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Blended learning factors influencing student engagement in higher education

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ABSTRACT

This study examines the factors associated with student engagement (SE) in blended learning environments in higher education, with particular attention to the mediating role of perceived usefulness (PU). Drawing on the information systems success model and the technology acceptance model (TAM), an integrated research model incorporating system quality (SQ), content quality (CQ), teacher support (TS), interaction (IN), PU, and SE was proposed and empirically tested. Data were collected from 288 undergraduate students at universities in Vietnam and analyzed using partial least squares structural equation modeling (PLS-SEM). The results indicate that SQ, CQ, TS, and IN are significantly associated with PU. PU, in turn, shows a strong positive association with SE. While SQ and TS are also directly related to engagement, the relationships between CQ, IN, and SE are primarily indirect through PU, highlighting its central mediating role. These findings contribute to a more nuanced understanding of how blended learning factors jointly explain SE and offer theoretical and practical insights for the design and implementation of blended learning in higher education.

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1. INTRODUCTION

The rapid integration of digital technologies into higher education has fundamentally transformed teaching and learning practices, particularly through the widespread adoption of blended learning models. Blended learning, which combines face-to-face instruction with online learning activities, has been widely promoted for its potential to enhance flexibility, accessibility, and learning effectiveness. Meta-analytic evidence suggests that blended learning can lead to learning outcomes that are comparable to, or even superior to, those of traditional instructional approaches [1]. Consequently, universities worldwide increasingly rely on learning management systems (LMS) to support blended learning implementation.

Despite the growing prevalence of blended learning, its effectiveness cannot be assumed solely based on technological availability. Prior research indicates that the success of e-learning and blended learning systems depends on multiple interrelated factors, including system quality (SQ), content quality (CQ), and instructional support [2]–[4]. While these factors are often evaluated in terms of system success or user satisfaction, less is known about how they jointly contribute to students' active involvement in learning processes, commonly conceptualized as student engagement (SE).

SE has emerged as a central construct in higher education research due to its strong association with learning outcomes, persistence, and academic success. Engagement is generally understood as a multidimensional construct encompassing students' behavioral, emotional, and cognitive involvement in

learning activities [5]. In the context of higher education, engagement reflects students' active participation, sustained effort, and psychological investment in their learning experiences [6], [7]. Recent studies further emphasize that engagement is not merely an individual attribute but is shaped by learning environments, instructional practices, and technological affordances [8], [9].

Within blended learning environments, instructor-related factors and interaction (IN) processes play a particularly important role in shaping students' learning experiences. Teacher support (TS), including guidance, feedback, and encouragement, has consistently been linked to higher levels of SE across various educational contexts [10], [11]. Similarly, meaningful IN among students and between students and instructors has been shown to enhance understanding, motivation, and engagement, especially in technology-mediated learning settings [12], [13]. These findings are closely aligned with the community of inquiry (CoI) framework, which emphasizes teaching presence and IN as key determinants of meaningful learning in online and blended environments [14], [15].

In addition to environmental and instructional factors, students' perceptions of technology play a critical mediating role in determining learning-related outcomes. According to the technology acceptance model (TAM), perceived usefulness (PU) represents the extent to which individuals believe that using a particular system enhances their performance [16]. Empirical evidence consistently demonstrates that PU influences learners' attitudes, continued use of learning technologies, and learning-related behaviors in online and blended contexts [17], [18]. Recent studies further suggest that PU may serve as an important psychological mechanism through which instructional quality and support translate into higher levels of SE. However, its role as an integrated mediating mechanism linking multiple blended learning factors to SE has not yet been sufficiently theorized and empirically examined [10].

Although prior studies have examined relationships among blended learning factors and SE, existing research often focuses on direct effects or alternative learning outcomes. Recent studies in higher education have investigated SE and related constructs in online and blended learning contexts, such as motivation, self-directed learning readiness, and teaching styles [19]–[21]. However, these studies tend to examine isolated predictors or different outcome variables, and provide limited insight into the underlying mechanisms through which multiple blended learning factors jointly shape SE. In particular, the role of PU as an integrated mediating mechanism linking SQ, CQ, TS, and IN to SE remains insufficiently examined, especially in higher education settings within developing countries.

