Integrating Self-Determination and Flow Theory: A Multidimensional Analysis of Gaming Experience Effects on Gamified Learning

Cao Shanshan

Zhuzhou No.2 Middle School Fengxi School Junior High School, China

DOI: https://dx.doi.org/10.47772/IJRISS.2025.905000292

Received: 02 May 2025; Accepted: 13 May 2025; Published: 12 June 2025

ABSTRACT

Differences in learners' game experience significantly affect their motivation, experience and effect of gamified learning, but the related mechanisms are not yet clear, and there is a lack of targeted design strategies. In this study, we constructed a hypothetical model of game experience differences affecting gamified learning based on the grand theory perspective, and collected data on visual cognition, learning motivation, experience and effect of 25 high and low game experience middle school students through eye tracking and questionnaire survey, to validate the model and analyse the path of influence of the differences. The results show that the high-experience group showed stronger intrinsic motivation, positive emotions and learning effects, while the low-experience group relied on external motivation; the mechanism of action is that the high-experience group reduces external motivation, enhances intrinsic motivation and positive emotions, and optimises the learning effects in combination with the mind-flow experience and perceived achievement. Finally, four types of design strategies are proposed: promoting the transformation of "external motivation" to "internal motivation", balancing the difficulty of the task with the skill level, using positive emotions to enhance cognitive processing, and scientifically designing the game elements and mechanisms to meet the needs of learners with different experiences.

Keywords: gamified learning; game experience; grand theoretical perspectives; motivation to learn; pathways of influence

INTRODUCTION

Game-based learning has significant advantages in stimulating motivation, enhancing learning engagement, and optimising learning outcomes [1]. However, not all learners can benefit from gamified learning, and the mismatch between the individual characteristics of some learners and the gamified learning format is an important reason for the unsatisfactory learning effect [2]. Among them, the differences in learners' gaming experience have a key impact on the experience and effectiveness of gamified learning [3]. In recent years, some scholars have attempted to apply gamification learning related theories to analyse the impact of game experience differences [4-5] However, due to the numerous theories related to gamification learning, and the mutual supportive parts and uniqueness of the theories, it is difficult to comprehensively and systematically explore the impact of game experience differences on gamification learning motivation, experience, behaviours, and effects and their intrinsic mechanisms in the previous studies based on a single theory or a single-point approach. It is difficult for previous studies based on a single theory or a single point to comprehensively and systematically investigate the influence of differences in game experience on motivation, experience, behaviour and effects of game-based learning, as well as its underlying mechanisms. Professor Sheldon of the University of Missouri proposed the research method of Grand Theory in 2019 [6], which advocates integrating evidence from multiple theories or perspectives, constructing a grand theoretical system capable of comprehensively explaining the mechanism behind the problem, and verifying it through empirical research, effectively making up for the one-sidedness of a single theory in explaining the problem.

Based on the grand theory perspective, this study integrates multiple theoretical perspectives in the field of gamified learning, deeply analyses the potential impact of learners' game experience differences on gamified learning, constructs a hypothetical model of the impact mechanism and conducts experimental verification. In the end, we propose the optimal design countermeasures of gamified learning for learners with different levels of game experience, aiming to solve the following three research questions: first, from the perspective of the grand theory, what are the effects of learners' differences in game experience on their visual cognition, learning motivation, learning experience, and learning effect in gamified learning? Second, what are the mechanisms by which learners' game experience differences affect gamified learning, and can the hypothetical model constructed based on the grand theory perspective be verified? Third, based on the grand theory perspective, what are the countermeasures to optimise the design of game-based learning for learners with different game experiences?

LITERATURE REVIEW

Based on the big theory perspective, this study organically integrates the self-determination theory, the mind-flow theory, the cognitive-emotional theory of digital learning and the gamified learning theory, deeply analyses the influence of learners' differences in gaming experience on gamified learning from different perspectives, and constructs a hypothetical model of the influencing mechanism, and the specific process is shown in Fig. 1.

Self-Determination Theory

Self-determination theory was proposed by Deci and Ryan in 1985 [7], which views motivation as a continuum that is categorised as unmotivated, externally motivated and internally motivated in descending order according to the degree to which motivation is self-determined and internalised. Due to the different social environments and experiences that individuals have, such as differences in the level of learners' gamification experiences, this can lead to individuals being differently self-driven in specific domains (e.g., gamified learning). Specifically, some individuals have a higher degree of internalised external motivation and stronger internal motivation [8], which can provide individuals with more sustained interest, excitement, and impetus for learning, leading to a positive emotional experience, which in turn enhances learning outcomes. The following hypotheses are proposed based on the viewpoints of self-determination theory:

H1: High game-experienced learners obtain higher levels of internal motivation in gamified learning; H2: Internal motivation is effective in promoting knowledge retention, i.e., increasing the quantity of learning; H3: High game-experienced learners internalise a high degree of external motivation, so their external motivation is relatively low; H4: External motivation can promote the quantity of learning to a certain extent; H5: Internal motivation induces positive emotions; H6: External motivation can inhibit positive emotions; H7: Positive emotions can promote the quantity of learning; H8: The external motivation of learners with high gaming experience is partially internalised into internal motivation; H9: A high level of quantity of learning can help to improve the learners' ability to apply knowledge, i.e. to improve the quality of learning. This is shown in Figure 1(a).

Theory of mind flow The mindstream experience was proposed by Mihaly Csikszentmihalyi. When an individual is fully engaged in a task and the difficulty of the task is highly matched to the individual's skill level, the individual enters a "state of mind flow" [9]. In gamified learning, game elements and mechanisms can continuously attract learners to fully engage in learning, causing them to generate mind flow and stimulate a positive emotional state. This positive emotion will continuously motivate learners to generate new mind streams throughout the entire gamified learning process, which will enhance learners' perceived achievement and learning satisfaction, and ultimately achieve better learning outcomes. Learners with high gaming experience are more familiar with the game scene and have a relatively high level of gaming skills, so it is easier for them to match with the gamified learning task and enter the "state of mind flow" [10]. Based on this, the following hypotheses are added to this study:

H10: Highly game-experienced learners whose task difficulty is highly matched to their individual skills are able to achieve higher levels of mind-flow experience;

H11: High mind-flow experience promotes perceived achievement;
H12: Increased perceived achievement significantly increases learning satisfaction;
H13: An increase in learning satisfaction significantly increases the amount of learning;

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue V May 2025

H14: Positive emotions are conducive to sustained stimulation of the mindflow experience. This is shown in Figure 1(b).

Cognitive Affective Theory of Digital Learning

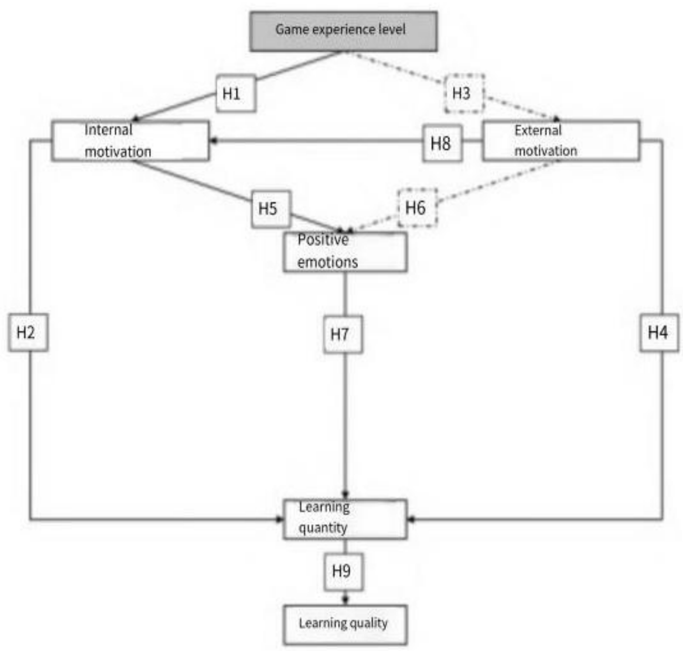
In 2020, Professor Mayer proposed a theoretical model of cognitive-emotional theory of digital learning. The model suggests that in digital learning, cognitive processing is not the only activity of the learner, but the learner's emotion will have an impact on the cognitive processing process, which in turn will have an effect on the learning effect [11]. As one of the types of digital learning, the emotional state of learners in gamified learning should not be underestimated in terms of its impact on the learning process and effect. Learners with high gaming experience have a more enjoyable experience in gamified learning, which helps to increase the efficiency of visual cognitive processing during learning, and thus contributes to the improvement of learning outcomes [12]. This theoretical model provides support for hypothesis H7 and is supplemented by the following hypotheses:

