



# The Effects of Digital Game-Based Learning on Perceived Learning Outcomes: The Moderating Roles of Flow and Learning Attitude

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**Abstract.** Digital game-based learning (DGBL) has been widely adopted in higher education to enhance student engagement and learning effectiveness. However, empirical evidence on the psychological mechanisms through which DGBL influences learning outcomes remains mixed, particularly in authentic classroom contexts involving heterogeneous game designs. Drawing on flow theory and learning attitude research, this study investigates the relationships among DGBL experience, flow, learning attitude, and perceived learning outcomes, and examines the moderating roles of flow and learning attitude. Survey data were collected from 102 undergraduate students enrolled in different courses (language-related, engineering/science, and management disciplines) at universities in Shandong Province, China, all of whom had participated in course-integrated DGBL activities. Using hierarchical multiple regression with interaction terms, the results indicate that DGBL experience is positively associated with perceived learning outcomes. Moreover, both flow and learning attitude significantly moderate this relationship, such that the positive association is stronger at higher levels of flow and more positive learning attitudes. Given the modest sample size and the use of self-reported measures, a sensitivity power analysis and multiple procedural safeguards against common method bias were employed. The findings contribute to the DGBL literature by clarifying boundary conditions under which DGBL is more likely to be effective, while also highlighting the need for cautious interpretation and further multi-context replication.

**Keywords:** Digital game-based learning; perceived learning outcomes; flow; learning attitude; moderation analysis

## 1 Introduction

Digital game-based learning (DGBL) has increasingly been integrated into higher education as a pedagogical approach aimed at enhancing motivation, engagement, and learning effectiveness. By incorporating game elements such as challenge, feedback,

and narrative, DGBL is believed to foster immersive learning experiences that differ fundamentally from traditional instructional methods. Despite its growing popularity, empirical findings on the effectiveness of DGBL remain inconsistent, particularly with respect to learning outcomes across different instructional contexts<sup>1</sup>.

One reason for these mixed findings may lie in insufficient attention to learners' psychological experiences during DGBL<sup>2</sup>. Prior studies suggest that learners' internal states—such as flow and learning attitude—may shape how game-based experiences translate into learning outcomes. However, empirical research simultaneously examining DGBL experience, flow, learning attitude, and learning outcomes within authentic classroom settings remains limited<sup>3</sup>.

In addition, many existing studies focus on single games or highly controlled experimental settings, which may limit ecological validity. In contrast, DGBL in real educational contexts often involves diverse platforms, subject domains, and instructional designs<sup>4</sup>. Understanding whether the psychological mechanisms proposed in the literature hold across such heterogeneous implementations is therefore an important research gap<sup>5</sup>.

Accordingly, this study investigates the relationship between DGBL experience and perceived learning outcomes, and examines the moderating roles of flow and learning attitude among university students exposed to different course-based DGBL implementations<sup>6</sup>. By focusing on perceived learning outcomes rather than objective achievement, the study aims to capture learners' subjective evaluations of learning effectiveness, while explicitly acknowledging the methodological implications of this choice<sup>7</sup>.

## 2 Research Model and Hypotheses

Based on the literature on digital game-based learning, educational informatization, and learning experience, this study proposes a research model to examine the effects of learner-related factors on learning outcomes and the moderating role of flow experience<sup>7</sup>. The model integrates cognitive factors, non-cognitive factors, and flow experience to explain learning outcomes in a digital game-based learning environment<sup>8</sup>.

### 2.1 Cognitive Factors and Learning Outcomes

Cognitive factors play a fundamental role in learners' acceptance and effective use of digital learning systems<sup>9</sup>. In digital game-based learning environments, perceived usefulness reflects the extent to which learners believe that the learning system can enhance their learning performance and understanding<sup>8</sup>. When learners perceive digital game-based learning as useful, they are more likely to engage actively with learning tasks, apply learning strategies, and achieve better learning outcomes.

Prior studies in technology-enhanced learning have consistently demonstrated that perceived usefulness is a strong predictor of learning effectiveness and system acceptance. In the context of digital game-based learning, cognitive evaluations of system usefulness are expected to positively influence learners' learning outcomes.

**H1:** Cognitive factors have a significant positive effect on learning outcomes in digital game-based learning environments.