To address this gap, this study investigates how SQ, CQ, TS, and IN are associated with SE, with PU serving as a central mediating variable. Using partial least squares structural equation modeling (PLS-SEM) and survey data from undergraduate students in blended learning contexts, this study extends prior research by proposing and testing an integrated mediation framework that differentiates between direct, indirect, and partially mediated relationships. By clarifying the distinct mediating patterns of PU, the study contributes to a more nuanced understanding of how blended learning environments explain SE in higher education.

2. THEORETICAL BACKGROUND AND HYPOTHESES

2.1. Student engagement in higher education

SE is widely recognized as a key determinant of learning quality and academic success in higher education. It refers to students' active involvement, effort, and interest in learning activities. SE is commonly viewed as a multidimensional construct encompassing behavioral, emotional, and cognitive components, emphasizing both active participation and psychological investment [5].

In higher education, engagement extends beyond classroom participation to include IN with learning resources, instructors, and peers across physical and digital environments and is shaped by learning contexts rather than being solely an individual attribute [6], [7]. Engagement is also closely associated with motivational and self-regulatory factors, such as academic motivation and self-efficacy, which influence students' persistence and effort in learning [22]–[25]. With the increasing use of LMS, SE has become closely linked to students' experiences in technology-enhanced and blended learning environments and is increasingly viewed as a holistic indicator of educational quality and success in higher education [8], [9].

Although SE is widely conceptualized as a multidimensional construct encompassing behavioral, emotional, and cognitive components, prior research in higher education has also operationalized engagement as a unidimensional reflective construct when the focus is on students' overall involvement and learning investment rather than on distinct sub-dimensions [6]–[8]. In technology-enhanced and blended learning contexts, these dimensions are often highly interrelated and jointly reflect students' general engagement with learning activities. Accordingly, this study conceptualizes SE as a single higher-order construct capturing students' overall engagement experience in blended learning environments.

2.2. Blended learning and student engagement

Blended learning, which combines face-to-face instruction with online and technology-mediated activities, has become widely adopted in higher education and has been associated with enhanced learning outcomes by integrating classroom IN with digital flexibility [1]. However, its effectiveness depends not only on instructional design but also on how students experience and engage with the blended learning environment. In this context, SE has emerged as a central concern in blended learning research.

SE in blended learning is influenced by multiple interrelated factors, including SQ, learning content, instructional support, and IN. Prior research emphasizes that engagement emerges from the dynamic IN among students, instructors, and digital learning environments rather than from technology alone, and that learning platforms contribute to engagement only when they are meaningfully integrated into instructional practices [8], [26]. Accordingly, this study adopts an integrated framework to examine how SQ, CQ, TS, and IN are associated with SE. PU is conceptualized as a key mediating mechanism linking blended learning factors to engagement outcomes. This framework enables a more comprehensive understanding of how blended learning environments shape students' engagement experiences.

2.3. System quality and content quality

2.3.1. System quality

SQ refers to the extent to which a LMS is reliable, easy to use, accessible, and technically functional. Within the information systems success model, SQ is regarded as a key factor shaping users' perceptions and experiences when interacting with information systems [3]. In educational settings, high SQ facilitates efficient access to learning materials and smooth navigation of learning platforms, which are important conditions for students' sustained participation in online and blended learning activities.

Empirical evidence suggests that SQ is positively associated with students' PU of learning systems and their overall learning experiences. When learning systems function effectively and support academic tasks, students are more likely to perceive them as beneficial for their learning performance [2], [4], [17]. In addition, reliable and user-friendly systems may reduce technical barriers and support continued participation in blended learning activities, which is closely related to higher levels of SE. Accordingly, SQ is expected to be positively associated with PU and SE.

- H1: SQ positively influences PU.
- H2: SQ positively influences SE.

