' learning intention in a gamified learning environment

Variable	Item	Content	Source
Perceived ease of use	1	It's easier to understand the learning content in the gamified learning environment.	Lowry et al. [19]; Venkatesh et al. [38]
	2	The learning software in the gamified learning environment has a clear, friendly interface.	
	3	The software in the gamified learning environment is easy to operate.	
Perceived usefulness	4	The gamified learning environment allows me to quickly understand key and difficult points during the learning process.	Lowry et al. [19]; Venkatesh et al. [38]
	5	The gamified learning environment alleviates my stress during the learning process.	
	6	The gamified learning environment helps me socialize during the learning process.	
Curiosity	7	I'm curious about the software used in the gamified learning environment.	Lowry et al. [19]; Leong et al. [39]
	8	The gamified learning environment triggers my imagination.	
	9	The gamified learning environment triggers my curiosity.	
Pleasure	10	I think it is fun to learn through a gamified approach.	Lowry et al. [19]; Leong et al. [39]
	11	I find engagement in gamified learning to be pleasant.	
	12	Exchanges among my classmates are a lot of fun in the gamified learning environment.	

Perceived control	13	I can effectively handle each step of the gamified learning process.	Lowry et al. [19]; Leong et al. [39]
	14	I have a good understanding of the rules in the gamified learning environment.	
	15	I can master every skill in the software of the gamified learning environment.	
Intention to use	16	I hope that the school will continue to employ gamified learning in the future.	Lowry et al. [19]; Leong et al. [39]
	17	I'm willing to invest more time and energy to learn in a gamified learning environment.	
	18	I'll recommend gamified learning to my classmates and friends.	
Sense of focus and immersion	19	I enjoy engaging in a gamified learning environment both physically and mentally.	Lowry et al. [19]; Leong et al. [39]
	20	I feel that time passes quickly when I engage in a gamified learning environment.	
	21	I'm more concentrated when I engage in a gamified learning environment.	
Learning outcomes	22	I can better understand what I'm learning in a gamified learning environment.	Lowry et al. [19]
	23	I can express my ideas and viewpoints with greater clarity in a gamified learning environment.	
	24	My confidence in learning is enhanced in a gamified learning environment.	
Reward/penalty	25	The reward-penalty mechanism in the gamified learning environment has improved my learning efficiency.	
	26	The reward-penalty mechanism in the gamified learning environment effectively monitors my learning behavior.	
	27	The reward-penalty mechanism in the gamified learning environment has enhanced my ability to reflect.	

4 Data Analysis and Results

4.1 Hypothesis Testing and Statistical Results

This study examined the influence of psychological factors, including perceived ease of use, perceived usefulness, curiosity, pleasure, and perceived control, on the learning process, intention to use, sense of focus and immersion, and learning outcomes. Additionally, it tested the moderating effect of reward/penalty between perceived ease of use and the learning process. The results of the data analysis and hypothesis testing are presented in Table 2 and Table 3 and Fig. 3, respectively.

Table 2. Linear regression analysis results

Goodness-of-fit measures						Collinearity statistics	
	Correlation coefficient (R)	Coefficient of determination (R2)	Incremental R2	F-statistic	t-value	Tolerance	VIF
Perceived ease of use->Learning process	.739	.547	.545	265.32***	17.19***	1.000	1.000
Perceived usefulness->Intention to use	.707	.500	.498	245.14***	15.66***	1.000	1.000
Curiosity->Intention to use	.653	.426	.424	182.12***	13.50***	1.000	1.000

Curiosity->Sense of focus and immersion	.670	.448	.446	199.19***	14.11***	1.000	1.000
Pleasure->Intention to use	.617	.381	.378	150.79***	12.28***	1.000	1.000
Pleasure->Sense of focus and immersion	.645	.416	.413	174.31***	13.20***	1.000	1.000
Perceived control->Sense of focus and immersion	.628	.394	.392	159.46***	12.63***	1.000	1.000
Intention to use->Learning outcomes	.675	.456	.453	205.12***	14.32***	1.000	1.000
Sense of focus and immersion->Learning outcomes	.650	.422	.420	179.16***	13.39***	1.000	1.000

***P < .001

Note: VIF = Variance Inflation Factor. To prevent collinearity in the regression model, the VIF can be used to determine high multicollinearity. A VIF value of 10 and above indicates collinearity between independent variables

