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Online Course Satisfaction and Continuance Intention Among Materials Science and Engineering Students

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Abstract

Purpose: This study examines the key factors influencing online course satisfaction and continuance intention among undergraduate students majoring in Materials Science and Engineering at three public universities in Chengdu, China. **Research design, data and methodology:** A quantitative survey was conducted with 481 students who had prior online learning experience. A validated five-point Likert-scale questionnaire was developed, with content validity assessed through the Item-Objective Congruence (IOC) method and pilot-tested for reliability (Cronbach's $\alpha > 0.8$). Data were analyzed using Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) to evaluate relationships among the constructs. **Results:** The results showed that system quality ($\beta = 0.170$), self-efficacy ($\beta = 0.132$), perceived usefulness ($\beta = 0.186$), confirmation ($\beta = 0.168$), and perceived ease of use ($\beta = 0.282$) significantly influenced students' satisfaction with online courses. Satisfaction had the strongest direct effect on continuance intention ($\beta = 0.401$), highlighting its mediating role in the model. **Conclusions:** The study offers evidence-based insights for educational institutions and policymakers to enhance the quality of online learning environments. While the findings contribute to understanding student engagement in engineering-related disciplines, further studies across diverse academic contexts are recommended to generalize results and inform broader educational reforms.

Keywords: Online Courses, Course Satisfaction, Continuance Intention, Undergraduate Students

JEL Classification Code: A22, I23, L86, O30

1. Introduction

The transformation of education was further accelerated by the COVID-19 pandemic, which catalyzed a significant shift in educational paradigms (Bao, 2020; Hodges et al., 2020). As pivotal contributors to future societal development, undergraduate students in Chinese universities have played a crucial role in shaping educational quality and driving innovation in pedagogical approaches (Li et al., 2021). Chengdu, serving as an educational hub in the western region, attracts a substantial concentration of university students and has emerged as a representative model for nationwide online education practices (Zhang & Wang, 2022). Consequently, investigating the factors influencing online course satisfaction and continuance intention among undergraduate students in Chengdu's higher education institutions holds considerable practical and theoretical significance (Sun et al., 2023).

Despite the rapid expansion of online learning, engineering students often report unique challenges such as the lack of hands-on practice and difficulty in engaging with technical content remotely, leading to uneven satisfaction and dropout rates (Xu et al., 2023). This reveals a pressing problem in maintaining the quality and sustainability of online education in technologically demanding disciplines.

Although recent studies have addressed general online learning satisfaction, limited research has focused on how

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psychological, system, and experiential factors jointly influence student engagement in online engineering education. This highlights a significant research gap, especially in regional hubs like Chengdu that serve as pilot areas for national educational reforms (Zhao & Wu, 2023).

This study not only provides insights into the dynamics of online learning environments but also contributes to the broader discourse on educational adaptability in the face of global disruptions (Dhawan, 2020). The findings are expected to inform policymaking and institutional strategies aimed at enhancing the efficacy and sustainability of online education systems (Almaiah et al., 2022). By focusing on Chengdu, a city emblematic of educational innovation in China, this research underscores the importance of regional case studies in understanding the complexities of educational transitions (Chen et al., 2021). Ultimately, the exploration of satisfaction and continuance intention within this context offers valuable implications for both academic research and practical applications in the field of education (Davis et al., 2023).

The present study analyzes key variables influencing satisfaction and continuance intention in online learning, including system quality, learner self-efficacy, perceived usefulness and ease of use, and confirmation of expectations, all grounded in updated models of digital learning behavior (Wang et al., 2022; Wei & Yu, 2023). The significance of this study lies in its potential to support universities and policymakers in creating more engaging, responsive, and student-centered online education platforms. Thus, the objectives of this study are: (1) to examine the relationship between system quality, self-efficacy, perceived usefulness, perceived ease of use, confirmation, and satisfaction; (2) to analyze the influence of satisfaction on continuance intention; and (3) to offer evidence-based recommendations for improving online learning systems in engineering education.

