

Mechanism of Serious Gamification: Enhancing Learning Engagement Through Dual Dimensions of Flow Experience

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ABSTRACT

Serious gamification, defined as the use of full-featured and high-level games in non-game contexts, has garnered significant scholarly attention. However, existing studies show divergent results, leading us to conjecture that the mechanism of serious gamification's impact on learning engagement is still underexplored. Therefore, this study investigates serious gamification's effects on learning engagement through dual dimensions (i.e., absorption and smooth and automatic running) of flow experience using goal-setting theory and stimulus-organism-response theory. A field experiment will be conducted in an Enterprise Resource Planning course, comparing the ERPsim game with traditional instruction to examine whether serious gamification elevates learners' behavioral, cognitive, and emotional engagement, and explore how the two flow dimensions function in this process. It aims to enrich theoretical understanding of flow-mediated gamification mechanisms and provide practical guidance for optimizing serious gamification design in higher education.

Keywords: Serious gamification, dual dimensional flow experience, learning engagement, SOR theory, ERPsim game.

INTRODUCTION

Enhancing learning outcomes in higher education has long remained a pivotal challenge for educational researchers and practitioners alike. Amid technological advances, serious gamification, such as ERPsim games, has emerged as a key pedagogical approach in Information Systems (IS). However, the theoretical exploration of its underlying mechanisms still lags behind its practical application.

Recent meta-analyses indicate that serious gamification generally improves learning engagement, motivation, and academic performance (Zainuddin *et al.*, 2020). However, some studies report null or even detrimental effects (Ekici, 2021). This reveals a research gap: dual countervailing mechanisms may coexist in its engagement pathways, and examining experiential outcomes in specific contexts is critical to understanding these mechanisms (Liu *et al.*, 2017).

Flow, which is defined as a positive psychological state of complete absorption in an activity (Csikszentmihalyi, 1975), plays a key role in serious gamification. Nevertheless, most existing studies either treat flow as a single concept (Sailer & Sailer, 2021; Hamari & Koivisto, 2014) or focus only on one of its components (Rivkin *et al.*, 2018). Rheinberg *et al.*'s Flow Short Scale (FKS) conceptualizes flow as two correlated yet distinct dimensions. The first dimension includes the sensation of focusing on and controlling the activity, along with smooth and automatic thinking processes. The second dimension, by contrast, involves the feeling of full involvement, distorted sense of time, optimal challenge, and intense concentration (Rheinberg *et al.*, 2003). Weibel and Wissmath (2011) later gave explicit names to these two dimensions: smooth and automatic running experience and absorption experience. They also confirmed the statistical independence of these two dimensions as separate psychological constructs through confirmatory factor analysis.

Building on the aforementioned theoretical gaps and research foundations, this study draws on Goal-Setting Theory (GST) (Locke & Latham, 2002) and Stimulus-Organism-Response (SOR) Theory (Mehrabian & Russell, 1974; Jacoby, 2002) to propose the following hypothesis: Serious gamification (stimulus S) enhances tripartite learning engagement through the two dimensions of flow (organism O). The tripartite learning engagement includes behavioral, emotional and cognitive dimensions, which corresponds to response R (Fredricks *et al.*, 2004; Reeve, 2013), and the two dimensions of flow are defined as separate psychological constructs (Rheinberg *et al.*, 2003; Weibel & Wissmath, 2011). A field experiment will be conducted to compare ERPsim-based gamified instruction (a typical serious gamification application) with traditional instruction (Bauer *et al.*, 2022), and Partial Least Squares-Structural Equation Modeling (PLS-SEM) (Henseler *et al.*, 2016) will be used to test the theoretical model. The core objective of this study is to address the following research question:

Research Question (RQ): What are the engagement pathways in serious gamification, and how do the two flow dimensions mediate these pathways?

LITERATURE REVIEW

Serious Gamification

Defined as "the application of full-featured, high-level games in non-game contexts," serious gamification has shown great potential to enhance learning outcomes in educational and professional settings. Empirical studies indicate that it improves knowledge acquisition and critical thinking through simulating complex systems, with evidence of outperforming traditional teaching methods in specific disciplinary scenarios. This pedagogical tool is particularly effective in fostering interdisciplinary problem-solving skills via role-playing and dynamic decision-making scenarios.