Table 3. Hypothesis testing results

Research hypothesis		Testing results
H1	Perceived ease of use has a significant positive influence on the learning process.	Supported
H2	Perceived usefulness has a significant influence on the intention to use.	Supported
H3	Curiosity has a significant influence on the intention to use.	Supported
H4	Curiosity has a significant influence on learners' sense of focus and immersion.	Supported
H5	Pleasure has a significant influence on the intention to use.	Supported
H6	Pleasure has a significant influence on learners' sense of focus and immersion.	Supported
H7	Perceived control has a significant influence on learners' sense of focus and immersion.	Supported
H8	Behavioral intention to use has a significant positive influence on learning outcomes.	Supported
H9	Sense of focus and immersion have a significant positive influence on learning outcomes.	Supported
H10	Rewards/penalties have a positive moderating effect on the relationship between perceived ease of use and the learning process.	Supported

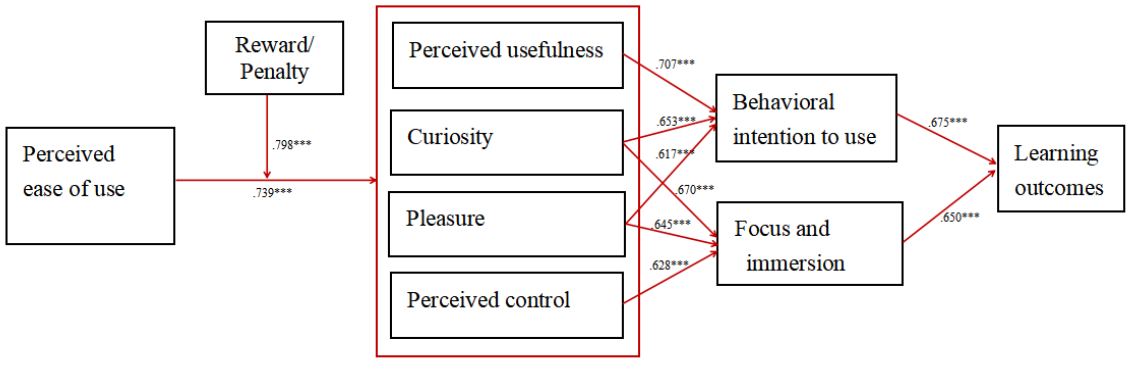

Fig. 3. Analysis result

H1: Perceived ease of use has a significant positive influence on the learning process.

Perceived ease of use is considered as a core determinant of digital users' evaluations of the level of ease in operating a system [31]. Statistical analysis revealed that perceived ease of use was highly positively correlated with the learning process (R = .739). Perceived ease of use explained approximately 54.7% of the variation in the learning process (R2 = .547), indicating a significant influence. A standardized coefficient (β) of .739, a high significant F-statistic (265.32), and a t-value of 17.19 further supported this hypothesis.

H2: Perceived usefulness has a significant influence on the intention to use.

In the HMSAM, usefulness is regarded as a key factor that influences users' intention to use a technology. It plays a crucial role in explaining users' behavioral intentions [19]. The statistical data suggested a highly positive correlation between perceived usefulness and the intention to use (R = .707). Perceived usefulness explained approximately 50% of the variation in the intention to use (R2 = .500), indicating a significant influence. A standardized coefficient (β) of .707, a highly significant F-statistic (245.14), and a t-value of 15.66 further supported this hypothesis.

H3: Curiosity has a significant influence on the intention to use.

Curiosity involves both the sensory and cognitive dimensions. It plays an important role in driving users to engage with a technological system [19, 20]. The research results indicated a highly positive correlation between curiosity and the intention to use (R = .653). Curiosity explained approximately 42.6% of the variation in the intention to use (R2 = .426), indicating a significant influence. A standardized coefficient (β) of .653, a highly significant F-statistic (182.12), and a t-value of 13.50 further supported this hypothesis.

H4: Curiosity has a significant influence on the sense of focus and immersion.

Statistical analysis revealed that curiosity and the sense of focus and immersion were highly positively correlated (R = .670), with curiosity explaining approximately 44.8% of the variation in the sense of focus and immersion (R2 = .448). This indicates the significant influence of curiosity on the sense of focus and immersion. A standardized coefficient (β) of .670, a highly significant F-statistic (199.19), and a t-value (14.11) further supported this hypothesis.

H5: Pleasure has a significant influence on the intention to use.

Statistical analysis revealed that pleasure was highly positively correlated with the intention to use (R = .617), with pleasure explaining approximately 38.1% of the variation in the intention to use (R2 = .381), indicating a significant influence. A standardized coefficient (β) of .617, a highly significant F-statistic (150.79), and a t-value of 12.28 further supported this hypothesis.

H6: Pleasure has a significant influence on the sense of focus and immersion.

The data showed a highly positive correlation between pleasure and the intention to use (R = .645), with pleasure explaining approximately 41.6% of the variation in the sense of focus and immersion (R2 = .416). This indicates a significant effect of pleasure on the sense of focus and immersion. A standardized coefficient (β) of .645, a highly significant F-statistic (174.31), and a t-value of 13.20 further supported this hypothesis.