2. Literature Review

2.1 System Quality

System quality (SYQ) refers to the functional performance and core characteristics of an information system, encompassing aspects such as accuracy, adaptability, availability, convenience, efficiency, and flexibility. It emphasizes essential features such as dependability, responsiveness, and usability, which collectively enhance user satisfaction and interaction with IS/IT systems (Cheng, 2019). As a fundamental factor influencing user satisfaction, system quality plays a critical role across various platforms, particularly in websites and e-learning environments. Alkhawaja et al. (2022) identified system quality as a core antecedent of perceived usefulness and intention to use in e-learning, highlighting responsiveness and integration as key attributes. Similarly, Achmadi and Oktrivina (2021) found that digital infrastructure and reliable content delivery significantly improve user trust and satisfaction in Indonesian e-learning systems. Given its foundational role in shaping system experience, system quality is expected to significantly influence students' satisfaction with online courses.

H1: System quality has a significant impact on students' satisfaction with online course.

2.2 Self-efficacy

Self-efficacy (SE), traditionally conceptualized by Bandura, represents an individual's capacity to mobilize and execute the necessary actions to achieve specific goals. In online learning environments, SE specifically refers to learners' confidence in managing digital tools and their belief in their ability to succeed in a virtual academic setting. This includes aspects such as navigating platforms, accessing learning resources, and self-regulating one's learning pace (Singh & Sharma, 2021). Students with higher levels of SE typically show greater resilience in overcoming online learning challenges and demonstrate increased persistence and satisfaction.

Empirical investigations by Shao (2018) and Gupta and Bamel (2023) have shown that SE positively influences learners' evaluations of system usefulness and satisfaction. SE is also closely tied to motivation and engagement, as learners who feel competent are more likely to persist with e-learning despite technical or cognitive challenges. These insights align with current digital learning frameworks that prioritize learner agency, self-regulation, and confidence as key drivers of satisfaction. Given its influence on learner motivation, autonomy, and system navigation confidence, self-efficacy is expected to significantly enhance students' satisfaction with online courses.

H2: Self-efficacy has a significant impact on students' satisfaction with online course.

2.3 Perceived Usefulness

Perceived Usefulness (PU) is widely recognized in technology acceptance models as a core factor that shapes users' beliefs about the effectiveness of digital platforms. In educational settings, PU refers to students' perception of how well an online system supports their academic goals and enhances their learning outcomes. Empirical research indicates that when learners view an e-learning platform as beneficial to their performance, their satisfaction and intention to continue using the system increase significantly (Hafifah & Sulistyo, 2023; Singh & Sharma, 2021). PU also serves as a mediating factor between system functionality and engagement in many digital learning models.

In domains beyond education, including finance and healthcare, PU has been shown to directly affect satisfaction and behavioral intention, highlighting its cross-contextual importance (Anwar et al., 2024). In online education, PU often reflects how the platform improves academic efficiency, increases flexibility in time management, and provides useful resources. Accordingly, perceived usefulness is expected to exert a positive and significant influence on students' satisfaction with online learning.

H3: Perceived usefulness has a significant impact on students' satisfaction with online course.

2.4 Perceived Ease of Use

Perceived Ease of Use (PEU) refers to how effortless users find it to interact with a system. It is considered one of the strongest predictors of satisfaction and system acceptance in technology-related fields. Singh and Sharma (2021) found that intuitive navigation and clear layout significantly increased e-learning satisfaction among Indian students. Islam et al. (2018) and Liu et al. (2024) further emphasized that PEU supports emotional engagement and strengthens the effect of PU in user-centered platforms. When systems are difficult to navigate, cognitive overload and frustration may occur, diminishing learning outcomes and satisfaction. Conversely, easy-to-use platforms reduce learners' reliance on technical support, improving confidence and motivation. In light of these findings, perceived ease of use is expected to significantly influence students' satisfaction with online course environments.

H4: Perceived ease of use has a significant impact on students' satisfaction with online course.