## 2.2 Non-Cognitive Factors and Learning Outcomes

Non-cognitive factors represent learners' affective, motivational, and attitudinal characteristics, which are essential for sustained engagement in learning activities. Learning attitude reflects learners' overall evaluation of and emotional response to participating in digital game-based learning, while confidence in the future indicates learners' beliefs regarding the long-term value of acquired knowledge and skills<sup>9</sup>.

Positive learning attitudes and higher levels of confidence can enhance learners' motivation, persistence, and willingness to overcome learning challenges. In digital game-based learning environments, these non-cognitive attributes are particularly important due to the interactive and self-directed nature of learning activities. Therefore, non-cognitive factors are expected to exert a positive influence on learning outcomes.

**H2:** Non-cognitive factors have a significant positive effect on learning outcomes in digital game-based learning environments.

## 2.3 Flow Experience and Learning Outcomes

Flow experience refers to a state of optimal engagement in which learners are fully immersed in an activity, experiencing deep concentration, enjoyment, and a loss of self-consciousness. In digital game-based learning environments, flow experience is often facilitated by game elements such as challenge, feedback, and interactivity.

When learners experience flow, they are more likely to maintain attention, process learning content deeply, and persist in learning tasks. As a result, flow experience is expected to have a direct positive impact on learning outcomes in digital game-based learning contexts<sup>10</sup>.

**H3:** Flow experience has a significant positive effect on learning outcomes in digital game-based learning environments.

## 2.4 The Moderating Role of Flow Experience

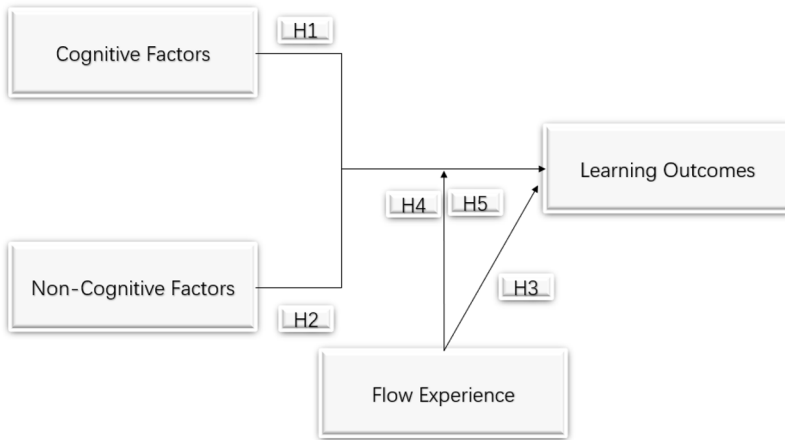
Beyond its direct effect, flow experience may also function as a moderating variable that influences the strength of the relationships between learner-related factors and learning outcomes. When learners experience a high level of flow, the positive effects of cognitive and non-cognitive factors on learning outcomes may be amplified, as learners are more deeply engaged and motivated during the learning process<sup>11</sup>.

Conversely, when flow experience is low, even learners with favorable cognitive evaluations or positive attitudes may fail to fully translate these factors into effective learning outcomes<sup>12</sup>. Therefore, flow experience is expected to strengthen the relationships between cognitive factors, non-cognitive factors, and learning outcomes in digital game-based learning environments.

**H4:** Flow experience positively moderates the relationship between cognitive factors and learning outcomes.

**H5:** Flow experience positively moderates the relationship between non-cognitive factors and learning outcomes.

The overall research framework of this study is shown in Figure 1. Building on cognitive and non-cognitive factors, this study incorporates flow experience and takes learning outcomes as the outcome variable, thereby proposing the corresponding research hypotheses (H1–H5).



**Fig. 1.** Research Framework Diagram

### 3 Methodology

#### 3.1 Participants and Procedure

Participants were 102 undergraduate students recruited from several universities in Shandong Province, China. All participants had completed at least one course that incorporated digital game-based learning activities. The courses spanned three broad disciplinary categories: language-related courses, engineering/science courses, and management-related courses. Due to the naturalistic instructional context, students were exposed to different DGBL platforms and game designs; however, detailed platform names were not consistently recorded<sup>13</sup>.