Serious gamification enables multidimensional pedagogical improvements at behavioral and cognitive levels. Embedded real-time feedback mechanisms—such as task prompts and virtual rewards—prolong focused learning duration and boost intrinsic motivation (Dicheva *et al.*, 2015). When combined with progress visualization tools, structured incentive systems allow learners to independently identify knowledge gaps and optimize learning strategies. Additionally, the risk-controlled environments it provides facilitate cyclical trial-and-error correction, thereby enhancing knowledge retention and behavioral transfer efficacy.

ERPsim Game

ERPsim, developed by the ERPsim Laboratory at HEC Montréal (Canada), is a quintessential application of serious gamification in educational technology; as an Enterprise Resource Planning (ERP) simulation platform, it integrates SAP ERP transaction operations and real-time market feedback, immerses learners in a virtual business environment to simulate an enterprise's core business processes, requires participants to make holistic decisions on demand forecasting, procurement, production scheduling, and marketing within an operational cycle, imposes high demands on learners' competencies by requiring them to master specialized knowledge and advanced operational skills in ERP system management to complete tasks, and compared to traditional case-based pedagogy, it has a pedagogical advantage in transforming abstract management paradigms into cognitively mappable visual interfaces through dynamic data interaction—additionally, as a typical application paradigm of serious gamification, it not only demonstrates disciplinary adaptability in business education but also establishes scalable simulation training programs for employee skill enhancement amid organizational digital transformation, thereby empirically validating the dual efficacy of serious gamification in both teaching and professional development.

Flow Experience

Rooted in educational psychology, Flow theory posits that cognitive characteristics, which are critically influential to learning outcomes (Mayer, 2014), remain underexplored in serious gamification research. Defined as "a holistic experiential state characterized by intense focus, control, and enjoyment during goal-directed activities" (Csikszentmihalyi, 1975), flow manifests in learning contexts as a positive psychological state combining challenge, reward, and immersion (Finneran & Zhang, 2005). As early as the 20th century, researchers identified concentrated attention, sense of control, time distortion, and enjoyment as key features of flow, as they observed these phenomena in diverse learning contexts. Sustaining this state requires balancing task difficulty and skill level; optimal equilibrium fosters sustained engagement, task enjoyment, and minimal external distractions (Ekici, 2021).

Rheinberg *et al.* (2003) reconstructed Flow theory via empirical research and factor analysis, identifying two dimensions of flow experience: smooth and automatic running experience (reflecting focus, control, and fluent cognitive processes) and absorption experience (reflecting full engagement, time distortion, optimal challenge, and absent-mindedness). Weibel *et al.* (2011) further verified the statistical independence of these two dimensions, which represent distinct psychological processes, in their study of simple, fast-paced games like Sonic the Hedgehog. Thus, for complex serious gamification tools such as the ERPsim game (featuring complete processes, complex graphics, high task difficulty, and contextualized interactive mechanisms), dividing flow into these two dimensions is necessary. This enables building a multidimensional evaluation system, identifying the synergistic mechanism between the two dimensions, and optimizing the instructional design effectiveness of serious gamification.

Learning Engagement

Learning engagement refers to the degree to which learners actively participate in learning activities. It is a three-dimensional construct encompassing behavioral, emotional, and cognitive dimensions (Fredricks *et al.*, 2004; Reeve, 2013), and represents an active learning approach adopted by students to pursue higher learning effectiveness and academic achievements. Most studies indicate that learning engagement is a crucial factor influencing students' learning effects and has a significant impact on their academic performance. In their groundbreaking research, Noe *et al.* (2010) proposed that research related to learning should focus on the degree of learners' engagement, and emphasized the need to study different learning methods to promote learning engagement—because increased engagement can lead to high-quality educational outcomes such as academic achievements and progress (Fredricks *et al.*, 2004; Noe *et al.*, 2010).

Despite differences in the conceptualization of learning engagement in academic circles, the most common and widely accepted classification includes three dimensions: behavioral, emotional, and cognitive. Behavioral engagement refers to the process in which learners make efforts, concentrate attention, and maintain perseverance; emotional engagement refers to the positive emotions generated during learning; cognitive engagement refers to the behavior of strategically adopting learning strategies (Reeve, 2013). These dimensions are both unique and interconnected (Fredricks *et al.*, 2004; Reeve, 2013), and can be regarded as a multidimensional structure when examined. Existing studies have explored the three dimensions of learning engagement from the perspective of separate or combined investigation, and all have confirmed that these dimensions contribute to students' learning progress. Given that research related to serious gamification suggests that learning engagement in its context may include these three dimensions, this study also divides learning engagement into behavioral, emotional, and cognitive dimensions for analysis.