2.3.2. Content quality

CQ refers to the extent to which learning materials are accurate, relevant, well structured, and aligned with learning objectives. In blended learning contexts, CQ plays an important role in supporting learning, as students rely heavily on digital materials outside the classroom. Within the information systems success model, CQ is considered a key factor shaping users' evaluations of system value and effectiveness [3].

Empirical studies suggest that high-quality learning content is positively associated with students' PU of learning systems, particularly when materials are clear, up to date, and aligned with learning goals [2], [4]. Well-designed content has also been linked to positive learning experiences and sustained engagement, as students are more likely to invest effort and remain involved in learning activities when learning materials are perceived as relevant and meaningful [17]. Accordingly, CQ is expected to be positively associated with PU and SE in blended learning environments.

- H3: CQ positively influences PU.
- H4: CQ positively influences SE.

2.4. Teacher support and interaction

2.4.1. Teacher support

TS refers to the extent to which instructors provide guidance, feedback, encouragement, and academic assistance throughout the learning process. In blended learning environments, TS plays an important role in connecting face-to-face and online components and supporting students' navigation of learning activities. It has also been consistently associated with higher levels of SE and positive learning outcomes [11].

Beyond direct instructional roles, TS also shapes students' perceptions of learning technologies by influencing how digital tools are integrated into teaching practices. Empirical studies suggest that TS is positively associated with SE through technology-related perceptions and motivational factors and contributes to students' confidence and positive evaluations of learning systems in online and blended contexts [10], [27]. Recent researches [14], [15], [28]–[30] further highlights the continued importance of TS in information and communications technology (ICT)-supported and AI-assisted learning environments, aligning with the CoI framework, which emphasizes teaching presence as a core element of meaningful

learning experiences. Accordingly, TS is expected to be positively associated with PU and SE in blended learning environments.

- H5: TS positively influences PU.
- H6: TS positively influences SE.

2.4.2. Interaction

IN refers to the extent and quality of exchanges among students, instructors, and learning materials within a learning environment and occurs through both face-to-face and online communication in blended learning contexts. It is widely recognized as a core element supporting learning processes in technology-enhanced education and is closely related to students' learning experiences. In blended learning settings, IN plays a particularly important role in connecting pedagogical practices with digital learning environments.

Prior research suggests that meaningful IN is associated with students' cognitive involvement, motivation, and engagement by facilitating knowledge construction and social connection. Supportive and structured IN may also satisfy students' needs for relatedness and competence, which are important conditions for sustained engagement [12]–[15]. Recent reviews further indicate that IN supported by digital technologies is most effective when it promotes collaboration and purposeful learning activities in higher education [31]. In blended learning environments, IN may also shape students' perceptions of learning technologies by supporting communication and collaboration. Through these processes, IN is expected to be positively associated with PU and, indirectly, with SE.

- H7: IN positively influences PU.
- H8: IN positively influences SE.

2.5. Perceived usefulness as a mediating variable

PU refers to the extent to which individuals believe that using a system enhances their performance and is a central construct in the TAM [16]. In educational contexts, PU reflects students' beliefs that learning technologies and digital platforms effectively support their learning processes and academic performance. Prior research in online and blended learning suggests that PU is positively associated with learning-related outcomes such as satisfaction, continued system use, and SE. Students who perceive learning systems as useful are more likely to invest effort and actively participate in learning activities [17], [18]. Accordingly, PU is expected to be positively associated with SE. Thus, the hypothesis was proposed as:

- H9: PU positively influences SE.

Beyond its direct association with engagement, PU may function as a key mediating mechanism through which blended learning factors shape SE. SQ and CQ influence students' experiences with learning platforms and materials, while TS and IN signal how learning technologies contribute to learning goals and academic performance. Through these processes, students may develop more favorable evaluations of learning systems, which are reflected in higher PU [2], [3], [10].

Empirical evidence further indicates that technology-related perceptions frequently mediate the relationships between instructional or environmental factors and engagement-related outcomes in technology-enhanced learning contexts. Building on this perspective, this study conceptualizes PU as a central mediating mechanism linking SQ, CQ, TS, and IN to SE. Accordingly, the mediation hypotheses are proposed:

- H10: PU mediates the relationship between SQ and SE.
- H11: PU mediates the relationship between CQ and SE.
- H12: PU mediates the relationship between TS and SE.
- H13: PU mediates the relationship between IN and SE.

