Modeling the Interrelationships Among Environmental and Cognitive Factors in MOOCs: Toward an Innovative Relational Learning Frameworkin Postgraduate Education

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ABSTRACT:

This study aims to model the interrelationships among environmental and cognitive factors in Massive Open Online Courses (MOOCs) and to propose an innovative relational learning framework for postgraduate education. While prior research has predominantly focused on isolated predictors of learning outcomes, this study reconceptualizes learning as a dynamic and interconnected process shaped by multiple interacting mechanisms. Grounded in the Expectation–Confirmation Model (ECM) and Social Cognitive Theory (SCT), the proposed framework integrates key constructs, including learning environment support, perceived usefulness, satisfaction, intrinsic motivation, and self-regulated learning, to explain how learning engagement emerges within a relational system.

A quantitative research design was employed, with data collected from 432 postgraduate students enrolled in MOOCs-integrated courses. Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to examine both direct and indirect relationships among variables. The findings indicate that learning environment support plays a foundational role in shaping cognitive evaluations, particularly through perceived usefulness as a critical mediating mechanism. Intrinsic motivation significantly influences self-regulated learning, which in turn enhances learning engagement alongside satisfaction.

Importantly, the results support the proposed relational learning framework, demonstrating that learning outcomes emerge from structured interrelationships among environmental, cognitive, and motivational factors rather than from isolated variables. In alignment with Sustainable Development Goal 9 (SDG 9), which emphasizes innovation and the development of resilient systems, this study contributes to advancing theoretical innovation in digital learning by introducing a mechanism-based relational perspective. The findings also provide practical implications for

designing more adaptive and sustainable online learning environments in postgraduate education
Keywords: MOOCs, relational learning framework, interrelationships, learning engagement, PLS-SEM, self-regulated learning, postgraduate education

1. Introduction

The rapid expansion of Massive Open Online Courses (MOOCs) has significantly transformed higher education by enabling flexible, scalable, and widely accessible learning opportunities. Despite their strong structural potential, a persistent challenge remains: unsustained learning engagement, particularly among postgraduate students who face higher cognitive load and greater demands for self-regulation (Zheng & Wardzala, 2020; Hashmi et al., 2025).

Previous research has attempted to explain this issue through a factor-centric approach, focusing on key variables such as perceived usefulness, satisfaction, and motivation (Bhattacherjee, 2001; Alraimi et al., 2015). While this approach effectively identifies influential factors, it has important conceptual limitations. Specifically, it treats variables as independent and assumes linear and additive relationships, which fail to fully capture the complexity of learning processes in digital environments.

Learning in MOOCs does not arise from isolated variables but rather from relational processes that are sequentially interconnected. For example, a high-quality learning environment may influence learners' perceptions of system usefulness, which in turn affects satisfaction and ultimately leads to learning engagement. Similarly, intrinsic motivation may encourage learners to develop self-regulated learning strategies, which are critical for sustained engagement (Joo et al., 2018). These relationships suggest that outcomes are not driven by single variables but emerge from a multidimensional structure of interrelated factors.

This limitation highlights a critical research gap: most MOOC studies lack mechanism-level explanations of how various factors interact to produce learning outcomes, particularly in the context of postgraduate learners, whose cognitive and behavioral processes are more complex than those of general learners (Zimmerman, 2002).

To address this gap, the present study proposes a shift from a variable-centric explanation to a relationship-centric perspective by integrating two theoretical frameworks:
(1) the Expectation–Confirmation Model (ECM), which explains the roles of perceptions and satisfaction in system usage (Bhattacherjee, 2001), and
(2) Social Cognitive Theory (SCT), which emphasizes the interaction among environmental, cognitive, and behavioral factors (Bandura, 1986).

This integration enables the development of a structural model that systematically explains the mechanisms underlying learning processes.

Accordingly, the objective of this study is to develop and test an interrelationship model between environmental and cognitive factors in the MOOC context, with a particular focus on explaining how these factors interact to generate learning engagement. This study also contributes to Sustainable Development Goal 9 (SDG 9), which emphasizes innovation and the development of resilient infrastructures to support sustainable progress. In the context of digital learning, understanding the complex interrelationships among environmental, cognitive, and behavioral factors represents a critical step toward advancing innovative educational systems. Rather than relying on traditional linear models, this study adopts a relational modeling approach to uncover the underlying mechanisms that drive learning engagement in MOOCs. Such an approach reflects the growing need for analytically robust and system-oriented frameworks that can support the design of more adaptive and effective digital learning environments (Joo et al., 2018; Misangyi et al., 2017; Woodside, 2013). This study aims to fill the gap in mechanism-level explanations in MOOC research, extend ECM

and SCT into digital learning contexts, and provide a structural explanation of learning engagement among postgraduate learners.