H15: High game-experienced learners engage in gamified learning with higher levels of positive emotions;
H16: Positive emotion positively moderates visual cognitive behaviours in highly game-experienced learners, as evidenced by an increase in gaze time per minute;
H17: Increased gaze time per minute enhances the amount of learning. See Figure 1(c) for details.

Game-based Learning Theory

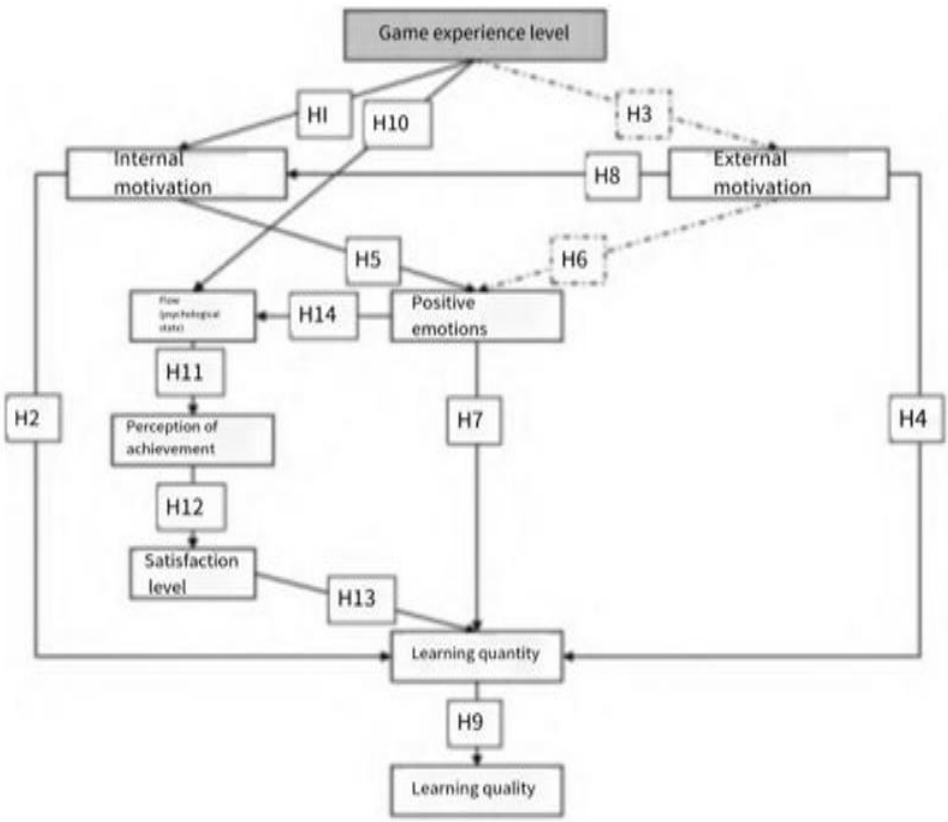
In 2014, Landers proposed the theory of gamified learning. The theory states that the integration of gamified features into the learning process has an impact on the learning process and effects, which is divided into two processes: mediation and moderation. The mediating process is that gamification features and teaching content are mediated by learners' learning behaviours and attitudes, which in turn affects learning outcomes; the moderating process is that gamification features modulate the effects of teaching design and content on learning by improving learners' behaviours and attitudes in order to enhance learning outcomes. Gamification features can affect learning through one or more paths in the mediation and moderation processes [13].

Gamification learning theory also supports hypotheses H7, H15, H16 and H17. Because high game-experienced learners are more adaptive to the gamified environment, their cognitive strategies will be optimised, presenting more effective visual cognitive behaviours, higher levels of positive emotions, and ultimately better learning outcomes [14]. Based on this, this study adds a new hypothesis H18: The gamification elements in gamified learning materials will attract high game-experienced learners to invest more visual cognitive resources, which is reflected in longer gaze time per minute. See Figure 1(d) for details.