2.5 Confirmation

Confirmation (CONF) refers to the degree to which users' experiences meet or exceed their expectations of system performance. Rooted in Expectation-Confirmation Theory, it posits that when expectations are fulfilled, users report higher satisfaction and stronger post-adoption intention. Cheng (2020) demonstrated that confirmation significantly contributes to e-learning satisfaction by validating students' assumptions about platform quality and accessibility. Tan and Kim (2015) found similar outcomes in cloud computing, where positive disconfirmation elevated user trust and engagement. This process reinforces learners' belief that the system is worth continued investment, especially in online education where initial perceptions can shape long-term attitudes. Accordingly, confirmation is anticipated to be a significant determinant of students' satisfaction in online learning systems.

H5: Confirmation has a significant impact on students' satisfaction with online course.

2.6 Satisfaction

Satisfaction (SAT) captures students' affective and evaluative responses after using an online system. It encompasses enjoyment, perceived usefulness, ease of access, and the overall emotional experience of system interaction. Cheng (2019) and Singh and Sharma (2021) identified satisfaction as a critical predictor of continuance intention, especially when learners feel empowered and supported by the system. Cheng (2020) and Roca et al. (2006) found that satisfaction mediates the relationship between system factors and future behavior in e-learning settings.

Satisfaction is widely used as a key performance indicator in online education. Its role extends beyond immediate feedback and serves as a predictor of future engagement, loyalty, and recommendation behavior. Thus, satisfaction is expected to exert a direct and substantial influence on continuance intention in e-learning contexts.

H6: Satisfaction has a significant impact on students' continuance intention in online course.

2.7 Continuance Intention

Continuance Intention (CI) is the likelihood that students will persist in using an online learning platform beyond initial exposure. It is a central construct in IS continuance models, influenced by satisfaction, PU, and confirmation. Cheng (2020) demonstrated that high satisfaction and confirmed expectations significantly boost continuance among e-learning users. Singh and Sharma (2021) reinforced this by showing that perceived learning benefit and user experience jointly shape CI in higher education. Another research has demonstrated CI's strong dependence on learner satisfaction, with satisfied MOOC participants exhibiting greater persistence (Chen et al., 2014).

As digital platforms become integrated into mainstream education, understanding what drives students to continue using them is essential for institutional planning, pedagogical refinement, and resource allocation. Consequently, examining CI provides insights into how institutions can foster long-term student engagement with online courses.

3. Research Methods and Materials

3.1 Research Framework

Two principal theories, UTAUT (Unified Theory of Acceptance and Use of Technology) and ISSM (Information Systems Success Model), form the conceptual foundation of this study. Cheng (2019) developed an initial framework exploring the relationship between system quality and satisfaction. A second framework, proposed by Singh and

Sharma (2021), highlights the relationships among self-efficacy, perceived usefulness, perceived ease of use, and satisfaction. The third framework, introduced by Cheng (2020), analyzes the relationships among confirmation, satisfaction, and continuance intention. The figure below illustrates the integrated conceptual framework derived from these models.

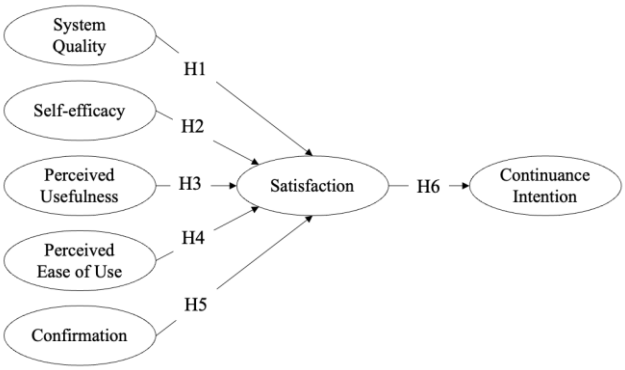

Figure 1: Conceptual Framework

This study aims to investigate the primary variables that impact online course satisfaction and continued usage intentions among undergraduate students from the School of Materials Science and Engineering at three representative public universities in Chengdu, Sichuan Province, China. The conceptual framework examines the roles of seven latent variables: five independent variables (system quality, self-efficacy, perceived usefulness, perceived ease of use, and confirmation), one mediating variable (satisfaction), and one dependent variable (continuance intention). The study also analyzes the causal relationships among these latent variables to assess the extent of their influence on one another. The structure of the framework has led to the formulation of the following hypotheses.