2. Literature Review and Theoretical Framework

2.1 From Factor-Centric Models to Relationship-Centric Models

Traditional models in information systems research, such as the Expectation–Confirmation Model (ECM), have been widely used to explain continuance intention by focusing on key predictors such as perceived usefulness and satisfaction (Bhattacherjee, 2001). Although these models are effective in predicting outcomes, they often oversimplify the complexity of learning processes by reducing them to linear cause-and-effect relationships.

Recent research has called for a shift toward relational perspectives, which emphasize the interactions among variables (Joo et al., 2018). This perspective is particularly important in digital learning environments, where multiple factors operate simultaneously and dynamically influence one another.

2.2 Expectation–Confirmation Model (ECM)

The ECM is based on the assumption that perceived usefulness and satisfaction are primary determinants of post-adoption behavior (Bhattacherjee, 2001). In the context of MOOCs, perceived usefulness reflects learners' evaluations of the platform's effectiveness, while satisfaction represents their affective responses to the learning experience. In the context of MOOCs, perceived usefulness reflects learners' evaluations of the platform's effectiveness, while satisfaction represents their affective responses to the learning experience (Bhattacherjee, 2001; Yap et al., 2023). Previous studies have demonstrated that learning-related outcomes are shaped through sequential relationships among perceived value, satisfaction, and behavioral intention, highlighting the importance of mechanism-based modeling approaches (Wang & Prompanyo, 2020).

However, ECM does not fully explain how these variables interact with other factors, such as motivation and self-regulated learning. This limitation highlights the need to extend the model to incorporate a broader range of variables and relationships.

2.3 Social Cognitive Theory (SCT)

Social Cognitive Theory provides a complementary framework by emphasizing the reciprocal interactions among environmental, cognitive, and behavioral factors (Bandura, 1986). In the MOOC context, environmental support (e.g., system quality and resource availability) influences cognitive evaluations, which subsequently affect learning behaviors. Digital literacy plays a critical role in shaping learners' cognitive processing and self-regulated learning behaviors, which function as essential mechanisms in online learning environments (Pengfei, 2026).

Therefore, this study integrates ECM and SCT to develop a relationship-centric model that more clearly captures these interactions.

3. Research Model and Hypotheses

Under Objective 2 of this study, which aims to examine the structural relationships among environmental factors, cognition, motivation, and learning behavior, a research model is developed in the form of a relational structure to explain the mechanisms underlying learning engagement in the context of postgraduate MOOCs.

Unlike approaches that treat variables as independent factors, this model is based on the assumption that learning outcomes emerge from a mechanism chain a sequence of interconnected influences among multidimensional variables.

3.1 Conceptual Model Structure

The research model is designed to reflect a systematic learning process

and is structured into three main levels of relationships:

(1) Environment → Cognition Learning Environment Support (LES) serves as the initial

determinant shaping learners' perceptions of the system, particularly Perceived Usefulness (PU)

and Satisfaction (SAT). This relationship aligns with the Expectation Confirmation Model (Bhattacherjee, 2001).

(2) Cognition → Affect
Perceived Usefulness (PU) functions as a key mechanism that

leads to Satisfaction (SAT), reflecting the transition from cognitive evaluation to affective response.

(3) Motivation → Behavior
Intrinsic Motivation (IM) plays a crucial role in stimulating

Self-Regulated Learning (SRL), which is a key mechanism for learning in online environments where learners must rely heavily on self-direction (Zimmerman, 2002).

3.2 Hypotheses Development

To empirically test the structural relationships proposed in the model,

the following causal hypotheses are formulated:

Group 1: Effects of Environment on Cognition
H1: Learning Environment Support (LES) has a positive effect

on Perceived Usefulness (PU).
H2: Learning Environment Support (LES) has a positive effect on Satisfaction (SAT).
These hypotheses are based on the premise that system quality is a key determinant of learners' perceptions (Alraimi et al., 2015).

Group 2: Cognitive-to-Affective Mechanism
H3: Perceived Usefulness (PU) has a positive effect on

Satisfaction (SAT).
This reflects the role of PU as a mediating mechanism within the ECM framework.

Group 3: Effects of Motivation on Learning Behavior
H4: Intrinsic Motivation (IM) has a positive effect on Self-

Regulated Learning (SRL).
This hypothesis is grounded in Self-Determination Theory, which posits that intrinsic motivation is a fundamental driver of autonomous learning (Ryan & Deci, 2000).