3. METHOD

3.1. Research design

This study employed a quantitative, cross-sectional research design to examine the relationships among blended learning factors, PU, and SE in higher education. The research focused on associative rather than causal relationships and collected data using a structured questionnaire. The proposed research model was tested using PLS-SEM, which is appropriate for theory development and prediction-oriented research models [32].

3.2. Participants and data collection

The study sample consisted of undergraduate students from several public universities in Vietnam, including Thuongmai University, National Economics University, and Vietnam National University, who had experience with blended learning supported by LMS. Data were collected through an online survey administered during the academic semester. After data screening, a total of 288 valid responses were retained for analysis, which is considered adequate for PLS-SEM analysis [32].

3.3. Measurement instruments

All constructs in the research model were measured using previously validated scales adapted to the blended learning context. SQ, CQ, TS, IN, PU, and SE were measured using multiple items rated on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Minor wording adjustments were made to ensure clarity and contextual relevance for Vietnamese higher education. The measurement items and their sources are presented in Table 1.

Table 1. Construct measurement items and sources

Factors	Items	Item detail	Source
SQ	SQ1	LMS is easy to use	[2]–[4]
	SQ2	LMS is reliable and functions properly	
	SQ3	LMS is well structured and easy to navigate	
	SQ4	LMS responds quickly when I use it	
CQ	CQ1	Learning materials on the LMS are clear and understandable	[2]–[4]
	CQ2	Learning content is relevant to the course objectives	
	CQ3	Learning materials are up to date	
	CQ4	Content provided on the LMS supports my learning needs	
TS	TS1	The instructor provides timely feedback through the LMS	[10], [11], [27]
	TS2	The instructor clearly explains learning activities and expectations	
	TS3	The instructor encourages student participation in online activities	
	TS4	The instructor supports students when difficulties arise	
IN	IN1	I frequently interact with other students through the LMS	[12], [14], [15]
	IN2	Online discussions help me better understand the course content	
	IN3	I feel comfortable interacting with instructors online	
	IN4	IN through the LMS enhances my learning experience	
PU	PU1	Using the LMS improves my learning performance	[16]–[18]
	PU2	The LMS helps me learn more effectively	
	PU3	The LMS enhances my learning productivity	
	PU4	Overall, the LMS is useful for my learning	
SE	SE1	I actively participate in learning activities	[5]–[7]
	SE2	I am motivated to engage in this course	
	SE3	I put effort into learning the course materials	
	SE4	I am interested in the learning activities of this course	
	SE5	I am actively involved in the learning process	

3.4. Data analysis procedure

Data analysis was conducted using SmartPLS. Following established PLS-SEM guidelines, the analysis proceeded in two stages. First, the measurement model was assessed in terms of internal consistency reliability, convergent validity, and discriminant validity. Second, the structural model was evaluated to examine hypothesized relationships, including direct and mediating effects of PU. Bootstrapping procedures were employed to assess the significance of path coefficients [32]. Common method bias was assessed using the full collinearity variance inflation factor (VIF) approach. All full collinearity VIF values were below the recommended threshold of 3.3, indicating that common method bias is unlikely to threaten the validity of the results [33].

4. RESULTS AND DISCUSSION

4.1. Results

4.1.1. Measurement model assessment

The measurement model was evaluated in terms of internal consistency reliability and convergent validity. As shown in Table 2, all constructs indicate satisfactory reliability, with Cronbach's alpha values ranging from 0.823 to 0.929 and composite reliability (CR) values exceeding the recommended threshold of 0.70. Convergent validity is also supported, as the average variance extracted (AVE) values for all constructs range from 0.654 to 0.780, exceeding the minimum criterion of 0.50. These results suggest that the measurement scales exhibit adequate reliability and convergent validity, providing a sound basis for subsequent structural model analysis.