3.2 Research Methodology

This study employed an empirical, quantitative survey approach to investigate the factors influencing online course satisfaction and continuance intention among undergraduate students majoring in Materials Science and Engineering. The sample was drawn from three representative public universities in Chengdu, Sichuan Province, China: Sichuan University, Southwest Jiaotong University, and the University of Electronic Science and Technology of China. The selected students had prior experience with online learning, making them suitable participants for the study. A non-probability sampling strategy was employed, incorporating judgmental, quota, and convenience sampling techniques.

The research instrument, a structured questionnaire based on established constructs, was designed using a five-point Likert scale to measure observed traits. Prior to full distribution, the instrument underwent a rigorous validation process. Content validity was assessed by three associate professors from Xihua University, each holding a Ph.D. and possessing 11 to 15 years of experience in educational research. The Item-Objective Congruence (IOC) method was used to evaluate item relevance and clarity, with the lowest score recorded at 0.67, meeting acceptable validity thresholds (Zamanzadeh et al., 2021). Following this, a pilot test was conducted with 30 randomly selected students to evaluate the internal consistency reliability of the instrument. Cronbach's Alpha values exceeded 0.80 for all constructs, indicating strong reliability, consistent with current psychometric standards (Taber, 2021).

After these preliminary steps, the finalized questionnaire was distributed to 500 undergraduate students, yielding 481 valid responses. The collected data were analyzed using advanced statistical techniques. Confirmatory Factor Analysis (CFA) was applied to assess construct validity, while Structural Equation Modeling (SEM) was employed to test the proposed hypotheses and examine the direct, indirect, and total effects among the latent variables. JAMOVI was used for initial data analysis, including descriptive statistics and reliability testing, while AMOS was employed for CFA and SEM due to its strength in visual modeling and latent variable analysis. The combined use of both platforms ensured comprehensive and efficient analysis across all stages (Hair et al., 2021).

3.3 Population and Sample Size

The participants in this study were selected from three well-established public universities in Chengdu, Sichuan University, Southwest Jiaotong University, and the University of Electronic Science and Technology of China. These institutions are recognized for their excellence in materials science and technological research. The target population consisted of undergraduate students enrolled in materials science and engineering programs who had accumulated at least six months of experience with online learning platforms. To ensure adequate statistical power for structural equation modeling (SEM), a sample size recommendation of at least 10 observations per estimated parameter was considered. Based on this rule and the study's model complexity, a minimum of 425 cases was deemed appropriate, consistent with recent guidelines for SEM (Hair et al., 2021). The initial pool included 1,508 participants. After applying screening and filtering procedures using non-probability sampling methods, a total of 500 eligible respondents were selected. Following data cleaning, 481 valid responses were retained, and 19 incomplete or

inconsistent questionnaires were excluded from the final dataset.

3.4 Sampling Technique

This study employed a combination of non-probability sampling methods, including judgmental, quota, and convenience sampling, to ensure targeted and practical respondent selection. Initially, a total of 1,508 students enrolled in materials science and engineering programs across three representative public universities in Chengdu, Sichuan University, Southwest Jiaotong University, and the University of Electronic Science and Technology of China, were identified using judgmental sampling. This purposive technique enabled the researchers to focus on students who had accumulated a minimum of six months of experience with online learning and were actively enrolled in their respective programs.

Subsequently, quota sampling was implemented to proportionally allocate the sample size across universities and academic levels (freshman to senior), as presented in Table 1. This approach ensured adequate representation of each subgroup in the final dataset. Finally, the researchers employed convenience sampling to administer the survey, both offline through face-to-face interviews on campus and online using platforms such as Wenjuanxing and chat-based applications. This multi-stage non-probability approach provided a balance between methodological rigor and logistical feasibility in accessing a diverse sample of students.