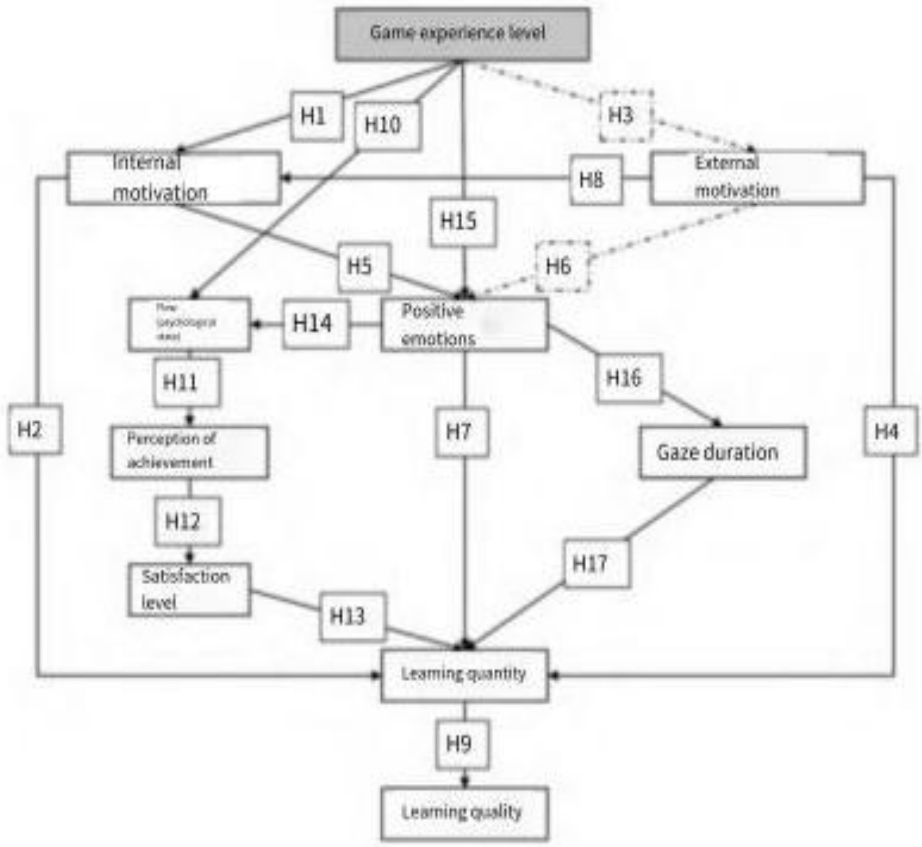


(a) Hypothetical model based on self-determination theory

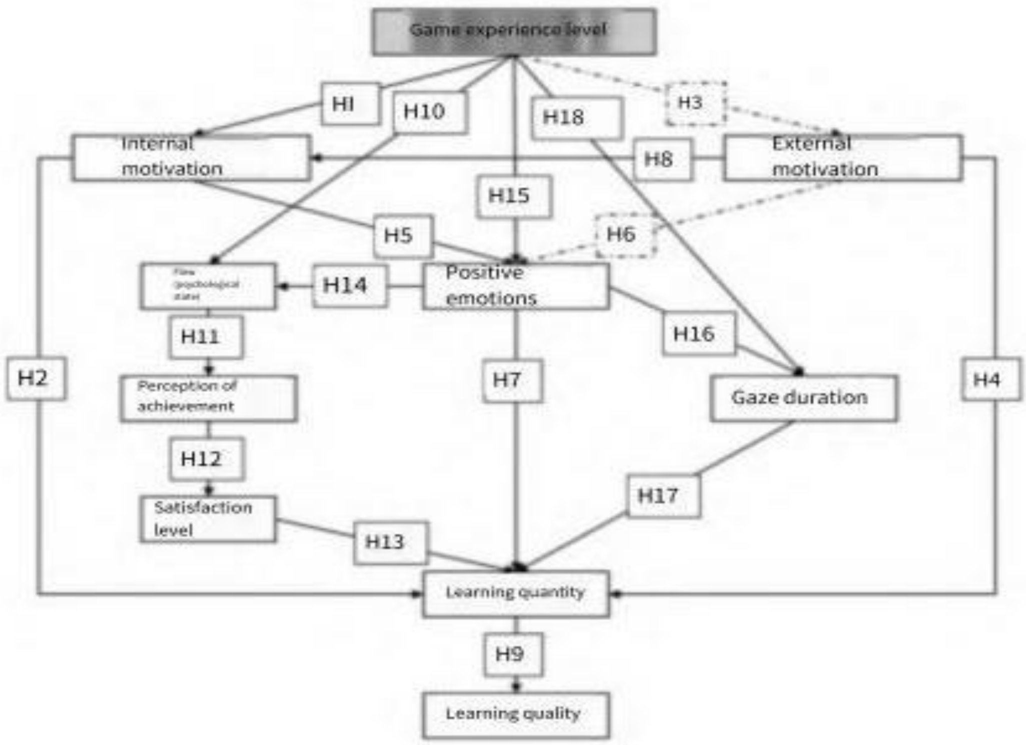
ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue V May 2025



(b) Addendum hypothetical model based on mind-flow theory



(c) Adding a hypothetical model based on the cognitive-emotional theory of digital learning



(d) Adding a hypothetical model based on the gamified learning theory (full model)

Note: Solid arrows indicate positive impacts and dashed arrows indicate negative impacts.

Through comprehensive analysis, it can be seen that this study takes the big theory perspective as the cornerstone, organically integrates the core meaning of the four major theories, and systematically puts forward 18 research hypotheses by combining domestic and international related research results, thus constructing a hypothetical model of the influence mechanism of the differences in game experience on game-based learning, and its complete structure is shown in Fig. 1(d). The model will be validated and optimised based on rigorous experimental design to ensure its scientific validity and effectiveness.

Research methodology

Experimental design and subject selection

This study implements the experiment based on the constructed hypothetical model of the mechanism of the influence of game experience differences on gamified learning. The experiment was conducted in a one-way between-subjects design, in which the independent variable was set to be the learners' game experience level, which was specifically divided into two levels: high and low; and the dependent variables covered learning motivation (including internal and external motivation), learning experience (including positive emotions, mind-flow experience, perceived achievement, and satisfaction), visual cognition (using gaze time as a measure), and learning effectiveness (including learning quantity and learning quality) .

A total of 90 subjects were recruited from a secondary school to participate in the experiment. The subjects were asked to complete a questionnaire about their level of gaming experience, and according to their scores on the questionnaire, the top 30 scores were selected to form the high gaming experience group, and the bottom 30 scores were selected to form the low gaming experience group. During the screening process, subjects with high prior knowledge (with a total score of 30 on the prior knowledge test, those with a score higher than 18 were considered to have a high level of knowledge) and those with an eye movement sampling rate of less than 60% were excluded. Due to strict filtering criteria, only 25 participants were retained in each group. Although this ensured data quality, the relatively small sample size limited statistical power and generalizability. Future studies

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue V May 2025

will aim to recruit more diverse and larger samples across multiple institutions to enhance statistical validity and external applicability.The remaining subjects were not involved in the follow-up experiment but were still paid accordingly.To further address the issue of limited statistical power, future research could adopt several strategies. First, incorporating a larger number of covariates (such as personality traits, learning styles) in the statistical model could help control for confounding variables and increase the precision of the estimates. Second, using advanced statistical methods like Bayesian analysis or bootstrapping could potentially improve the reliability of results with small samples by reducing the reliance on traditional significance testing. Additionally, a multi-wave longitudinal design could be considered to collect data over time, enabling the examination of both immediate and long-term effects of gamified learning. This approach would not only increase the sample size by tracking the same subjects but also provide deeper insights into the dynamic relationship between game experience, learning processes, and outcomes. These enhancements would contribute to more robust statistical analysis and more comprehensive understanding of the research topic.

After the chi-square test, the results showed that there was no significant difference between the two groups of subjects in terms of gender ratio ($p = 0.470$); as analysed by the t-test, there was also no significant difference between the two groups of subjects in terms of both age ($F = 1.121$, $p = 0.358$) and level of prior knowledge ($F = 0.013$, $p = 0.285$). The overall technical line of this study is shown in Figure 2.