Discriminant validity was assessed using the heterotrait–monotrait (HTMT) ratio. As shown in Table 3, all HTMT values are below the recommended threshold of 0.85, indicating adequate discriminant validity among the constructs. Taken together, the results confirm that the measurement model satisfies the required reliability and validity criteria for PLS-SEM analysis.

Table 2. Measurement model assessment

Construct	Cronbach's alpha	CR	AVE
SQ	0.823	0.883	0.654
CQ	0.832	0.889	0.666
TS	0.844	0.895	0.681
IN	0.832	0.888	0.665
PU	0.888	0.922	0.748
SE	0.929	0.947	0.780

Table 3. Discriminant validity (HTMT criterion)

Constructs	SQ	CQ	TS	IN	PU	SE
SQ	-					
CQ	0.428	-				
TS	0.468	0.488	-			
IN	0.053	0.347	0.125	-		
PU	0.666	0.716	0.617	0.390	-	
SE	0.539	0.543	0.541	0.269	0.736	-

4.1.2. Structural model and hypothesis testing

The structural model was assessed using PLS-SEM with a bootstrapping procedure of 5,000 resamples. The results of hypothesis testing are reported in Table 4. SQ shows a significant positive effect on PU (β=0.349, t=7.611, p<0.001), supporting H1, and also demonstrates a significant direct association with SE (β=0.124, t=2.521, p=0.012), supporting H2. CQ is positively related to PU (β=0.330, t=7.575, p<0.001), providing support for H3; however, its direct association with SE is not statistically significant (β=0.080, t=1.397, p=0.163), and thus H4 is not supported.

TS exhibits significant positive effects on both PU (β=0.246, t=5.081, p<0.001) and SE (β=0.154, t=2.792, p=0.005), supporting H5 and H6. IN also shows a significant positive effect on PU (β=0.212, t=5.569, p<0.001), supporting H7, while its direct association with SE is not significant (β=0.047, t=0.976, p=0.329), leading to the rejection of H8. In addition, PU demonstrates a strong positive association with SE (β=0.450, t=6.180, p<0.001), supporting H9.

Table 4. Structural model and hypothesis testing

Hypothesis	Structural path	β	t-value	p-value	Result
H1	SQ→PU	0.349	7.611	0.000	Supported
H2	SQ→SE	0.124	2.521	0.012	Supported
H3	CQ→PU	0.330	7.575	0.000	Supported
H4	CQ→SE	0.080	1.397	0.163	Not supported
H5	TS→PU	0.246	5.081	0.000	Supported
H6	TS→SE	0.154	2.792	0.005	Supported
H7	IN→PU	0.212	5.569	0.000	Supported
H8	IN→SE	0.047	0.976	0.329	Not supported
H9	PU→SE	0.450	6.180	0.001	Supported

Figure 1 presents the research model with standardized path coefficients and R^2 values for the endogenous constructs. The model explains 60.7% of the variance in PU (R^2=0.607) and 48.3% of the variance in SE (R^2=0.483), indicating moderate explanatory power. These results suggest that the proposed model adequately captures key determinants of PU and SE in blended learning contexts.

4.1.3. Mediation analysis

To further examine the mediating role of PU, specific indirect effects were tested using a bootstrapping procedure with 5,000 resamples. The results of the mediation analysis are presented in Table 5. The findings demonstrate that PU exhibits significant indirect effects in the relationships between SQ, CQ, TS, IN, and SE. More specifically, the indirect effects of SQ (β=0.157, t=4.703, p<0.001) and TS (β=0.111, t=3.848, p<0.001) on SE through PU are significant, indicating partial mediation, as their direct paths to SE are also significant. In contrast, the indirect effects of CQ (β=0.149, t=4.612, p<0.001) and IN (β=0.096, t=4.234, p<0.001) are significant while their direct effects on SE are not, suggesting full mediation. Overall, these results highlight the central mediating role of PU in explaining how blended learning factors are associated with SE.

