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Enhancing Learning Outcomes and Self-Efficacy through Online Learning Interactions: A Comprehensive Study on College Students in China

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ABSTRACT

This study examines how online learning interactions affect learning outcomes and self-efficacy among Chinese college students, with particular attention to the mediating role of perceived satisfaction. Grounded in social constructivism and Moore's interaction model, the study analyzes the relationships among three major forms of interaction—instructor–learner, learner–learner, and learner–content interaction—and their influence on students' academic performance and confidence in learning. A quantitative design was adopted, and survey data were collected from 384 students enrolled in Chinese art colleges. The data were analyzed using partial least squares structural equation modeling. The results indicate that online learning interactions have a significant effect on both learning outcomes and self-efficacy, emphasizing the importance of active engagement and participation in digital learning contexts. The findings further show that perceived satisfaction mediates the relationship between online learning interactions and self-efficacy, but does not significantly mediate the relationship between online learning interactions and learning outcomes. By clarifying these relationships, the study extends current understanding of how digital teaching practices can be refined to improve students' learning experiences and educational outcomes. The findings offer useful implications for educators, policy makers, and other higher education stakeholders, while also highlighting the need to create interactive online learning environments that foster both academic development and personal growth.

1. Introduction

The rapid development of information technology, particularly the mobile internet, has significantly influenced education, enabling online learning, a method allowing educational and professional courses to be taken over the internet rather than in traditional settings (Panigrahi et al., 2018). This shift represents a fundamental change in knowledge acquisition, impacting human life

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profoundly. Online learning, dating back nearly two centuries to correspondence courses in Europe, has become increasingly prevalent, especially in Chinese universities, due to its flexibility and the COVID-19 pandemic's effects on conventional education methods (Chiodini, 2020). The pandemic has underscored the value of online learning, facilitating uninterrupted education through technology. This learning mode, now considered standard in higher education, has transformed student interaction and learning outcomes, with platforms like Tencent Conference and Dingding being widely used. This study focuses on the impact of online learning interactions on the learning outcomes and self-efficacy of art college students in Chongqing, China, contributing to enhancing online education.

2. Problem Statement

The rapid expansion of online learning in higher education has brought increased attention to a range of challenges that require systematic responses. Among the most prominent issues are the costs associated with preparing instructors for online teaching, students' sense of isolation in virtual environments, and inequalities in access to technology. At the same time, the relative effectiveness of online learning compared with face-to-face instruction remains unsettled, as prior studies have reported inconsistent findings regarding academic achievement, student engagement, and the clarity of learning outcomes (Mushtaque et al., 2022; Zheng et al., 2020; Zapata-Cuervo et al., 2021). In the field of music education in particular, the shift toward online instruction has revealed both opportunities and constraints. Although some studies indicate that students are capable of performing well in online music courses, persistent concerns remain regarding the quality of feedback, coordination in ensemble practice, and the maintenance of student engagement (Li, 2020; Nsairat et al., 2022; Rucsanda et al., 2021).

These challenges became even more pronounced during the COVID-19 pandemic, especially in China, where universities were required to transition rapidly to online learning. This sudden shift disrupted interactive and collaborative forms of learning and underscored the importance of strengthening students' adaptability to digital environments as well as their self-efficacy in online study (Ng et al., 2022). In addition, the relationship between self-efficacy and learner satisfaction in online contexts remains insufficiently understood. Although self-efficacy has consistently been identified as an important predictor of academic performance, empirical findings on how it influences learner satisfaction, and how the two constructs interact, have been inconsistent across studies. This suggests the need for a more nuanced investigation into their interrelationship within online learning settings (Alegre, 2014; Alzahrani & Seth, 2021; Yang et al., 2022; Aldhahi et al., 2022).

In light of these mixed findings and the continuing need to clarify the educational value of online learning, more rigorous and comprehensive research is required. To respond to this gap, the present study draws on social constructivism theory and Moore's three forms of interaction to construct a model explaining the relationships among students' online learning interactions, learning outcomes, and self-efficacy. Such inquiry is important for generating practical evidence that can assist educators, policymakers, and other stakeholders in refining instructional technology and improving its contribution to student learning and academic success (Schmid et al., 2014).

3. Research Questions

This research is structured around the following guiding research questions:

RQ1: Do online learning interactions (Instructor-Learner interaction, Learner-Learner interaction, Learner-Content interaction) promote learning outcomes of college students?

RQ2: Do online learning interactions (Instructor-Learner interaction, Learner-Learner interaction, Learner-Content interaction) promote the self-efficacy of college students?

RQ3: Does perceived satisfaction mediate the effect between online learning interactions (Instructor-Learner interaction, Learner-Learner interaction, Learner-Content interaction) and learning outcomes of college students?

RQ4: Does perceived satisfaction mediate the effect between online learning interactions (Instructor-Learner interaction, Learner-Learner interaction, Learner-Content interaction) and self-efficacy of college students?

Therefore, the research questions the study aims to answer are the main drivers of online learning outcomes, self-efficacy from online interaction, and perceived satisfaction.