Table 1: Sample Units and Sample Size

University Name	Grade	Population Size	Proportional Sample Size
Sichuan University	Freshman	195	65
	Sophomore	183	61
	Junior	160	53
	Senior	174	58
Southwest Jiaotong University	Freshman	158	52
	Sophomore	118	39
	Junior	117	39
	Senior	108	36
University of Electronic Science and Technology of China	Freshman	72	24
	Sophomore	72	24
	Junior	80	26
	Senior	71	23
Total		**1,508**	**500**

4. Results and Discussion

4.1 Demographic Information

The demographic analysis of the 481 respondents revealed that 47.2% were from Sichuan University, 33.3% from Southwest Jiaotong University, and 19.5% from the University of Electronic Science and Technology of China. A higher proportion of male students were enrolled in the Materials Science and Engineering program, accounting for 62.2% of the sample, while female students made up 37.8%. In terms of academic year distribution, 28.3% were freshman, 24.7% sophomore, 23.7% junior, and 23.3% senior.

Table 2: Demographic Information

Demographic and General Data (N=481)		Frequency	Percentage
University	Sichuan University	227	47.2
	Southwest Jiaotong University	160	33.3
	University of Electronic Science and Technology of China	94	19.5
Gender	Male	299	62.2
	Female	182	37.8
Grade	Freshman	136	28.3
	Sophomore	119	24.7
	Junior	114	23.7
	Senior	113	23.3

4.2 Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis (CFA) was conducted to assess the measurement model as part of the Structural Equation Modeling (SEM) process, following the two-step approach proposed by Anderson and Gerbing (1988). The CFA aimed to validate the relationships between observed indicators and their corresponding latent constructs.

Table 3 presents the results of the CFA. All standardized factor loadings ranged from 0.758 to 0.865, exceeding the recommended minimum threshold of 0.70, indicating strong item reliability (Hair et al., 2021). In terms of reliability, the Composite Reliability (CR) values ranged from 0.859 to 0.905, well above the acceptable threshold of 0.70, demonstrating high internal consistency across all constructs (Hair et al., 2021). Furthermore, the Average Variance Extracted (AVE) values ranged from 0.603 to 0.677, surpassing the recommended benchmark of 0.50, thereby indicating sufficient convergent validity (Hair et al., 2021). These results confirm that the measurement model has satisfactory psychometric properties, supporting its appropriateness for further structural equation modeling.

Table 3: CFA, CR, and AVE Results

Variable	Source of Questionnaire (Measurement Indicator)	No. of Item	Cronbach's Alpha	Factor Loading	CR	AVE
System Quality (SYQ)	Cheng (2019)	4	0.918	0.810-0.842	0.892	0.673
Self-efficacy (SE)	Singh and Sharma (2021)	5	0.894	0.801-0.831	0.890	0.669
Perceived Usefulness (PU)	Singh and Sharma (2021)	5	0.882	0.809-0.836	0.894	0.677
Perceived Ease of Use (PEU)	Singh and Sharma (2021)	4	0.891	0.830-0.853	0.905	0.706
Confirmation (CONF)	Cheng (2020)	3	0.862	0.833-0.845	0.877	0.703
Satisfaction (SAT)	Cheng (2019), Singh and Sharma (2021)	4	0.900	0.824-0.865	0.906	0.707
Continuance Intention (CI)	Cheng (2020)	4	0.887	0.758-0.791	0.859	0.603

Note: CR = Composite Reliability, AVE = Average Variance Extracted

As shown in Table 4, the model demonstrated a good fit across multiple indices. Incremental fit measures (CFI, NFI, and TLI) all exceeded 0.80, and absolute fit indices (CFI ≥ 0.90, TLI ≥ 0.90, RMSEA ≤ 0.08, CMIN/DF ≤ 3, etc.) were within acceptable thresholds, confirming model adequacy (Sathyanarayana & Mohanasundaram, 2024). Collectively, these results indicate that the measurement model satisfies the required fit criteria, confirming the reliability and construct validity of the latent variables.