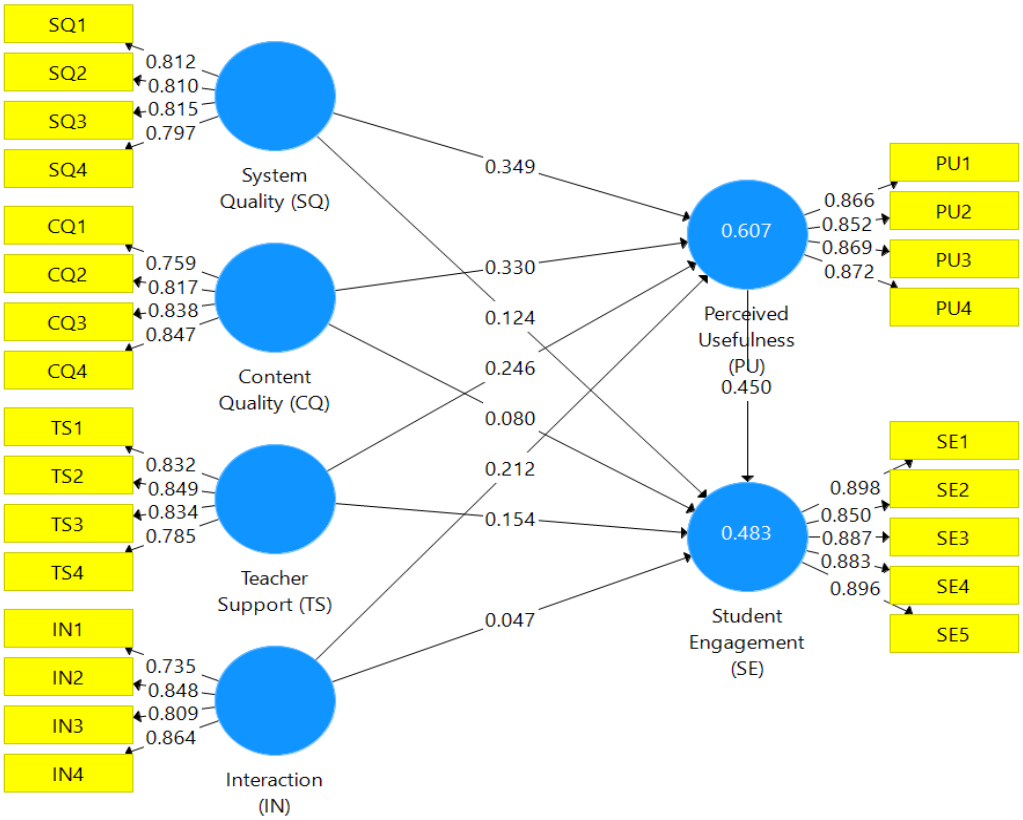

Figure 1. Research model and structural relationships

Table 5. Indirect (mediation) effects

Hypothesis	Indirect path	β	t-value	p-value	Result
H10	SQ→PU→SE	0.157	4.703	0.000	Supported
H11	CQ→PU→SE	0.149	4.612	0.000	Supported
H12	TS→PU→SE	0.111	3.848	0.000	Supported
H13	IN→PU→SE	0.096	4.234	0.000	Supported

4.2. Discussion

This study examined factors associated with SE in blended learning environments by integrating system-related, pedagogical, and interactional dimensions. PU was conceptualized as a central mediating mechanism in the proposed framework. Overall, the findings provide empirical support for the integrated framework and are largely consistent with prior research on technology-enhanced learning and SE in higher education.

The results indicate that SQ, CQ, TS, and IN are all significantly associated with PU. This pattern is consistent with the TAM and the information systems success framework, which emphasize that high-quality systems, learning content, and instructional support are closely related to users' evaluations of usefulness [3], [4], [16]. Similar findings have been reported in blended and online learning contexts, where system reliability and content relevance are key antecedents of PU and positive learning experiences [2], [17]. Recent evidence further suggests that technology interface characteristics are closely related to students' engagement and satisfaction by shaping their perceptions of usefulness and ease of IN [34].