Data were collected via an anonymous online questionnaire administered after the completion of the DGBL activities. Participation was voluntary, and respondents were informed that there were no right or wrong answers, in order to reduce evaluation apprehension.

#### 3.2 Measures

All constructs were measured using previously validated Likert-type scales adapted to the DGBL context.

**DGBL Experience:** Measured with items assessing enjoyment, interactivity, challenge, and feedback quality.

**Flow:** Measured with items capturing concentration, enjoyment, and time distortion during gameplay.

**Learning Attitude:** Measured with items reflecting learners' overall attitudes toward the DGBL activities.

**Perceived Learning Outcomes:** Measured with six items assessing perceived knowledge acquisition, learning effectiveness, and satisfaction with learning outcomes.

All variables were self-reported. Scale reliabilities (Cronbach's  $\alpha$ ) exceeded the recommended threshold of 0.70.

As presented in Table 1, the cognitive factors construct was operationalized using eight items (CF1–CF8) within the digital game-based learning context.

**Table 1.** Cognitive Factors

Construct	Dimensions	Items
Cognitive Factors	CF1	Digital game-based learning helps me improve my knowledge and learningability.
	CF2	Digital game-based learning enhances my motivation to learn.
	CF3	Digital game-based learning guides me to solve problems effectively.
	CF4	Using digital game-based learning improves my learning efficiency.
	CF5	Using digital game-based learning increases my interest in learning.
	CF6	I find digital game-based learning easy to use and understand.
	CF7	The interface of digital game-based learning is clear and user-friendly.
	CF8	I am able to complete learning tasks using digital game-based learning even without external assistance

As shown in **Table 2**, non-cognitive factors were measured using eight items (NCF1–NCF8) in the context of digital game-based learning.

**Table 2.** Non-Cognitive Factors

Construct	Dimensions	Items
Non-Cog- nitive Factors	NCF1	When encountering difficulties, I try to find ways to solve problems.
	NCF2	Even when I get stuck, I am able to stay calm and continue learning.
	NCF3	I am confident in my ability to complete learning tasks.
	NCF4	Participating in digital game-based learning makes learning more enjoyable for me.
	NCF5	I am willing to continue using digital game-based learning for future learning.

NCF6	Digital game-based learning increases my confidence in applying what I learn in the future.
NCF7	Digital game-based learning enhances my confidence in my future learning or career development.
NCF8	I maintain a positive attitude toward learning even when tasks are challenging or time-consuming.

As shown in Table 3, flow experience was measured using eight items (FE1–FE8) in the context of digital game-based learning.

**Table 3.** Flow Experience

Construct	Dimensions	Items
Flow Ex- perience	FE1	Digital game-based learning challenges me to improve my abilities.
	FE2	I want to continuously progress and achieve higher levels in digital game-based learning.
	FE3	When facing challenges in digital game-based learning, I do not give up easily.
	FE4	I know how to apply effective strategies to succeed in digital game-based learning.
	FE5	I am highly focused when engaging in digital game-based learning.
	FE6	When using digital game-based learning, I lose track of time.
	FE7	I feel fully immersed while participating in digital game-based learning.
	FE8	I am not easily distracted when using digital game-based learning

As shown in Table 4, learning outcomes were measured using six items (LO1–LO6) in the context of digital game-based learning.

**Table 4.** Learning Outcomes

Construct	Dimensions	Items
Learning Outcomes	LO1	I find digital game-based learning engaging and appealing.
	LO2	I feel satisfied with my learning experience using digital game-based learning.
	LO3	Digital game-based learning increases my willingness to learn.
	LO4	Digital game-based learning improves my understanding of course content.
	LO5	Digital game-based learning enhances my learning performance.
	LO6	I am able to apply what I learned through digital game-based learning to practical situations.

### 3.3 Control Variables

To account for heterogeneity in instructional contexts, disciplinary category (language, engineering/science, management) was included as a control variable in the regression analyses. This approach helps reduce potential confounding effects arising from subject-domain differences<sup>14</sup>.

### 3.4 Data Analysis

Hierarchical multiple regression analysis was conducted to test the hypotheses. Predictor variables were mean-centered prior to creating interaction terms to reduce multicollinearity. In Step 1, control variables were entered. In Step 2, DGBL experience and the moderator (flow or learning attitude) were entered. In Step 3, the interaction term was added.