Table 4: Goodness of Fit for Measurement Model

Index	Criterion	Statistical Value
CMIN/DF	< 3.00	1.068
GFI	≥ 0.90	0.954
AGFI	≥ 0.90	0.943
NFI	≥ 0.90	0.959
CFI	≥ 0.90	0.997
TLI	≥ 0.90	0.997
RMSEA	< 0.08	0.012

Note: CMIN/DF = The ratio of the chi-square value to degree of freedom, GFI = goodness-of-fit index, AGFI = adjusted goodness-of-fit index, NFI = normalized fit index, CFI = comparative fit index, TLI = Tucker Lewis index and RMSEA = root mean square error of approximation

Table 5 presents the results of the discriminant validity analysis. In line with the criteria proposed by Sathyanarayana and Mohanasundaram (2024), discriminant validity was assessed by comparing the square root of the AVE for each construct with its correlations with other constructs. The results confirmed that the square root of the AVE for each latent variable was greater than its corresponding inter-construct correlations, thereby providing evidence of discriminant validity in this study.

Table 5: Discriminant Validity

Variable	Factor Correlations						
	SYQ	SE	PU	PEU	CONF	SAT	CI
SYQ	**0.820**						
SE	0.418	**0.818**					
PU	0.126	0.127	**0.823**				
PEU	0.158	0.143	0.125	**0.840**			
CONF	0.228	0.181	0.194	0.152	**0.838**		
SAT	0.287	0.265	0.253	0.310	0.294	**0.841**	
CI	0.313	0.316	0.297	0.280	0.293	0.402	**0.777**

Note: The diagonally listed value is the AVE square roots of the variables

4.3 Structural Equation Model (SEM)

Structural Equation Modeling (SEM) was employed to test the hypothesized relationships among latent constructs and to evaluate the overall model structure. Following the two-step modeling approach, the structural model was assessed after validation of the measurement model through Confirmatory Factor Analysis (CFA). The SEM analysis was conducted using AMOS software.

As shown in Table 6, the structural model demonstrated a good fit across multiple indices. These include the Chi-square to degrees of freedom ratio (CMIN/DF), Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). All values met or exceeded the recommended threshold criteria, confirming the model's adequacy for testing the proposed causal relationships (Sathyanarayana & Mohanasundaram, 2024).

Table 6: Goodness of Fit for Structural Model

Index	Criterion	Statistical Value
CMIN/DF	< 3.00	1.339
GFI	≥ 0.90	0.937
AGFI	≥ 0.90	0.925
NFI	≥ 0.90	0.946
CFI	≥ 0.90	0.986
TLI	≥ 0.90	0.984
RMSEA	< 0.08	0.027

Note: CMIN/DF = The ratio of the chi-square value to degree of freedom, GFI = goodness-of-fit index, AGFI = adjusted goodness-of-fit index, NFI = normalized fit index, CFI = comparative fit index, TLI = Tucker Lewis index and RMSEA = root mean square error of approximation

4.4 Research Hypothesis Testing Result

The strength of the relationships between the independent and dependent variables in the proposed hypotheses was assessed using standardized path coefficients (β) and corresponding t-values. As presented in Table 7, all six hypotheses were supported at a statistically significant level ($p < 0.05$). Satisfaction demonstrated the strongest direct effect on continuance intention ($\beta = 0.401$, $t = 7.670$). Among the predictors of satisfaction, Perceived Ease of Use (PEOU) exhibited the highest standardized path

coefficient (β = 0.282, t = 5.891), followed by Perceived Usefulness (PU) (β = 0.186, t = 3.926), System Quality (SYQ) (β = 0.170, t = 3.597), Confirmation (CONF) (β = 0.168, t = 3.514), and Self-Efficacy (SE) (β = 0.132, t = 2.794). These results indicate that all latent variables contributed significantly to the structural model, providing empirical support for the hypothesized relationships.