PU, in turn, shows a strong positive association with SE. This suggests that students are more likely to invest cognitive, behavioral, and emotional effort when they perceive blended learning systems as beneficial for achieving their academic goals. This finding aligns with engagement research emphasizing the role of students' subjective evaluations of learning experiences [5], [7] and with empirical evidence linking technology acceptance to engagement-related outcomes in higher education [17].

Regarding direct relationships, SQ and TS are significantly associated with SE, whereas CQ and IN are not. The direct role of SQ is consistent with information systems and service quality research, suggesting that reliable and accessible learning platforms are important conditions for students' sustained involvement in

learning activities [2], [3]. This result also aligns with recent evidence from the Vietnamese higher education context, where service quality has been linked to students' satisfaction and loyalty, indicating broader implications for engagement and commitment [35]. This pattern is further consistent with prior findings showing that well-designed blended and online learning environments are associated with higher levels of SE and satisfaction [36].

Similarly, the significant direct associations between TS and both PU and SE highlight the important role of instructors in blended learning environments. Prior studies consistently indicate that instructional guidance, feedback, and teaching presence are closely related to students' motivation and engagement [10], [11], [27], in line with the CoI framework, which emphasizes teaching presence as a core element of meaningful learning in technology-mediated contexts [14], [15]. This interpretation is further supported by empirical evidence showing that supportive teaching practices are associated with higher levels of SE and satisfaction in online and blended higher education settings [37].

In contrast, CQ and IN do not exhibit significant direct associations with SE, although both are significantly related to PU. This pattern suggests that these factors influence engagement primarily through students' evaluations of the learning system rather than through immediate behavioral responses. Similar indirect or context-dependent relationships between content, IN, and engagement have been reported in prior studies, particularly in blended and online learning settings [8], [13].

Importantly, the mediation analysis provides evidence that PU plays a central mediating role in the relationships between blended learning factors and SE. PU fully mediates the relationships involving CQ and IN and partially mediates the relationships involving SQ and TS. These findings extend existing mediation-based research by highlighting technology-related perceptions as a key psychological mechanism linking learning environments to engagement outcomes in higher education [10].

Overall, the proposed model demonstrates moderate explanatory power and accounts for a substantial proportion of variance in PU and SE. The findings are consistent with evidence from developing and transitional higher education contexts, which emphasize the importance of instructional support and learning conditions in shaping SE [38]. Taken together, the results suggest that effective blended learning implementation involves not only robust systems and high-quality content but also strong instructional support that enhances students' perceptions of usefulness.

5. CONCLUSION

This study examined factors associated with SE in blended learning environments in higher education by integrating system-related, pedagogical, and interactional dimensions, with PU conceptualized as a central mediating mechanism. Using PLS-SEM and survey data from undergraduate students in Vietnam, the findings indicate that SQ, CQ, TS, and IN are significantly associated with students' PU of blended learning systems. PU, in turn, shows a strong positive association with SE, highlighting its central role in explaining how blended learning environments relate to students' involvement in learning. While SQ and TS are also directly associated with SE, the effects of CQ and IN appear to operate primarily through PU, underscoring the importance of students' evaluations of learning technologies.

From a theoretical perspective, this study extends prior research on SE and technology-enhanced learning by integrating the information systems success model and the TAM, thereby offering a more nuanced understanding of the mechanisms through which blended learning factors are related to engagement outcomes. Practically, the findings suggest that higher education institutions should not only invest in reliable and user-friendly LMS but also emphasize instructional support and teaching practices that enhance students' perceptions of usefulness. Instructors play a particularly important role in translating blended learning designs into engaging learning experiences, highlighting the need for ongoing professional development in both pedagogical and technological competencies. Despite its contributions, this study has limitations, including its cross-sectional design, the use of a unidimensional measure of SE, and data collection within a single national context. Accordingly, future research employing longitudinal or experimental designs, adopting multidimensional engagement measures, and examining diverse cultural and institutional settings would be valuable for further validating and extending the proposed model.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY

Derived data supporting the findings of this study are available from the corresponding author [NTH] on request.

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