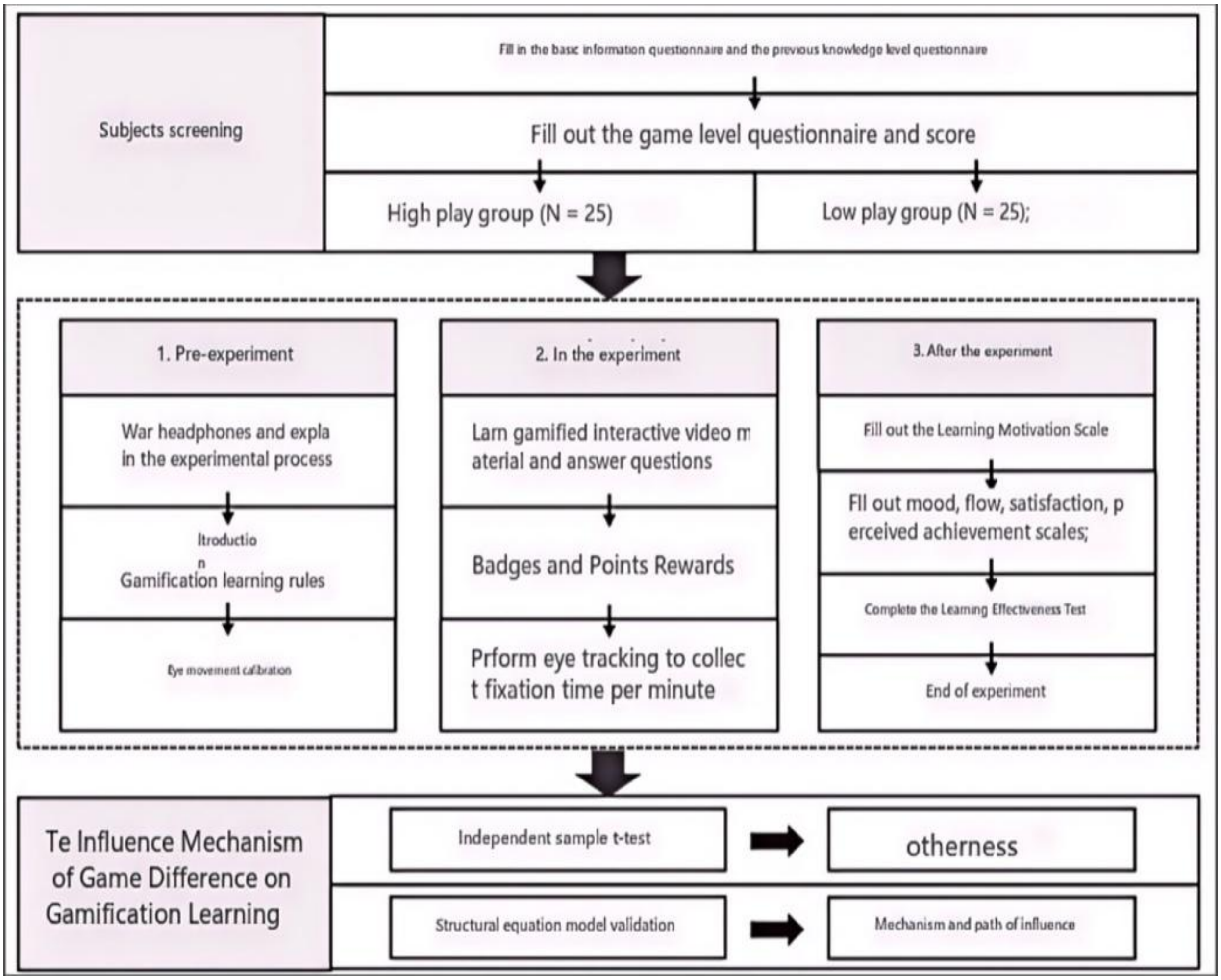


Figure 2 Technical route

Experimental Material

In this experiment, an interactive game-based English teaching video was used as the material, which was adapted from the topic of "English Expressions of Daily Life Objects" in the junior high school English curriculum. Although the video content was informative and gamified elements were embedded, the limited duration and relatively simple interaction may have constrained learners' immersion. Future improvements include incorporating more immersive elements such as narrative-driven learning, adaptive difficulty, and real-time feedback to better simulate game environments. Finally, Articulate Storyline 3.9 software was used to complete the production of the video. These improvements aim to transcend the current video's instructional constraints by fostering a player-centric ecosystem, where learners' choices, skills, and emotional states actively shape the learning journey. For instance, a "reward badge system" could unlock special content (e.g., bonus mini-games about cultural idioms) as learners progress, while a "mood tracker" visualizing real-time engagement levels would enable educators to refine content flow. By prioritizing immersive interactivity over passive information delivery, the enhanced video would not only address the immersion gap but also align gamified learning more closely with adolescents' digital-native preferences, potentially boosting long-term retention and enjoyment of English vocabulary acquisition.

The gamification design of the experimental materials is based on the "Dynamics - Mechanisms - Components" (DMC) gamification design framework proposed by Werbach and Hunter. We added fun game mechanics such as guessing games and word solitaire in the instructional videos, and also set up gamification elements such as point rewards and unlocking levels in the interactive features. Finally, Articulate Storyline 3.9 software was used to complete the production of the video.

Experimental equipment and scales

Details of the scales and equipment used in each phase of the experiment are shown in Table 1 below.

Table 1 Experimental equipment and scales

Experimental Phase	Measurement Indicators	Experimental Scales and Equipment	Explanation
Pre-testing	Subject's basic information	Basic Information Questionnaire	Name, gender, age, etc. of the subject.
	Prior knowledge level	Prior Knowledge Level Questionnaire (Cronbach's α = 0.953)	Focused on knowledge of "English Expressions of Daily Life Items", with 6 Likert scale questions to assess subjects' knowledge base.
	Game experience level	Game Experience Level Questionnaire (Cronbach's α = 0.890)	Adapted from Petry et al.'s Game Addictiveness Questionnaire, consisting of nine five-point Likert scale items (scores range from 9 to 45), higher scores indicate more gaming experience.
Experiments	Visual cognition	Tobii X120 Eyetracker	Real-time recording of gaze duration during learning; gaze duration per minute (total gaze duration / total recording time) used as the core index to eliminate interaction duration interference.

Post-experimental	Positive emotions	Positive Emotions Scale (Cronbach's α = 0.921)	Uses the positive emotions section from the PNES by Watson and revised by Qiu Lin, covering nine common positive emotional states on a five-point Likert scale.
	Intrinsic and extrinsic motivation	Intrinsic and Extrinsic Motivation Scale (Cronbach's α = 0.790)	Translated from Pintrich et al.'s scale; three questions each on intrinsic and extrinsic motivation, using a five-point Likert scale.
	Heart Flow Experience	Heart Flow Experience Scale (Cronbach's α = 0.940)	Adapted from Kiili et al.'s scale, with five five-point Likert scale items measuring flow experience.
	Perceived achievements	Perceived Achievement Scale	Developed by Maggie Han; contains one question using a seven-point Likert scale based on subjects' self-perceived performance in learning.
	Learning satisfaction	Learning Satisfaction Questionnaire (LSQ)	Developed by Yang Jiumin; includes one five-point Likert scale question asking subjects to rate their enjoyment and satisfaction with the learning materials.
	Quantity and quality of learning	Learning Effectiveness Test Questions (Cronbach's α = 0.862)	Retention tests assess memory of learned material (quantity), while transfer tests assess understanding and application of learning (quality), based on evaluation criteria from reference [23].

ANALYSIS AND DISCUSSION OF RESULTS

A Grand Theoretical Perspective on the Impact of Learners' Differences in Game Experience on Gamified Learning

This study compares the experimental data of the high gaming experience group with the low gaming experience group, and the mean (M), standard deviation (SD) and independent samples t-test results are shown in Table 2.By analysing the data, the following conclusions were drawn:

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue V May 2025

Table 2 Descriptive statistics of the experimental data (M± SD) and t-test results

Measurement Dimension	Measurement Indicators	Low Game Experience Group (N=25)	High Game Experience Group (N=25)	t-test Results
Visual Cognition	Gaze duration per minute	42.183 ± 4.750	41.657 ± 5.104	t = 0.377, p = 0.708
Motivation	Internal motive	10.240 ± 1.640	11.200 ± 1.414	t = -2.216, p = 0.031 **
	External motivation	11.760 ± 1.665	10.760 ± 2.437	t = 1.694, p = 0.097 *
Learning Experience	Positive emotions	28.440 ± 6.001	33.320 ± 7.482	t = -2.544, p = 0.014 **
	Learning satisfaction	4.120 ± 0.726	4.040 ± 0.539	t = 0.443, p = 0.660
	Heart Flow Experience	17.440 ± 2.902	17.440 ± 3.709	t = 0.000, p = 1.000
	Perceived achievements	4.440 ± 1.293	4.480 ± 1.262	t = -0.111, p = 0.912
Learning Effect	Number of studies	11.000 ± 2.828	11.360 ± 1.469	t = -0.565, p = 0.575
	Quality of learning	9.280 ± 2.492	10.480 ± 2.417	t = -1.728, p = 0.090 *

Differences in visual cognitive processes were not significant

In the experiment, both groups of learners used the same gamified learning materials, and the shorter learning time and lower game skill requirements resulted in similar cognitive inputs for learners with different game experiences. The absence of significant differences in visual behaviour may stem from the uniformity of experimental material and limited task complexity. Future research will explore additional behavioural metrics, such as decision time, interaction frequency, and heatmap distribution, to better distinguish cognitive engagement levels across experience groups.