THEORETICAL GROUNDING AND HYPOTHESIS DEVELOPMENT

The mechanism of serious gamification can be accounted for by Goal-Setting Theory and Stimulus-Organism-Response (SOR) Theory. First, according to Goal-Setting Theory put forward by Locke and Latham, the theory holds that specific and challenging goals can significantly improve performance compared with vague or simple ones (Locke & Latham, 2002), and "specific and challenging goals" serve as its core premise. Therefore, in serious gamification scenarios where high challenges match high skill levels, learners can define their goals more clearly due to goal commitment, strive toward achievable objectives, and ultimately achieve knowledge internalization and the development of higher-order thinking abilities.

Originating from environmental psychology, SOR Theory, inspired by the Stimulus-Response (S-R) model, was expanded into the S-O-R model after integrating organismic responses such as individuals' internal states and psychological processes (Mehrabian & Russell, 1974). It is used to describe the interaction between the environment and human behavior, and to study individuals' behavioral responses to environmental stimuli (Jacoby, 2002). Although it is mainly and widely applied in consumer psychology and information behavior research, it has also been adopted in the gaming field (Triantoro *et al.*, 2019). Examples include comparing gamified questionnaires with traditional ones and analyzing the impact of serious gamification on consumer behavior. This study extends it to learning-oriented serious gamification, not only because it can effectively explain the mechanism of serious gamification, but also because it has been applied in gamification research scenarios outside the field of teaching. According to this theory, "Stimulus" (S) refers to external factors that affect an individual's internal state; "Organism" (O) is the internal psychological process between stimulus and response (playing a mediating role); and "Response" (R) is the outcome caused by the stimulus. Specifically, in learning scenarios, serious gamification (as the stimulus) affects learners' internal states (as the organism) through motivation and flow experience, and ultimately generates learning engagement (as the response).

Serious Gamification and Learning Engagement

In learning contexts, instructional design is key to enhancing learning engagement (Noe *et al.*, 2010), and improved user engagement is a main outcome of serious gamification (Gómez & Suárez, 2021). Serious gamification boosts learners' interest and participation by altering classroom behaviors.

Meanwhile, studies have pointed out that serious gamification can enhance learning outcomes through three pathways: cognitive, emotional, and behavioral (Landers *et al.*, 2018; Mullins & Sabherwal, 2020): Landers *et al.* (2018) proposed that changes in individuals' psychology and behavior serve as mediating variables between serious gamification and target outcomes (e.g., academic performance), while Mullins & Sabherwal (2020) emphasized the role of the cognitive-emotional pathway and noted that "the emotional pathway is unexpectedly an uncharted territory in serious gamification". Based on this, it can be inferred that these three pathways exist in serious gamification, and a fully-developed game environment will enhance engagement through them. Ultimately, this study predicts that learners participating in serious gamified courses will have higher levels of learning engagement in the dimensions of (a) behavior, (b) cognition, and (c) emotion. Given this, we propose the hypothesis that teaching through serious gamification can improve learners' learning engagement, and put forward three sub-hypotheses from the perspective of the three pathways, which are as follows:

H1. Serious gamification leads to a higher level of behavioral engagement such that learners' behavioral engagement will be significantly higher in the serious gamification session than in the non-gamified sessions.

H2. Serious gamification leads to a higher level of emotional engagement such that learners' emotional engagement will be significantly higher in the serious gamification session than in the non-gamified sessions.

H3. Serious gamification leads to a higher level of cognitive engagement such that learners' cognitive engagement will be significantly higher in the serious gamification session than in the non-gamified sessions.

Serious Gamification and Flow Experience

As previously mentioned, one of the explicit goals of serious gamification is to create a unique "game-like" experience. Csikszentmihalyi (1990) pointed out that games provide people with opportunities for experiences beyond the ordinary and offer a way to enter the state of flow; thus, serious gamification can be regarded as a means to foster flow experiences (Thomas & Baral, 2023).

This view is supported by existing research: flow experiences exist in gamified applications such as business simulations and game-based learning (Warmelink *et al.*, 2020). Moreover, studies from the perspective of the SOR theory—both predictive and empirical—have shown that serious gamification can induce flow experiences in participants (Huang *et al.*, 2019; Sailer & Sailer, 2021). Research indicates that in serious gamification scenarios, participants encounter "challenging yet achievable goals" and a "sense of control over the process"; these mechanisms induce flow by balancing challenge and skill levels, which in turn influences learning engagement. Therefore, we propose the following hypotheses:

H4a. Serious gamification enhances learners' absorption experience.

H4b. Serious gamification enhances learners' smooth and automatic running experience.