Table 7: Hypothesis Testing Result

Hypothesis	Standardized path coefficients (β)	t-value	Test Result
H1: SYQ → SAT	0.170	3.597*	Supported
H2: SE → SAT	0.132	2.794*	Supported
H3: PU → SAT	0.186	3.926*	Supported
H4: PEU → SAT	0.282	5.891*	Supported
H5: CONF → SAT	0.168	3.514*	Supported
H6: SAT → CI	0.401	7.670*	Supported

Note: *=p-value<0.05

5. Conclusions and Recommendation

5.1 Discussions and Conclusions

This study aimed to examine the key determinants influencing students' continuance intention in the use of online learning platforms, focusing on undergraduate students enrolled in materials science and engineering programs at three prominent public universities in Chengdu, China. Through the application of Structural Equation Modeling (SEM), the study tested six hypotheses derived from established models such as the Technology Acceptance Model (TAM) and Expectation-Confirmation Theory (ECT), using validated measurement constructs and psychometrically sound scales.

The empirical results confirmed that all six hypotheses were statistically supported, providing a strong foundation for understanding how system-related and learner-related factors contribute to satisfaction and continuance intention in an online educational environment. Among the independent variables, satisfaction emerged as the most robust and direct predictor of continuance intention (H6: β = 0.401, t = 7.670). This finding aligns strongly with the principles of Expectation-Confirmation Theory (Bhattacherjee, 2001), and is consistent with earlier research by Roca et al. (2006) and Singh and Sharma (2021), which emphasize that user satisfaction is a critical determinant of post-adoption behavior in digital learning systems.

With regard to the determinants of satisfaction, Perceived Ease of Use (H4) had the most substantial effect (β = 0.282), indicating that when students find a learning system intuitive and easy to navigate, their satisfaction significantly increases. This finding echoes results from Islam et al. (2018) and Liu et al. (2024), who demonstrated that the simplicity of system interaction fosters engagement and positive affective responses. In the context of engineering education, where complex content is often delivered through digital interfaces, the usability of the platform plays a particularly crucial role.

Perceived Usefulness (H3) was the next most influential factor (β = 0.186), reinforcing the assumption that students are more satisfied when they believe the system enhances their academic productivity. This finding supports the Technology Acceptance Model (Davis, 1989) and is consistent with empirical research by Hafifah and Sulistyo (2023), as well as Anwar et al. (2024), which show that usefulness is closely tied to motivation and continued system usage. Given the technical rigor of the materials science curriculum, learners may particularly value platforms that streamline content delivery and support task completion.

System Quality (H1) and Confirmation (H5) had moderate but significant effects on satisfaction (β = 0.170 and β = 0.168, respectively). The influence of system quality is in line with findings from Cheng (2019) and Alkhawaja et al. (2022), who identified platform reliability, integration, and response time as critical to user satisfaction. Meanwhile, the significance of confirmation supports the foundational assumptions of Expectation-Confirmation Theory, and aligns with the work of Sathyanarayana and Mohanasundaram (2024), who demonstrated that alignment between expectations and system performance enhances satisfaction across academic settings.

Self-Efficacy (H2), while statistically significant, exhibited the weakest influence on satisfaction (β = 0.132), suggesting that confidence in managing the online system plays a secondary role compared to other system- and task-related attributes. This somewhat contrasts with earlier research by Gupta and Bamel (2023) and Shao (2018), which highlighted self-efficacy as a strong determinant of online learning success. One possible explanation for this deviation lies in the demographic characteristics of the sample, students enrolled in a highly technical discipline such as materials science are likely to already possess a baseline level of digital competence, thereby reducing the variation in self-efficacy and its predictive strength.

In terms of indirect effects on continuance intention, Perceived Ease of Use again emerged as the most influential underlying factor, followed by Perceived Usefulness, System Quality, and Confirmation. These indirect effects reinforce the role of satisfaction as a mediating variable and highlight the multidimensional pathways through which system design, learner beliefs, and experience expectations influence long-term user engagement.

This study contributes to the body of literature on online learning adoption by confirming that both system-centered

factors (such as usability and functionality) and learner-centered variables (such as beliefs and expectations) collectively shape satisfaction and continuance intention. The findings are particularly valuable for educational institutions seeking to enhance digital learning environments for engineering students, as they underscore the need to prioritize intuitive design, performance reliability, and value-driven content. Moreover, by applying validated constructs within a Chinese university context, this research offers regionally relevant insights and practical implications for institutional decision-makers engaged in online education development and reform.