3.3 Methodological Implications for Objective 2

The specification of this model and its hypotheses plays a critical role in directly addressing Objective 2. It enables a systematic examination of causal relationships among variables, allowing for the identification of path relationships that lead to learning engagement.

Moreover, the model facilitates the analysis of mediation effects, particularly the roles of PU and SRL as intermediary mechanisms.

Therefore, this model is not merely a conceptual framework but also an analytical tool for explaining how environmental and psychological factors interact to produce learning outcomes in MOOCs. It highlights that learning does not result from isolated variables but rather from structured pathways of relationships, which can be empirically tested using PLS-SEM to provide deeper mechanism-level explanations.

4. Research Methodology

4.1 Research Design

This study adopts a quantitative approach by applying Partial Least Squares Structural Equation Modeling (PLS-SEM), which is appropriate for analyzing complex models with multidimensional relationships among variables (Hair et al., 2021).

4.2 Sample

The sample consists of 432 postgraduate students enrolled in courses

that integrate MOOCs into the instructional system. These learners operate in a context that requires a high degree of learning autonomy and advanced cognitive processing.

4.3 Research Instrument

All variables were measured using a structured questionnaire

developed from previously validated and reliable scales. A five-point Likert scale was employed for all measurement items.

4.4 Data Analysis

The reliability and validity of the measurement instruments were

assessed according to established criteria (Hair et al., 2021). Structural relationships among variables were analyzed using path analysis within the PLS-SEM framework.

5. Results

The structural model analysis indicates that the model demonstrates a high level of explanatory power for learning engagement in MOOCs ($R^2 \approx 0.60–0.70$). All hypotheses were statistically significant ($p < .05$), reflecting the robustness of the proposed relational framework.

5.1 Direct Effects

The results show that Learning Environment Support (LES) has a significant positive effect on Perceived Usefulness (PU) (high coefficient) and Satisfaction (SAT) (moderate to high coefficient), indicating that the learning environment serves as an upstream determinant of learners' cognitive and affective responses.

Additionally, Intrinsic Motivation (IM) has a strong positive effect on

Self-Regulated Learning (SRL). Both Satisfaction (SAT) and Self-Regulated Learning (SRL) significantly influence Learning Engagement (LE) through two distinct pathways:

- Affective pathway: SAT → LE
- Behavioral pathway: SRL → LE

5.2 Indirect Effects and Mediating Roles

Pathway 1: Environment–Cognition–Affect Mechanism (LES →

PU → SAT → LE) Perceived Usefulness (PU) functions as a mediating mechanism that transforms environmental quality into satisfaction, which subsequently leads to learning engagement. This suggests that environmental factors alone are insufficient; they must be interpreted and cognitively processed by learners.

Pathway 2: Motivation–Behavior Mechanism (IM → SRL → LE)

Intrinsic motivation enhances learners' ability to plan, monitor, and regulate their learning, which in turn leads to sustained engagement.

5.3 Integrated Mechanism

When both pathways are considered together, the model reveals a

dual-mechanism structure, as summarized below:

Table 1. Integrated Mechanisms of Learning Engagement

Type of Mechanism	Pathway	Function
Environmental Mechanism	LES → PU → SAT → LE	External → Cognition → Affect
Individual Mechanism	IM → SRL → LE	Internal → Behavior

Interpretation: The findings indicate that learning engagement emerges from the convergence of external structures and internal driving forces, rather than from any single factor alone.

6. Discussion

6.1 From Determinants to Mechanisms

Prior research (e.g., Bhattacherjee, 2001; Alraimi et al., 2015) has primarily focused on identifying key determinants such as perceived usefulness and satisfaction, yet has provided limited process-level explanations. This study demonstrates that learning engagement does not arise from isolated variables but from a **causal chain of interactions** among multiple factors.

6.2 The Role of Perceived Usefulness as a Key Mediator

Unlike the traditional ECM, this study positions Perceived Usefulness

(PU) as a transmission node. That is, PU is not merely a predictor but a mechanism that transforms system quality into satisfaction. This finding is consistent with Joo et al. (2018), while extending their work by revealing a multi-layered structural process. Technological environments influence learning outcomes through both direct and indirect pathways, particularly by shaping learners' cognitive evaluations and engagement processes (Feng & Feng, 2026).

6.3 Dual Pathways of Learning Engagement

Two distinct pathways of learning engagement are identified:

1. Affective Pathway (SAT → LE): Driven by positive learning experiences

2. Behavioral Pathway (SRL → LE): Driven by self-regulation capabilities

This dual-pathway structure aligns with Social Cognitive Theory (Bandura, 1986).