Flow Experience and Learning Engagement

Csikszentmihalyi pointed out that learning is not only a process of cognitive engagement but also one of emotional engagement. When learning meets the conditions for generating absorption experience, it will trigger changes at the behavioral level (Csikszentmihalyi, 2014). Empirical studies have confirmed that absorption experience exerts a positive impact on learning, and there is a positive correlation between knowledge acquisition during the learning process and learning engagement, indicating that absorption experience may promote learning engagement (Shernoff *et al.*, 2003; Skadberg & Kimmel, 2004; Ro *et al.*, 2018).

Previous studies have shown that smooth and automatic running experience is a positive factor for enhancing learning engagement. First, when participants enter a state of smooth operation, they can maximize the use of cognitive abilities at a high functional level, directly improving learning engagement; second, this state motivates individuals to enhance their abilities (Engeser & Rheinberg, 2008), prompting learners to continuously engage in online learning activities with high cognitive demands. Based on this, we hypothesize that smooth and automatic running experience will positively enhance learning engagement through the dual mechanisms of optimizing operational efficiency and stimulating growth-oriented motivation.

Based on the above discussion, it can be inferred that a fully-developed game context, as a stimulus (S), triggers the internal process (O) of flow experience—which includes two independent dimensions: absorption experience and smooth and automatic running experience—and further fosters higher levels of learning engagement (R) through three pathways: behavioral, cognitive, and emotional. Drawing on the theoretical basis of the dual-dimensional structure of flow (Rheinberg *et al.*, 2003; Weibel & Wissmath, 2011), this study argues that these two dimensions play differential mediating roles in the three pathways of (a) behavior, (b) cognition, and (c) emotion. Accordingly, we propose the following hypotheses:

H5a. Learners' smooth and automatic running experience mediates the relationship between serious gamification and behavioral engagement.

H5b. Learners' absorption experience mediates the relationship between serious gamification and behavioral engagement.

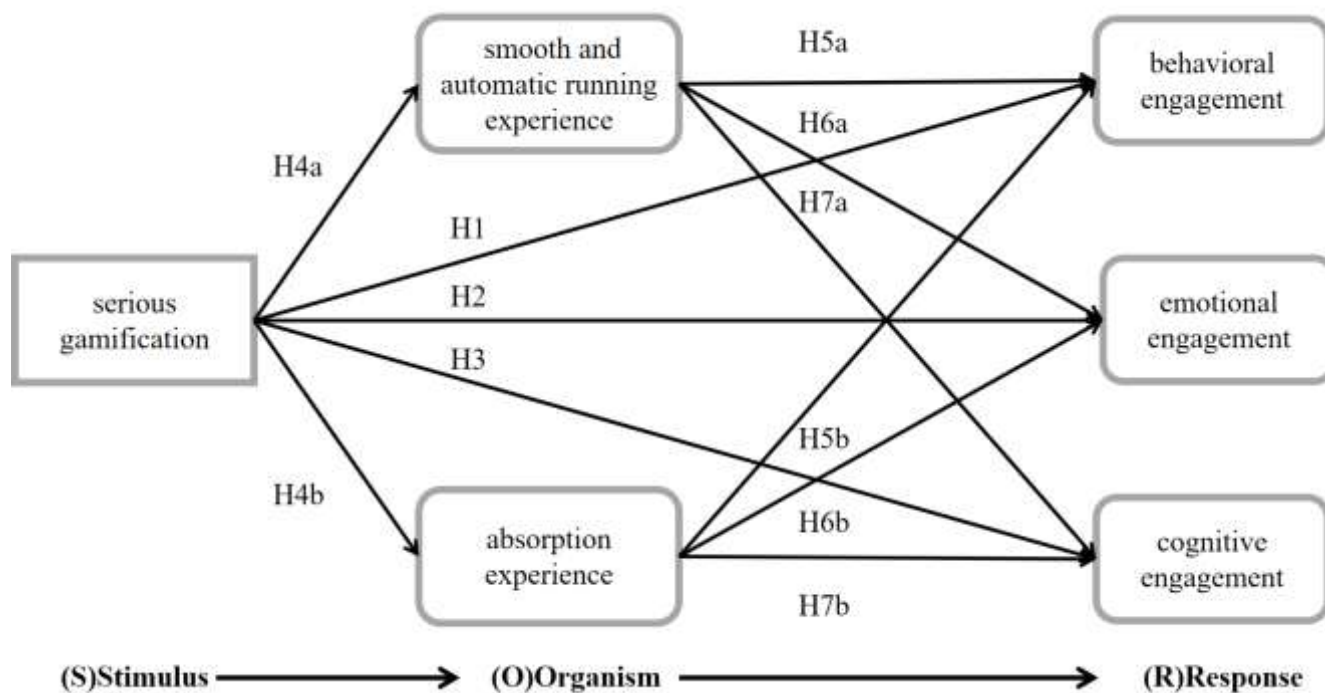
H6a. Learners' smooth and automatic running experience mediates the relationship between serious gamification and emotional engagement.