This study tries to uncover the impact of online interaction and perceived satisfaction on their students' learning outcomes and self-efficacy in online learning. Current research attempts to increase knowledge about the underlying link mechanisms between online learning interaction, perceived satisfaction, learning outcomes, and self-efficacy.

4. Literature Review

China's music education system, deeply embedded in its rich cultural heritage and open to Western classical influences, offers a multifaceted and progressive framework for studying music (Lan, 2018). The entry process into esteemed music institutions in China is notably rigorous, mandating that aspirants not only display technical prowess but also convey a profound emotional connection to music, frequently through performances evaluated by panels of experts (Zimmerman, 2009). This curriculum within Chinese music academies integrates traditional Chinese musical elements and instruments with the methodologies and theories of Western classical music, demonstrating a commitment to achieving excellence in music education and a comprehensive grasp of the international music landscape (Shi, 2021).

The advent of digital technology has catalyzed transformative changes in the realm of music education in China, with online courses emerging as significant platforms. These courses offer interactive and diverse educational experiences, including detailed video lectures on music history and hands-on tutorials on music production techniques, alongside the innovative use of virtual reality for concerts and musical experiences. Such developments underscore the alignment with Moore's framework of online learning interactions, highlighting the importance of interactions between learner and content, learner and instructor, and among learners as pivotal to cultivating an engaging and practical online educational experience (Li, 2020). These digital platforms cater to varying learning preferences and paces by providing individualized learning trajectories, significantly enhancing student engagement and learning outcomes (Koutsoupidou, 2016; South et al., 2014).

Additionally, including contemporary musical genres such as jazz, pop, and electronic music in the curriculum ensures that students receive a holistic education that prepares them for a wide range of professional paths in the music industry. When examined through the lens of sociocultural

constructivism learning theory, this approach recognizes the vital role of social context and cultural instruments in the learning process. It promotes an educational environment wherein students actively construct knowledge through engaging with diverse musical traditions and contemporary innovations.

Therefore, the fusion of traditional and modern elements and the integration of digital learning platforms position China's music education system as a leading model for cultivating versatile and globally impactful musicians. This system, by leveraging Moore's interaction model and the principles of sociocultural constructivism, offers a robust and dynamic educational experience that prepares students for the complexities and opportunities of the global music industry.

4.1 Moore's Online Learning Interactions Model

The significance of interaction in online learning environments, as highlighted by Moore (1989), has become increasingly evident, offering a means to transcend the limitations inherent in large-scale traditional lectures. Moore identified three critical types of interaction: learner-learner, instructor-learner, and learner-content, each contributing uniquely to the educational experience.

Learner-learner interaction, grounded in social constructivism and cognitive theories, facilitates student exchange of ideas, knowledge, and feedback. This type of interaction enriches learners' understanding and practical application of theoretical knowledge, supported by digital platforms that enable robust computer-mediated communication (Moore, 1989; Mcduff, 2016; Fatoni et al., 2020). This interaction remains underexplored online despite its benefits for knowledge co-construction and motivational support.

Instructor-learner interaction, characterized by the dynamic exchange between students and their instructors, is pivotal for customizing the learning experience to meet individual needs and levels. It encompasses guidance, support, encouragement, and motivation from the instructor, which is critical for learners to comprehend, adopt effective learning strategies, and apply knowledge practically (Moore, 1989; Bağrıacık et al., 2018; Lin et al., 2022; Elyakim et al., 2019). The evolution of this interaction, from simple question-answer sessions to more diversified strategies, underscores the need for further investigation into its impact on online learning.

Lastly, learner-content interaction involves the cognitive engagement of learners with the material, aiming for knowledge acquisition, deepened understanding, and perspective shifts. The presentation of content in diverse formats, enhanced by technological advances, is crucial in facilitating this interaction and addressing learners' individual needs (Moore 1989; Elyakim et al., 2019).

Moore's comprehensive examination of these interactions highlighted their foundational importance to effective online learning. This study seeks to delve into how these interactions influence students' learning outcomes and self-efficacy, addressing the gap in literature where previous research has often focused on isolated aspects of these interactions. By evaluating the significance and performance levels of each type of interaction, this research aims to contribute empirical evidence towards enhancing the quality of online education.

4.2 Sociocultural Constructivism Learning Theory

Sociocultural constructivism, a theory developed by Vygotsky in 1979, highlighted learning as a social process embedded within cultural contexts. It posits that learning occurs through

interactions within a social environment, emphasizing the active role of learners in constructing knowledge through engagement with their surroundings and peers (Vygotsky et al., 1979; Schreiber & Valle, 2013).

Vygotsky's theory highlights the importance of social interaction in cognitive development, suggesting that knowledge construction is a unique and personal process influenced by learners' prior experiences and cultural background. This approach to learning advocates for integrating experiences with new concepts, facilitating a more profound understanding through active participation (Schwandt, 1994; Prawat, 1992).