H7: Perceived control has a significant influence on the sense of focus and immersion.

The results indicated a highly positive correlation between perceived control and the sense of focus and immersion (R = .628). Perceived control explained approximately 39.4% of the variation in the sense of focus and immersion (R2 = .394). This highlights the significant influence of perceived control on the sense of focus and immersion. A standardized coefficient (β) of .628, a highly significant F-statistic (159.46), and a t-value of 12.63 further supported this hypothesis.

H8: Behavioral intention to use has a significantly positive influence on learning outcomes.

The statistical analysis found a highly positive correlation between the behavioral intention to use and learning outcomes (R = .675), with the behavioral intention to use explaining approximately 45.6% of the variation in learning outcomes (R2 = .456), indicating a significant influence. A standardized coefficient (β) of .628, a highly significant F-statistic (205.12), and a t-value of 14.32 further supported this hypothesis.

H9: The sense of focus and immersion has a significantly positive influence on learning outcomes.

According to the statistical analysis, the sense of focus and immersion was highly positively correlated with learning outcomes (R = .650), with the sense of focus and immersion explaining approximately 42.2% of the variation in learning outcomes (R2 = .422), indicating a significant influence. A standardized coefficient (β) of .650, a highly significant F-statistic (179.16), and a t-value of 13.39 further supported this hypothesis.

H10: Reward/penalty exerts a positive moderating effect on the relationship between perceived ease of use and the learning process, as shown in Table 4.

Table 4. Analysis of the moderating effect of reward/penalty on the relationship between perceived ease of use and the learning process

	Step1		Step2		Step3	
Dependent variable: Learning process	*β*	*t*	*β*	*t*	*β*	*t*
Independent variables						
Perceived ease of use	.739	17.185***	.575	12.199***	.601	12.990***
Reward/Penalty			.307	6.503***	.280	6.045***
Perceived ease of use × Reward/Penalty					.154	3.939***
F	295.323***		193.689***		141.978***	
R	.739		.783		.798	
R2	.547		.614		.637	

***P<.001

This study explored the influence of perceived ease of use and reward/penalty on the learning process and further analyzed the moderating effect of their interaction on the learning process. The results indicated that perceived ease of use and reward/penalty significantly influence the learning process, and reward/penalty plays a positive moderating role in their interaction.

First, according to Step 1 of the regression analysis, perceived ease of use had a significant influence on the learning process, with a correlation coefficient (R) of 0.739, a coefficient of determination (R2) of 0.547, and an F-statistic of 295.323, suggesting that perceived ease of use has a strong explanatory power for the learning process. Step 2 indicated a significant influence of reward/penalty on the learning process, with a correlation coefficient (R) of 0.783, a coefficient of determination (R2) of 0.614, and an F-statistic of 193.689, further confirming the significant influence of reward/penalty on the learning process. In Step 3, the interaction between perceived ease of use and reward/penalty was incorporated into the regression model, yielding a correlation coefficient (R) of 0.798, a coefficient of determination (R2) of 0.637, and an F-statistic of 141.978, indicating a significant influence of the interaction on the learning process. Additionally, the regression coefficient of the interaction was 0.154 and the p value was 0.000, which is smaller than 0.05, further verifying the significant influence of the interaction on the learning process. Thus, as a moderator, reward/penalty played a positive moderating role in the relationship between perceived ease of use and the learning process.

From Step 1 to Step 3, the explanatory power (R2) of the model increased from 0.739 to 0.798—an increase of 0.059. This increment reached a statistically significant level, indicating that reward/penalty as a moderator significantly enhanced the explanatory power of the model and further supporting the positive moderating effect of reward/penalty on the relationship between perceived ease of use and the learning process.

To sum up, this study verified the moderating effect of reward/penalty on the relationship between perceived ease of use and the learning process and demonstrated the significant positive influence of reward/penalty on the learning process.

Part 1: Perceived ease of use and the influence of each factor

This study examined the relationship between perceived ease of use and the learning process, intention to use, and learning outcomes. Each hypothesis (H1 to H9) described the linear relationship between a certain factor and the learning process or a relevant variable, and the statistical significance of these relationships was tested based on statistical data. Specifically, the correlation coefficient (R) measured the strength of linear correlation between variables, the coefficient of determination (R2) measured the explanatory power of the model for data variations, and the standardized coefficient (β) reflected the strength of an independent variable's influence on a dependent variable.