H6b. Learners' absorption experience mediates the relationship between serious gamification and emotional engagement.

H7a. Learners' smooth and automatic running experience mediates the relationship between serious gamification and cognitive engagement.

H7b. Learners' absorption experience mediates the relationship between serious gamification and cognitive engagement.

Based on the above discussion, the research model of this paper is shown in Figure 1.



Source: This study.

Figure 1: Research Model on the Educational Effectiveness and Mechanisms of serious gamification in Higher Education.

METHOD

This study will target third-year undergraduate students with no work experience. They major in Information Management and Information Systems, which is a national first-class undergraduate program, at a leading university in China. These students have strong learning willingness and are familiar with how to fill out questionnaires, which helps ensure the reliability of data collection. A field experiment will be conducted through the course "Enterprise Resource Planning". For the experimental group, students will use a syrup distribution game on an ERP platform for learning: each team will consist of 5–6 students, and they will make decisions such as demand forecasting during a period of 60 virtual days. During this process, the platform will provide real-time feedback on their operational performance. In contrast, the control group will receive traditional classroom lectures instead of using the game.

Questionnaires will be collected twice to gather data related to flow experience and learning engagement: the first collection will be for the experimental group, with questionnaires distributed immediately after they complete the game; the second collection will be for the control group, with questionnaires distributed after they finish the course lectures. To measure flow experience, the study will adopt the adapted 7-point Likert Flow Short Scale (FKS), which was developed by Rheinberg *et al.* (2003). This scale contains 10 items and covers two dimensions. For learning engagement assessment, the adapted 5-point Likert scale with 12 items from Reeve (2013) will be used, and this scale includes three dimensions. As suggested by Ekici (2021), knowledge tests and report submissions will be required to maintain students' learning motivation throughout the study. Finally, Partial Least Squares-Structural Equation Modeling (PLS-SEM) will be applied to test the study's theoretical model.

CONCLUSION AND CONTRIBUTION

This study, grounded in Goal-Setting Theory (GST) and Stimulus-Organism-Response (SOR) theory, will explore how serious gamification (using ERPsim games) influences learning engagement via the dual dimensions of flow experience. The expected conclusions are as follows: ERPsim's immersive design, which includes virtual enterprise operations, real-time market feedback, and competitive mechanisms, will significantly enhance both flow dimensions: smooth and automatic running experience and absorption experience. Through these two flow dimensions, serious gamification is expected to elevate all three learning engagement dimensions: behavioral engagement, emotional engagement, and cognitive engagement. We hypothesize that serious gamification can enhance learners' cognitive engagement. This differs from Dicheva *et al.*'s observation that ordinary games often boost positive emotions but rarely improve academic performance (Dicheva *et al.*, 2015; Thomas & Baral, 2023). Specifically, ERPsim requires students to analyze simulated market conditions, evaluate system feedback data, and make decisions to maximize enterprise profits within a limited timeframe. Such activities correspond to the high-order cognitive levels of "evaluating" and "creating" in the revised Bloom's taxonomy (Krathwohl, 2002). These cognitive tasks can effectively stimulate cognitive investment, further enhance higher-order thinking, support the achievement of advanced learning objectives in higher education, and thereby improve cognitive engagement.

The study's contributions will integrate theoretical and practical value. Theoretically, it enriches understanding of flow in gamification by testing Rheinberg *et al.*'s dual-dimensional framework (rather than treating flow as a unitary construct) and fills gaps in exploring intermediate psychological processes between serious gamification and engagement, via the "serious gamification → flow → tripartite engagement" model. It also expands serious gamification research beyond simple mechanics (e.g., points) to advanced platforms like ERPsim, addressing overlooked cognitive engagement impacts. Practically, it offers actionable guidelines: designers should strengthen immersive elements to boost absorption experience and align game difficulty with learner competencies (via pre-game scaffolding) to improve smooth thinking; educators can use ERPsim to supplement professional courses (e.g., business management), linking theory to practical decision-making and enhancing teaching effectiveness.

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