Motivation for Learning is Divided

Learners with different game experiences show different types of motivation in gamified learning. It has been shown that high game-experienced people often produce higher internal motivation in games [24], and this study confirms that the same rule applies to gamified learning scenarios. According to Cognitive Evaluation Theory (CET), high game-experienced learners are more inclined to choose gamified learning due to their familiarity with the game environment, and their interest in the game becomes a core source of internal motivation. On the contrary, low game-experienced learners are more concerned with external rewards such as points and badges, and such external incentives reduce the degree of internalisation of motivation, leading to a greater prominence of their external motivation.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue V May 2025

Similarities and differences in learning experiences

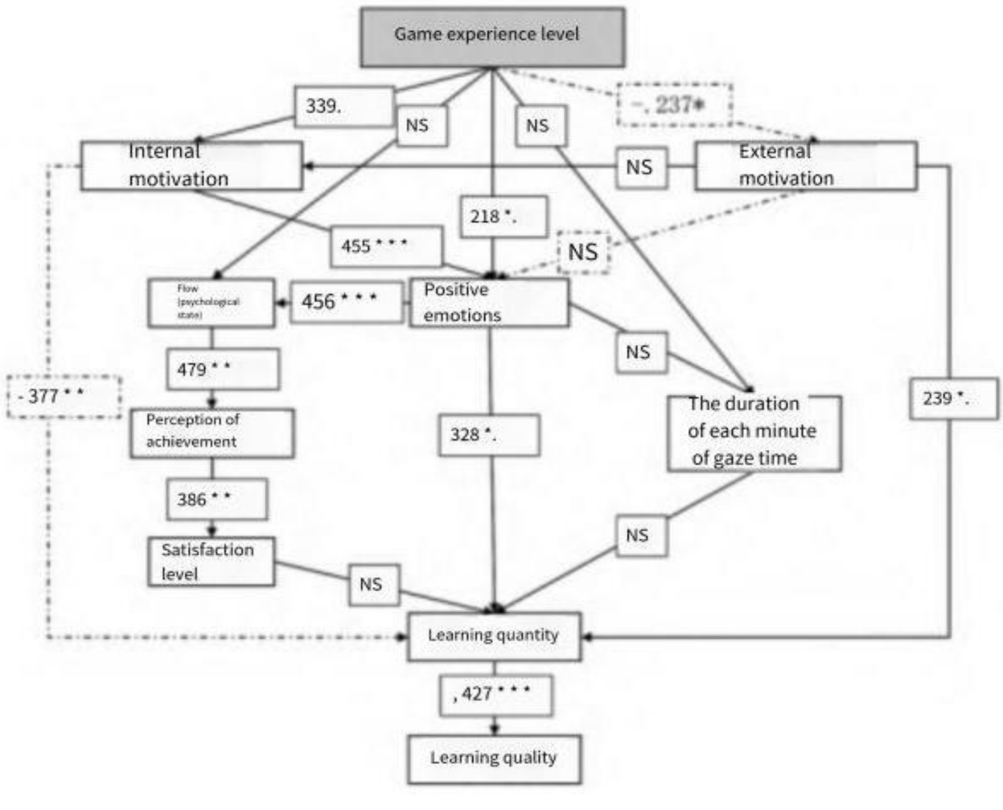
High-game-experienced learners had significantly higher levels of positive emotions than the low-game-experienced group, but the two groups did not show significant differences in terms of mind-flow experience, perceived achievement, and satisfaction with learning Sheldon's study noted that internally motivated behaviours are more likely to elicit positive emotions, whereas externally motivated behaviours are less likely to improve emotional states [25]. Therefore, high game experience learners have higher levels of positive emotions due to stronger internal motivation. However, due to the limited immersion and low skill requirements of the interactive gamified video used in the experiment, the two groups of learners had similar learning experiences, resulting in no significant differences in mind-flow experience, perceived achievement, and satisfaction.

Differences in learning outcomes

In terms of learning outcomes, the quality of learning was significantly better for high game experience learners than for the low game experience group, but there was no significant difference in the quantity of learning. Several studies have demonstrated the facilitating effect of game experience on learning, for example, Antzaka et al. found that learners with action video game experience had better reading performance [26]. The present study further suggests that learners with high game experience are able to comprehend the content more deeply with the combination of high levels of internal motivation and positive emotions, thus improving the quality of learning.

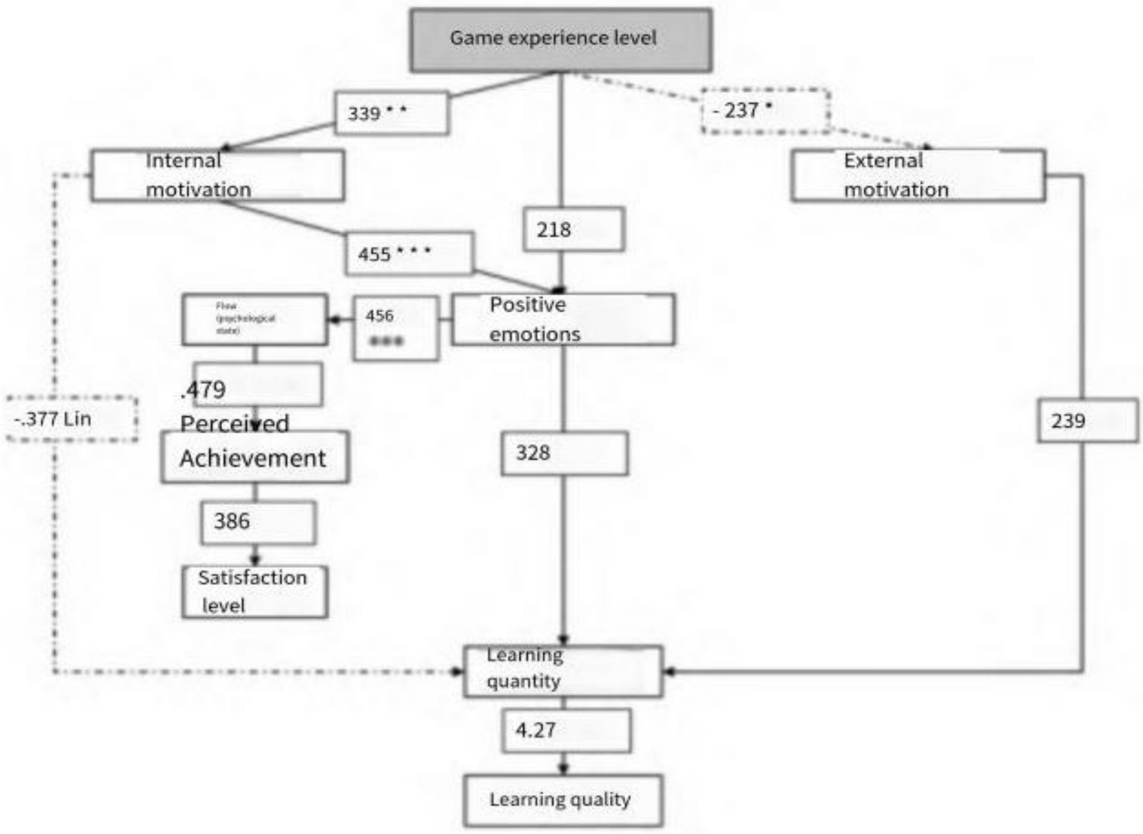
Validation of Mechanisms by which Differences in Gaming Experience Influence Gamified Learning

In order to deeply analyse the influence mechanism of game experience differences on gamified learning, this study imported the pre-constructed hypothesis model and two sets of experimental data into AMOS software, and carried out a systematic analysis with the help of structural equation modelling (SEM). The results of the analysis show that all the fit indicators of the model meet the standard requirements (see Table 3 for details), and Fig. 3 presents the validation model of the influence mechanism of game experience differences on gamified learning. The specific analyses are as follows:



(a) Original model

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue V May 2025



(b) Simplified model

Note: The solid line with arrows in the figure indicates a positive influence relationship between the variables, while the dashed arrows represent a negative influence relationship between the variables. The values in the rectangular boxes are the standardised path coefficients, and if they are labelled "NS", they indicate that the path relationship is not significant. The *, ** and ** symbols labelled next to the path coefficients correspond to different significance levels, where they indicate a significance level of less than 0.1, ** indicates a significance level of less than 0.05, and *** indicates a significance level of less than 0.001.