6.4 Complementarity between System and Learner

The findings clearly indicate that:

- A high-quality system without motivation → low engagement
- High motivation without a supportive system → reduced effectiveness

Therefore, learning engagement emerges from the alignment between system capabilities and learner capacities.

7. Theoretical Contributions

This study makes several systematic contributions to the theoretical understanding of learning in MOOCs, summarized in three key aspects:

First, it proposes a relational perspective that moves beyond the traditional factor-centric approach that has dominated prior MOOC research (Bhattacherjee, 2001; Alraimi et al., 2015). The findings demonstrate that learning engagement is not the result of any single factor but emerges from structured interrelationships among variables, forming a sequential mechanism from environment → cognition → affect → behavior.

Second, this study extends the Expectation–Confirmation Model (ECM) by conceptualizing Perceived Usefulness (PU) as a transmission mechanism between the learning environment and satisfaction, rather than merely a direct predictor. This perspective provides a deeper explanation of the internal processes underlying learning engagement and dynamically links ECM to digital learning experiences.

Third, this study integrates Social Cognitive Theory (SCT) (Bandura, 1986) into the structural model, demonstrating the existence of dual mechanisms:
(1) an environmental–affective mechanism, and
(2) a motivational–behavioral mechanism.

These findings confirm that learning in MOOCs results from the interaction between external structures and internal learner capabilities, consistent with the concept of reciprocal determinism, and address a key gap in prior research that has often examined these factors in isolation.

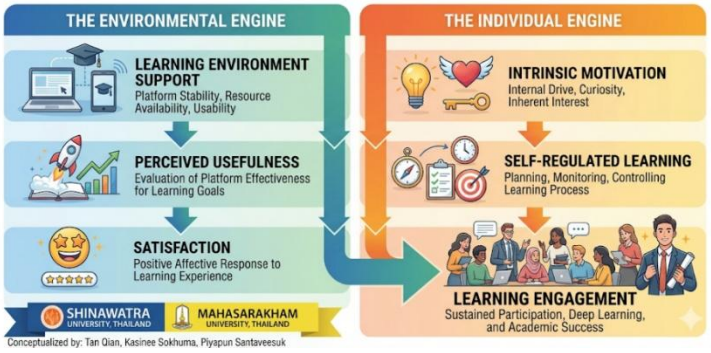

Figure 1: The Dual-Engine Model of Integrated MOOC Learning Ecosystem

In summary, this study makes a significant theoretical contribution by shifting from a variable-based explanation to a mechanism-based explanation, integrating the Expectation–Confirmation Model (ECM) and Social Cognitive Theory (SCT) within a relational modeling framework, and offering a process-oriented explanation of how learning engagement emerges in the MOOC context.

8. Practical Implications

The findings of this study provide important practical implications for the design and development of MOOCs in higher education. These implications can be categorized into three main dimensions:

8.1 Environment Design

Universities should prioritize the development of Learning

Environment Support (LES) as a systemic construct, rather than focusing solely on technological platform improvements. The design should enhance learners' perceptions by emphasizing:

- System usability
- Integrated learning resources
- Reduced complexity in accessing content

The results indicate that LES not only directly influences engagement

but also operates through Perceived Usefulness and Satisfaction, which serve as key learning mechanisms.

8.2 Learner Capacity Development

Educational institutions should design learning activities that

strengthen internal learner mechanisms, particularly:

- Intrinsic Motivation (IM): through approaches such as problem-based learning and authentic tasks
- Self-Regulated Learning (SRL): through training in goal setting, self-monitoring, and reflection

SRL is a critical variable that translates motivation into actual learning

behavior. Without development in this dimension, learners may not fully utilize the potential of the system.

8.3 Integrated Learning Design

The findings suggest that learning engagement arises from the

interaction of multiple mechanisms. Therefore, MOOC design should avoid fragmented approaches and instead adopt an integrated perspective, such as:

- Designing user experiences (UX) that connect content, assessment, and feedback
- Utilizing learning analytics to monitor both behavioral and affective dimensions
- Developing support systems that integrate both cognitive support and motivational support

8.4 Policy-Level Implications

At the policy level, universities should:

- Promote MOOC development as an ecosystem, rather than as a standalone tool
- Support the development of students' self-directed learning skills
- Invest in systems that enable continuous and sustained learning experiences

In conclusion, the findings indicate that enhancing learning engagement in MOOCs cannot be achieved by improving any single factor in isolation. Instead, it requires the holistic design of an interconnected system of factors, where environmental and psychological elements work together synergistically.

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