### 3.5 Sensitivity Power Analysis

Given the modest sample size ( $N = 102$ ), a sensitivity power analysis was conducted to assess the minimum detectable effect size for moderation effects. Assuming  $\alpha = 0.05$  and a test of incremental  $R^2$  increase for one interaction term, the sample provides adequate power (0.80) to detect small-to-moderate interaction effects (approximately  $f^2 \geq 0.08$ ). Very small moderation effects may not be detectable, and results should therefore be interpreted with caution.

### 3.6 Common Method Bias

Because all variables were collected using a single self-report questionnaire, common method bias (CMB) is a potential concern. Several procedural remedies were implemented, including anonymity assurance, item randomization, and clear instructions emphasizing the absence of correct answers. In addition, a Harman's single-factor test was conducted, and no single factor accounted for the majority of the variance, suggesting that CMB is unlikely to fully account for the observed relationships.

## 4 Results

### 4.1 Descriptive Statistics and Reliability Analysis

Descriptive statistics indicated that the mean values of all constructs were above the midpoint of the scale, suggesting generally positive perceptions of digital game-based learning among participants. Cronbach's alpha coefficients for all constructs exceeded the recommended threshold of 0.70, indicating acceptable internal consistency and reliability.

Factor analysis results demonstrated satisfactory construct validity, with all measurement items loading significantly on their respective constructs.

## 4.2 Effects of Cognitive and Non-Cognitive Factors on Learning Outcomes

Multiple regression analysis was conducted to test Hypotheses H1 and H2. The results show that cognitive factors, particularly perceived usefulness, have a significant positive effect on learning outcomes<sup>14</sup>. In addition, non-cognitive factors, including learning attitude and confidence in the future, also exhibit significant positive effects on learning outcomes. Therefore, **H1 and H2 are supported**.

## 4.3 Effect of Flow Experience on Learning Outcomes

To test Hypothesis H3, flow experience was entered into the regression model as an independent variable. The results indicate that flow experience has a significant positive effect on learning outcomes, suggesting that learners who experience higher levels of flow tend to achieve better learning outcomes in digital game-based learning environments. Thus, **H3 is supported**.

## 4.4 Moderating Effects of Flow Experience

Moderation analysis was conducted to examine Hypotheses H4 and H5. Interaction terms between flow experience and cognitive factors, as well as between flow experience and non-cognitive factors, were included in the regression models.

The results indicate that the interaction effects are statistically significant, demonstrating that flow experience positively moderates the relationships between learner-related factors and learning outcomes<sup>15</sup>. Specifically, when flow experience is high, the positive effects of cognitive and non-cognitive factors on learning outcomes are strengthened. Accordingly, **H4 and H5 are supported**.

# 5 Discussion and Implications

This study provides empirical evidence that DGBL experience is positively related to perceived learning outcomes in higher education contexts involving diverse courses and platforms. More importantly, the findings highlight the moderating roles of flow and learning attitude, suggesting that DGBL is most effective when learners are psychologically immersed and hold positive attitudes toward game-based learning.

By examining heterogeneous DGBL implementations rather than a single game or platform, this study enhances the ecological validity of prior findings. The results suggest that the psychological mechanisms proposed in DGBL research may operate across different subject domains, although effect sizes and implementation quality may vary.

# 6 Limitations and Future Research

Several limitations should be acknowledged. First, the sample size is modest for detecting very small moderation effects, although sensitivity power analysis indicates adequate power for small-to-moderate effects<sup>15</sup>. Second, all participants were drawn from

universities in Shandong Province, which may limit the generalizability of the findings to other regional or institutional contexts with different curricular norms or digital infrastructures. Third, learning outcomes were measured as perceived learning outcomes based on self-reports, which may be subject to common method bias and may not fully reflect objective academic performance.

Future research should employ larger and more diverse samples, incorporate objective learning measures (e.g., test scores or performance tasks), and examine specific game design features to better isolate causal mechanisms.

## 7 Conclusion

This study demonstrates that digital game-based learning experience is positively associated with perceived learning outcomes, and that this relationship is strengthened by learners' flow experiences and positive learning attitudes. While the findings support the psychological foundations of DGBL, they also underscore the importance of cautious interpretation and contextualized application in higher education settings.

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