Although 8 hypotheses were not supported, the remaining 10 revealed a robust core structure aligning with the grand theory framework. To avoid model overfitting, unsupported paths were removed and a simplified model was proposed, focusing on well-supported mechanisms such as intrinsic motivation–emotion–learning outcomes. The specific analyses are as follows:

Hypothesis Testing in the Perspective of Self-Determination Theory

It was tested that the path of game experience level on internal motivation was significant (Beta = 0.339, p = 0.014, SE = 0.436); internal motivation affected quantity of learning (Beta = -0.377, p = 0.013, SE = 0.213), quantity of learning affected quality of learning (Beta = 0.427, p < 0.001, SE = 0.145), internal motivation affecting positive emotions (Beta = 0.455, p < 0.001, SE = 0.564), positive emotions affecting quantity of learning (Beta = 0.328, p = 0.031, SE = 0.048), and the effect of level of gaming experience on external motivation (Beta = -0.237, p = 0.087, SE = 0.584), and the effect of external motivation on the amount of learning (Beta = 0.239, p = 0.064, SE = 0.136) paths were significant. However, the paths of external motivation on internal motivation (Beta = 0.145, p = 0.296, SE = 0.104), and external motivation on positive emotions (Beta = 0.049, p = 0.692, SE = 0.414) were not significant. This indicates that hypotheses H1, H2, H3, H4, H5, H7, and H9 are valid and H6 and H8 are not.

It can be seen that high game-experienced learners show higher internal motivation and lower external motivation in gamified learning. External motivation can directly contribute to the quantity and quality of learning, whereas internal motivation works indirectly through positive emotions. Higher internal motivation triggers positive emotions in learners, which in turn promotes learning effectiveness; in contrast, external motivation struggles to trigger positive emotions. This finding supports the idea that a combination of "high internal motivation + low external motivation" is most conducive to learning [27].

Hypothesis validation from a mind-flow theory perspective

The analyses found a non-significant effect of level of gaming experience on mindstream experience (Beta = -0.157, p = 0.254, SE = 0.898); a non-significant pathway of mindstream experience on perceived achievement (Beta = 0.479, p < 0.001, SE = 0.048), perceived achievement on satisfaction (Beta = 0.386, p = 0.003, SE = 0.066), the and positive emotions on mindstream experience (Beta = 0.456, p < 0.001, SE = 0.063) had significant paths of influence, but the effect of satisfaction on the amount of learning was not significant (Beta = 0.038, p = 0.766, SE = 0.455). Therefore, hypotheses H11, H12, and H14 are valid and H10 and H13 are not valid.

The results showed that the mindstream experience of high game experience learners was not significantly enhanced by game experience, but positive emotions could effectively drive them into a mindstream state, which in turn improved perceived achievement and learning satisfaction. However, optimisation of the learning experience alone did not significantly improve the quantity and quality of learning, which may be due to learners' over-immersion in gamification mechanisms, which distracted them from focusing on the learning task.

Hypothesis validation within a cognitive-emotional theory perspective of digital learning

The path of the effect of level of gaming experience on positive affect was significant (Beta = 0.218, p = 0.091, SE = 1.826), but the effects of positive affect on gaze time per minute (Beta = -0.118, p = 0.434, SE = 0.103), and gaze time per minute on number of learnings (Beta = 0.156, p = 0.227, SE = 0.059) were not significant. Thus, hypothesis H15 is valid and H16 and H17 are not valid.

This suggests that gamified learning scenarios are more likely to satisfy the needs of high game-experienced learners to "learn by playing", resulting in a stronger sense of belonging and confidence in task completion, which in turn stimulates positive emotions and contributes to the enhancement of learning outcomes. No significant difference in visual cognitive behaviour was observed because the two groups used the same learning materials and had the same visual information input in the experiment.

Hypothesis validation from a gamified learning theory perspective

The effect of level of gaming experience on gaze time per minute was not significant (Beta = -0.014, p = 0.928, SE = 1.461) , and hypothesis H18 was not tested.

Combined with other validated hypotheses (H7, H9, H15), it can be seen that although the gamified learning elements attracted high game-experienced learners to engage emotionally, the two groups did not present a difference in terms of visual cognitive level. Positive emotions play a key mediating role in which they effectively contribute to the quantity and quality of learning.

In summary, the hypothetical model proposed in this study was partially validated. The core mechanisms by which differences in game experience affect gamified learning can be summarised in four paths: ① game experience level → internal motivation → positive emotions → quantity of learning → quality of learning; ② game experience level → positive emotions → quantity of learning → quality of learning; ③ game experience level → external motivation → quantity of learning → quality of learning; and ④ game experience level → positive emotions → mindstream experience → perceived achievement → satisfaction with learning.

Design responses to gamified learning based on a grand theory perspective: coping with differences in game experience

Differences in gaming experiences are prevalent among the student population. Some learners have difficulties in adapting to the gamified learning environment due to their lack of game experience, which to a large extent has a negative impact on their learning experience and learning effect. Based on the perspective of the grand theory and the influence mechanism of game experience differences on gamified learning, this paper proposes the following optimised design measures for gamified learning resources, strategies and environments, with the aim of fully exploiting and giving full play to the potential advantages of gamified learning, and effectively enhancing the learning experience and learning effectiveness of learners with different levels of game experience.

Enabling "external" to "internal" motivation, relying on high levels of internal motivation to drive gamified learning

Self-determination theory makes it clear that internal motivation is autonomous (i.e., "endogenous"), while external motivation is controlling (i.e., "exogenous"). As the degree of internalisation gradually increases, "externally-driven" can be gradually changed into "internally-driven". When learners are driven by "internal drive", they can acquire richer knowledge and have a better learning experience. In the process of game-based learning, learners with high game experience tend to have high internal motivation and can participate in learning activities spontaneously and actively; while learners with low game experience have relatively high external motivation and are mainly driven by external rewards, so their learning experience and learning effect are slightly inferior compared to those with high game experience. Based on this, it is suggested that facilitating the transition from "external motivation" to internalisation among learners with different game experiences is the key to enhancing the effectiveness of gamified learning. For example, when using external rewards to motivate learners, we can help learners to set clear learning goals, visualise their progress and behaviour, and provide them with continuous encouragement and support. When learners are rewarded and realise that they have made progress, the external rewards will gradually be transformed into an internal motivation, prompting them to take "self-improvement" as the goal and actively complete the game-based learning tasks, thus realising the internalisation of the "external drive".