5.2 Recommendations

Drawing upon the validated findings of this study, a number of practical recommendations are proposed to enhance student satisfaction and continuance intention within online learning platforms, particularly for undergraduate engineering programs. These recommendations are aligned with the significant predictors identified in the SEM analysis, including Perceived Ease of Use, Perceived Usefulness, System Quality, Confirmation, Self-Efficacy, and Satisfaction.

First, as Perceived Ease of Use (PEOU) demonstrated the strongest influence on satisfaction, institutions should prioritize the simplification of online platform interfaces. This includes streamlining navigation pathways, minimizing loading times, and ensuring platform responsiveness across devices. Providing students with clear operational instructions, an intuitive layout, and a user-centered design can help reduce cognitive load, which in turn enhances satisfaction, as confirmed by prior studies (Islam et al., 2018; Singh & Sharma, 2021). Including a detailed FAQ section and responsive helpdesk will further support ease of access, especially for new users.

Second, Perceived Usefulness (PU) was found to significantly influence satisfaction, indicating that students value platforms that contribute to academic success. To address this, course content should be continuously updated and aligned with academic objectives and practical applications. Incorporating virtual simulations, interactive case studies, and scaffolded problem-solving exercises, particularly relevant to materials science (e.g., phase transformation, materials testing, or computational modeling), can enhance students' perceptions of usefulness. These practices are consistent with earlier findings from Hafifah and Sulistyo (2023) and Lestari et al. (2024).

Third, System Quality (SYQ) showed a moderate but significant effect on satisfaction, suggesting that platform reliability and technical performance matter. Institutions should therefore invest in maintaining robust server infrastructure, reducing system downtime, and optimizing platform speed. Monitoring platform usage through analytics tools can help detect performance bottlenecks and improve reliability, in line with Alkhawaja et al. (2022).

Fourth, Confirmation (CONF) was also a significant predictor of satisfaction, meaning that aligning learning outcomes with student expectations is essential. To ensure this alignment, course objectives and actual activities. such as virtual labs or technical tutorials, should be transparent and consistent. Providing clear syllabi, regular feedback, and reflective progress tools will help students calibrate their expectations and evaluate learning outcomes positively.

Although Self-Efficacy (SE) had the weakest significant effect, its role remains important, particularly for supporting diverse student needs. Educators can promote digital confidence through short onboarding sessions, peer-support groups, and training videos on platform navigation. While its effect was less pronounced among this sample, these supports are still advisable, especially for new users or students in less digitally intensive fields, as suggested by Gupta and Bamel (2023).

Lastly, as Satisfaction (SAT) was the strongest predictor of Continuance Intention (CI), institutions should adopt a holistic design approach, focusing not only on technical efficiency but also on learner experience. Features such as adaptive learning paths, milestone recognitions (e.g., digital badges), and real-time performance dashboards can improve student engagement and satisfaction. However, such recommendations should be considered in moderation, as this study did not directly assess gamification or reward mechanisms.

These recommendations are grounded in the empirical findings of this study and supported by relevant literature. By targeting the validated predictors of satisfaction and continuance intention, institutions can enhance the sustainability and impact of their online learning environments, particularly for STEM disciplines such as materials science and engineering.

5.3 Limitation and Further Study

The findings of this study are limited by its exclusive focus on undergraduate students majoring in Materials Science and Engineering in Chengdu, which may affect the generalizability of the conclusions to other disciplines or geographic regions. Additionally, the cross-sectional research design and the omission of variables such as instructor interaction constrain the comprehensiveness of the results. Cultural specificity may also influence the applicability of the findings in different educational contexts. Future research could be expanded along three key dimensions: theoretically, by integrating the Technology Acceptance Model (TAM) and Self-Determination Theory (SDT); methodologically, through the use of learning

analytics and longitudinal tracking; and practically, by developing intelligent recommendation systems and exploring university–industry collaboration models. These directions can contribute to a more nuanced understanding of the mechanisms underlying sustained engagement in online learning from a multidisciplinary perspective.

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