The results indicated a strong positive correlation between perceived ease of use and the learning process (R = 0.739). Perceived ease of use explained approximately 54.7% of the variation in the learning process (R2 = 0.547). Furthermore, the standardized coefficient (β = 0.739) demonstrated that perceived ease of use had a strong influence on the learning process. Significance testing of the regression model yielded an F-statistic of 295.323 and a corresponding p value smaller than 0.05, indicating statistical significance of the overall model. The significance of the t-value further supported the significant influence of perceived ease of use on the learning process, thereby verifying the validity of the hypotheses.

Part 2: Moderating effect of reward/penalty

In H10, we further discussed the moderating effect of reward/penalty on the relationship between perceived

ease of use and the learning process. Specifically, reward/penalty has a significant positive moderating effect on this relationship. A detailed analysis of the data obtained from each step is provided below:

Step 1 data: Perceived ease of use had a significant influence on the learning process, as demonstrated by a correlation coefficient of 0.739, a coefficient of determination of 0.547, and an F-statistic of 295.323.

Step 2 data: Reward/penalty also exhibited a significant influence on the learning process, which was further verified by a correlation coefficient of 0.783, a coefficient of determination of 0.614, and an F-statistic of 193.689.

Step 3 data: The interaction between perceived ease of use and reward/penalty had a significant influence on the learning process. A correlation coefficient of 0.798, a coefficient of determination of 0.637, an F-statistic of 141.978, a regression coefficient of 0.154, and a p value smaller than 0.001 suggested that reward/penalty had a positive moderating effect on the relationship between perceived ease of use and the learning process.

To summarize, as a moderator, reward/penalty significantly enhanced the explanatory power of the model and had a positive moderating effect on the relation between perceived ease of use and the learning process. These findings verified the significant moderating effect of reward/penalty in the learning process, further supporting the validity of the positive moderating role of reward/penalty in the relationship between perceived ease of use and the learning process.

4.2 Summary

The results of the data analysis indicated that multiple variables, including perceived ease of use, perceived usefulness, curiosity, pleasure, and perceived control, had significant influences on the learning process, intention to use, and learning outcomes. Among these variables, reward/penalty was a positive moderator between perceived ease of use and the learning process. A comprehensive analysis suggested that these factors all had significant effects on the learning process, intention to use, and learning outcomes and supported the key role of reward/penalty in moderating learning behaviors.

5 Conclusions

This study combined the HMSAM and the reward-penalty mechanism to investigate perceptions and usage experiences of gamified learning. It also examined students' engagement in the gamified learning process from the perspective of hedonic motivation.

We systematically discussed the effects of multiple factors, including perceived ease of use, perceived usefulness, curiosity, pleasure, and perceived control, on the learning process and intention to use. Additionally, we verified the significant influence of these factors by employing statistical methods including correlation analysis and regression analysis. The findings suggest that psychological factors, including perceived ease of use, perceived usefulness, curiosity, pleasure, and perceived control, play key roles in the learning process, directly affecting learners' intention to use, sense of focus and immersion, and learning outcomes.

Specifically, the findings demonstrate that perceived ease of use and perceived usefulness significantly affect learners' engagement in the learning process and their intention to use. This indicates that learners' understanding of the ease of use and usefulness of a tool is directly related to their learning motivations and behaviors. Curiosity and pleasure are key to stimulating learners' initiative and interest in continuous learning, especially when it comes to active learning and innovative learning approaches. Additionally, perceived control has a significant influence on the learning process. When learners have a sense of control over what they are learning, they exhibit higher learning effectiveness and intention to use. These psychological and behavioral factors mutually interact to jointly influence learners' learning experience and final outcomes.

Additionally, this study discussed the effect of reward/penalty as a moderator on the relationship between perceived ease of use and the learning process, thereby enriching the understanding of external influences on the learning process. The findings suggest that reward/penalty plays a significant positive moderating role in the relationship between perceived ease of use and the learning process. Specifically, the introduction of a reward-penalty mechanism promotes the positive influence of perceived ease of use on the learning process, thereby elevating learning outcomes and the learning experience. A reward-penalty system serves as an external stimulus for learning motivation and promotes the continuity and depth of the learning process by moderating learners' emotional responses and learning strategies. This finding highlights the significance of the reward-penalty

mechanism in learning environments, showing that it plays a significant role in promoting learner engagement and enhancing learning outcomes.

In summary, this study not only verified the significant influences of multiple psychological and behavioral factors, including perceived ease of use, perceived usefulness, curiosity, pleasure, and perceived control, on the learning process and intention to use, but also revealed the key moderating effect of reward/penalty on enhancing learning outcomes and improving the learning experience. These findings enrich the theoretical framework of learning motivation and behavior research and have significant implications for educational practice. Educators and course designers should further investigate these psychological factors and the reward-penalty mechanism to help in designing learning environments and educational modes that are better aligned with learners' needs. This would foster active learner engagement and learning behavior and improve learning outcomes and the overall quality of education.

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