Facilitating the matching of gamified learning "challenges" with learner "skills" to help learners get into a state of mindstream in gamified learning

According to the theory of mindstreaming, learners can only experience a state of mindstreaming when the "challenge" of a gamified learning task matches their "skill level". Learners with high gaming experience are able to generate higher levels of positive emotions in the process of participating in gamified learning, which in turn stimulates them to enter the state of mindfulness, thus obtaining higher levels of perceived achievement as well as learning satisfaction, and, on the whole, have a better experience of gamified learning. On the other hand, learners with low gaming experience, due to the lack of sufficient gaming experience, their level of gaming "skills" is significantly lower than that of learners with high gaming experience, so they cannot match the "challenge" of the gamified learning task, which is the root cause of their poor gamified learning experience. This is the root cause of their poor learning experience. Based on the above, it is recommended that learning environments with different levels of gamification be created to meet the actual needs of learners with different levels of gaming experience. For example, under the premise of ensuring the consistency of learning difficulty, teaching objectives and teaching content, the type and number of gamified elements in the learning process can be reasonably controlled, and "gamified" learning tasks of different difficulty levels can be set up at the same time. Learners with different gaming experiences can independently choose the appropriate gamified learning tasks according to their own learning needs, thus realising personalised and differentiated learning, and promoting a high degree of compatibility between gamified learning "challenges" and learners' gaming "skills". The state of the game is highly matched with the learners' game skills.

Stimulate "positive emotions", promote cognitive processing of gamified learning, and make joyful learning throughout the whole process of gamified learning

The cognitive-emotional theory of digital learning proposes that positive emotional states can facilitate learning by prompting learners to produce learning behaviours that are conducive to cognitive processing. In gamified learning, learners with high gaming experience are more likely to generate positive emotions, which in turn promote deep cognitive processing and ultimately achieve better learning results, while learners with low gaming experience find it difficult to generate positive emotional states, which directly leads to their poor learning results. In view of this, it is recommended that the concept of emotional design be introduced into the design process of game-based learning resources, so as to explore the fun of game-based learning and help learners reasonably regulate their own emotional state. To enrich immersion, future design may incorporate dynamic narrative scenarios, AI-based interaction agents, and adaptive challenges that respond to learner inputs in real time. These additions are expected to deepen learners' emotional involvement and engagementnt. For example, when the game-based learning process is about to enter a more difficult stage, text prompts, interesting sound effects, virtual peer help and other ways can be used to provide emotional support for learners to ensure that learners can complete difficult tasks in a positive emotional state. In addition, colourful and anthropomorphic designs can be made for the key parts of game-based learning that contain difficult knowledge points, and the voice-over and background music of the knowledge explanation can be optimized, so as to stimulate the positive emotions of the learners from both the visual and auditory channels, and then improve the cognitive process and learning effect of game-based learning [28].To further enhance immersion, future designs could integrate haptic feedback mechanisms (e.g., controller vibrations for correct answers) and social multiplayer modes. For instance, learners could collaborate in virtual labs to solve puzzles, with real-time emoticon reactions and voice chat fostering peer interaction. Additionally, adaptive difficulty scaling based on real-time performance data (e.g., auto-adjusting task complexity when engagement drops) and AR/VR integration (e.g., 360° historical reenactments or molecular modelling in science lessons) would deepen spatial and emotional engagement. These elements, combined with personalized avatars and achievement badges, create a multi-sensory, socially dynamic environment that sustains positive emotions and cognitive focus.

Skilful use of "game elements and mechanisms" to optimise gamified learning behaviours and achieve a balanced unity of education and gameplay

The theory of gamified learning suggests that the teaching content and gamified elements together constitute important factors influencing the attitudes and learning effects of gamified learning behaviours, and that these elements can optimise learning behaviours and attitudes, which in turn can promote the improvement of learning effects. Highly game-experienced learners are able to complete gamified learning tasks more efficiently under the influence of positive emotions. However, in this study, no significant differences in gamified learning behaviours were observed among learners from all game experience groups as the learning materials, game elements, and mechanisms used were the same. In order to stimulate efficient gamified learning behaviours among learners with different gaming experiences, it is recommended that a more scientific gamification design model be adopted to create a gamified learning environment that balances gameplay and education. For example, based on the Learning - Game Mechanism Model (LM - GM), Element - Mechanism - Emotion (MDA) and other gamification design frameworks, we can clarify the game elements, game mechanisms and emotional experiences in the gamification design scheme to ensure that the teaching objectives are closely integrated with the gamification design, so as to create a high-quality game for learners. To ensure the close integration of teaching objectives and gamification design, so as to create a high-quality gamified learning experience for learners.

Research constraints

Although this study explored the mechanism of the influence of learners' differences in game experience on gamified learning in a more systematic way, it still has certain limitations. Firstly, in terms of data measurement, a questionnaire in the form of a subjective report was mainly used to assess learners' motivation and emotional state, a method that may be influenced by subjects' subjective judgement and lead to some bias in the measurement results. Secondly, the gender ratio of subjects in the research sample is relatively homogeneous, with no significant difference between male and female ratios, which limits the in-depth analysis of the differences between different gender groups in gamified learning. In addition, the study is mainly based on learners in specific contexts, and the age and cultural background of the sample is relatively concentrated, which affects the broad applicability of the findings.

Directions for future research

In view of the above limitations, future research can be further improved in the following aspects: first, to introduce physiological measurements, such as electroencephalogram (EEG), electrocardiogram (ECG) and other physiological data collection techniques, in order to more objectively and accurately assess the motivational and emotional changes of learners in the process of game-based learning; second, to expand the scope of the sample to cover learners of different genders, ages and cultural backgrounds, so as to enhance the third is to explore diversified and precise game-based learning design strategies by combining different teaching contents and teaching scenarios, so as to deeply reveal the specific mechanism of the differences in game experience on learning effects in different contexts.

SUMMARY

Based on the perspective of grand theory integration, this study integrates self-determination theory, mind-flow theory, cognitive-emotional theory of digital learning and game-based learning theory, systematically analyses the influence of learners' differences in gaming experience on game-based learning, and verifies the relevant hypotheses through empirical research. On this basis, targeted optimization countermeasures are proposed, including promoting the transformation of external to internal drivers, facilitating the matching of challenges and skills, inducing positive emotions to optimize cognitive processing, and improving learning behaviours through the clever use of game elements and mechanisms. The research not only enriches the theoretical system in the field of game-based learning, but also provides valuable references for dealing with learner differences more effectively and improving the effectiveness of game-based learning in practice.

REFERENCE

1. SHARMA K , PAPAVLASOPOULOU S , GIANNAKOS M. Coding games and robots to enhance computational thinking: how collaboration and engagement moderate children's attitudes?[J]. International journal of child-computer interaction, 2019, 21: 65-76.
2. Li Xin . A structural design model and experimental study of educational games incorporating "adaptability"[J]. Journal of Distance Education, 2015, 33(2):97-103.
3. ORTIZ DE GORTARE A , ARONSSON K , GRIFFITHS M D. Game transfer phenomena in video game playing: a qualitative interview study[J]. International journal of cyber behaviour, psychology and learning, 2011, 1(3): 15-33.
4. Wang Guangxin, Liu Xingbo, Li Tong, Lu Hong . Research on the relationship between students' perceived digital game challenge level and learning attention[J]. China Electrochemical Education, 2016(8):107-114.
5. Ma Yingfeng, Guan Jingjing, Hu Ruonan . Research on positive emotion elicitation strategies of players in educational games[J]. Research on Electrochemical Education, 2017, 38(5):77-82.
6. SHELDON K M , PRENTICE M. Self-determination theory as a foundation for personality researchers [J]. Journal of personality, 2019, 87(1):5-14.
7. DECI E L , RYAN R M. The general causality orientations scale : self-determination in personality [J]. Journal of research in personality, 1985, 19(2):109-134.
8. RYAN R M, DECI E L. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being[J]. American psychologist, 2000, 55(1):68-78.
9. MIHALY C. Beyond boredom and anxiety: experiencing flow in work and play [M]. San Francisco: Jossey-Bass Publishers, 2000.
10. ZHANG Jinghong, ZHANG Yijing, FENG Fan, QIN Gao . Research on user experience of virtual reality competitive games based on cognition and emotion[J]. Science, Technology and Engineering, 2022, 22(16):6592-6598.
11. MAYER R E. Searching for the role of emotions in e-learning[J]. Learning and instruction, 2020, 70: 101213.
12. WANG X , MAYER R E , HAN M , et al. Two emotional design features are more effective than one in multimedia learning [J].
13. Journal of educational computing research, 2023, 60(8): 1991-2014.
14. LANDERS R N. Developing a theory of gamified learning linking serious games and gamification of learning [J]. Simulation & gaming, 2014, 45(6):752-768.
15. WILSON K A, BEDWELL W L, LAZZARA E H, et al. Relationships between game attributes and

learning outcomes: review and research proposals[J]. Simulation & gaming, 2009, 40(2):217-266.
16. WANG Xue, ZHANG Lei, WANG Graphics, QIAO Yufei, LI Huiyang. Research on learners' eye movement behaviour patterns and their action mechanism in pop-up teaching videos[J]. Journal of Distance Education, 2022, 40(5):103-112.
17. WERBACH K, HUNTER D. For the win, revised and updated edition: the power of gamification and game thinking in business, education, government, and social impact[M]. Philadelphia: University of Pennsylvania Press, 2020.
18. PETRY N M, REHBEIN F, GENTILE D A, et al. An international consensus for assessing internet gaming disorder using the new DSM-5 approach[J]. Addiction, 2014, 109(9):1399-1406.
19. Qiu L, Zheng Xue, Wang Yanfei . Revision of the Positive Affect Negative Affect Scale (PANAS)[J]. Applied Psychology, 2008, 14(3):249-254, 268.
20. PINTRICH P R, SMITH D A, GARCIA T, et al. A manual for the use of the motivated strategies for learning questionnaire [J].College students, 1993, 48(3):9- 76.
21. KIILI K, LAINEMA T. Evaluations of an experiential gaming model: the realgame case [C]// Proceedings of the ED-MEDIA 2006-World Conference on Educational Multimedia, Hypermedia & Telecommunications. Educational Multimedia, Hypermedia & Telecommunications. Orlando, FL: Association for the Advancement of Computing in Education (AACE), 2006: 2343-2350.
22. Han Meiqi. Research on Emotion Design in Multimedia Screen [D]. Tianjin: Tianjin Normal University, 2020.
23. Yang Jiumin. Teacher's influence on learning process and effect in online video courses [D]. Wuhan: Huazhong Normal University, 2014.
24. WANG Xue, WANG Graphics, QIAO Yufei, et al. Gamification design of online course resources for "learning and testing": theoretical model and mechanism[J]. Research on Electrochemical Education, 2023, 44(2): 92-98, 113.
25. BITTNER J, SCHIPPER J. Motivational effects and age differences of gamification in product advertising [J]. Journal of consumer marketing, 2014, 31(5): 391-400.
26. SHELDON K M,KASSER T. Pursuing personal goals: skills enable progress, but not all progress is beneficial [J]. Personality and social psychology bulletin, 1998, 24(12):1319-1331.
27. ANTZAKA A, LALLIER M, MEYER S, et al. Enhancing reading performance through action video games: the role of visual attention span[J]. Scientific reports, 2017, 7(1):1-10.
28. PENG Jingwen, LIU Shujing. Between "instinct" and "cognition": the division and integration of internal drive for learning[J]. Research on Higher Engineering Education, 2022(5):111-118.
29. WANG Xue, HAN Meiqi, GAO Zehong, WANG Zhijun. Research on the role mechanism and optimisation strategy of audio-visual emotional design in teaching video[J]. Journal of Distance Education, 2020, 38(6):50-61.
30. Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: defining "gamification". In Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments (pp. 9-15). ACM.
31. Hamari, J., Koivisto, J., & Sarsa, H. (2014). Does gamification work? - A literature review of empirical studies on gamification. in 2014 47th Hawaii International Conference on System Sciences (pp. 3025-3034). IEEE. Wikipedia
32. Seaborn, K., & Fels, D. I. (2015). Gamification in theory and action: a survey. International Journal of Human-Computer Studies, 74, 14-31.
33. Kapp, K. M. (2012). The gamification of learning and instruction: game-based methods and strategies for training and education. pfeiffer.
34. Bai, S., Hew, K. F., & Huang, B. (2020). Does gamification improve student learning outcome? Evidence from a meta-analysis and synthesis of qualitative data in educational contexts. Educational Research Review, 30, 100322.
35. Domínguez, A., Saenz-de-Navarrete, J., de-Marcos, L., Fernández-Sanz, L., Pagés, C., & Martínez-Herráiz, J. J. (2013). Gamifying learning experiences: practical implications and outcomes. Computers & Education, 63, 380-392. Wikipedia
36. Sailer, M., Hense, J. U., Mayr, S. K., & Mandl, H. (2017). How gamification motivates: an experimental study of the effects of specific game design elements on psychological need satisfaction. computers in Human Behavior, 69, 371-380.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue V May 2025

37. Su, C. H., & Cheng, C. H. (2015). A mobile gamification learning system for improving the learning motivation and achievements. Journal of Computer Assisted Learning, 31(3), 268 -286.
38. Huang, B., Hew, K. F., & Lo, C. K. (2019). Investigating the effects of gamification-enhanced flipped learning on undergraduate students' behavioural and cognitive engagement. Interactive Learning Environments, 27(8), 1106-1126.
39. Landers, R. N., & Armstrong, M. B. (2017). Enhancing instructional outcomes with gamification: an empirical test of the Technology-Enhanced Training Effectiveness Model. computers in Human Behavior, 71, 499-507.
40. Buckley, P., & Doyle, E. (2016). Gamification and student motivation. Interactive Learning Environments, 24(6), 1162-1175.
41. Barata, G., Gama, S., Jorge, J., & Gonçalves, D. (2013). Improving student engagement through gamification. in Proceedings of the First International Conference on Gameful Design, Research, and Applications (pp. 10-17). ACM.
42. Mekler, E. D., Brühlmann, F., Tuch, A. N., & Opwis, K. (2017). Towards understanding the effects of individual gamification elements on intrinsic motivation and performance. Computers in Human Behavior, 71, 525 -534.
43. Hanus, M. D., & Fox, J. (2015). Assessing the effects of gamification in the classroom: a longitudinal study on intrinsic motivation, social comparison, satisfaction, effort, and academic performance. computers & education, 80, 152-161.
44. Borges, S. D., Durelli, V. H. S., Reis, H. M., & Isotani, S. (2014). A systematic mapping on gamification applied to education. in Proceedings of the 29th Annual ACM Symposium on Applied Computing (pp. 216- 222). ACM.
45. Toda, A. M., Valle, P. H. M., & Isotani, S. (2017). The dark side of gamification: an overview of negative effects of gamification in education. in Proceedings of the 19th International Conference on Artificial Intelligence in Education (pp. 143-156). Springer.
46. 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.
47. Looyestyn, J., Kernot, J., Boshoff, K., Ryan, J., Edney, S., & Maher, C. (2017). Does gamification increase engagement with online programmes? a systematic review. ploS One, 12(3), e0173403.
48. Cheong, C., Filippou, J., & Cheong, F. (2014). Towards the gamification of learning: Investigating student perceptions of game elements. Journal of Information Systems Education, 25(3), 233 -244.
49. Nicholson, S. (2015). A recipe for meaningful gamification. in T. Reiners & L. C. Wood (Eds.), Gamification in Education and Business (pp. 1-20). Springer.