The theory also introduces the concept of scaffolding by Wood et al. (1976) as a strategy for educators to support learners in achieving tasks beyond their current abilities by building on what they already know. This concept aligns with Vygotsky's Zone of Proximal Development (ZPD), proposing that learning is most effective when it occurs beyond the learner's current level of competence, with scaffolding provided to bridge the gap (Vygotsky et al., 1978).

Sociocultural constructivism asserts that learning is inherently a collaborative activity, enhanced by digital technologies that facilitate interaction among learners and the broader learning community. This interaction stimulates cognitive growth and is influenced by cultural and historical contexts, making learning a dynamic and context-dependent activity (Gredler, 2009).

Furthermore, sociocultural constructivism has implications for learners' perceived satisfaction and self-efficacy in learning environments. It suggests that engaging interactions, particularly in online settings, can enhance satisfaction and foster a supportive learning community, increasing learners' self-efficacy. This is attributed to the positive reinforcement and confidence gained through collaborative learning and personalized feedback within the learner's social and cultural context (Donkin & Rasmussen, 2021; Mlambo et al., 2020).

By valuing collaboration, cultural relevance, and interactive learning, sociocultural constructivism offers a comprehensive framework for understanding and improving learning outcomes. It emphasizes that learning is about acquiring knowledge and making sense of information in a meaningful and relevant way to the learner's experiences and cultural background, thereby promoting more profound understanding and retention (Kümmel et al., 2020).

5. Proposition Development

5.1 Online Learning Interaction to Learning Outcomes

Online learning interaction plays a crucial role in promoting student engagement and academic success. Prior studies have shown that richer and more meaningful online interaction is positively associated with better learning outcomes, underscoring the importance of active learner participation in digital environments (Razali et al., 2020; Wang et al., 2016). In addition, existing research has noted that declining motivation in online learning can negatively affect students' performance, which further highlights the need to design interactive and engaging online learning environments that can maintain learners' interest and support positive educational outcomes (Salsa et al., 2022). Notably, active and constructive online participation has been shown to predict learning outcomes better than passive engagement, emphasizing the critical role interactions play during challenging times like the COVID-19 pandemic (Henderson, 2019; Baber, 2020). Therefore, fostering a vibrant online community that supports active learning, critical thinking, and a sense of

belonging can significantly influence students' learning outcomes. Based on these premises, the following propositions are derived:

Hypothesis 1: Online learning interactions (instructor-learner interaction, learner-learner interaction, learner-content interaction) have a significant influence on Learning Outcomes.

5.2 Online Learning Interaction to Self-Efficacy

Self-efficacy, or the accurate assessment and belief in one's abilities, plays a pivotal role in engaging with tasks, exerting effort, and persisting towards goals. It influences feelings, thought processes, and actions towards task completion and is essential for learning outcomes (Bandura & Walters, 1977; Mikalauskienė & Zalieckaitė, 2019). In educational contexts, for instance, self-efficacy has been linked to improved language skills among English learners (Sun & Wang, 2020).

Research indicates that online learning interactions can enhance self-efficacy by fostering meaningful exchanges within the digital learning environment. Such interactions provide social support, motivation, and positive feedback from instructors and peers, boosting students' confidence in their abilities (Kuo et al., 2014; Kuo & Walker, 2014). Active participation in online discussions and collaboration further reinforces students' belief in competence, contributing to increased self-efficacy. This highlights the importance of engaging, supportive online learning experiences in fostering students' self-efficacy.

Hypothesis 2: Online learning interactions (instructor-learner interaction, learner-learner interaction, learner-content interaction) have a significant influence on self-efficacy.

5.3 Perceived Satisfaction and Mediator

In the fields of social science and psychology, mediating variables are essential for explaining the mechanism through which independent variables influence dependent variables, thereby clarifying how external factors acquire psychological meaning. In the present context, perceived satisfaction functions as a mediator between online learning interactions and two important outcomes, namely learning outcomes and self-efficacy. This perspective implies that students' level of satisfaction with their online learning experiences can shape their engagement and motivation, which in turn affects both their academic performance and their confidence in their own abilities (Doménech-Betoret et al., 2017; Figueredo et al., 2013; Han et al., 2021; Saba, 2013).

Satisfaction with online interactions, including feedback from instructors and peers, impacts students' responses to feedback and learning strategies, affecting learning outcomes (Yildirim & Usluel, 2022; Dharmadjaja & Tiatri, 2021). Similarly, when students find online interactions satisfying, it reinforces their self-efficacy, enhancing their confidence and motivation, which are pivotal for academic success (Kuo et al., 2014b; Li & Moore, 2018). Accordingly, perceived satisfaction helps clarify how online learning interactions influence both learning outcomes and self-efficacy, while also reflecting the intricate interplay of cognitive, emotional, and social dimensions within online education. On the basis of these arguments, the following proposition is proposed:

Hypothesis 3: Perceived satisfaction is a significant mediator between online learning interaction (instructor-learner interaction, learner-learner interaction, learner-content interaction) and learning outcomes.

Hypothesis 4: Perceived satisfaction is a significant mediator between online learning

interactions (instructor-learner interaction, learner-learner interaction, learner-content interaction) and self-efficacy.

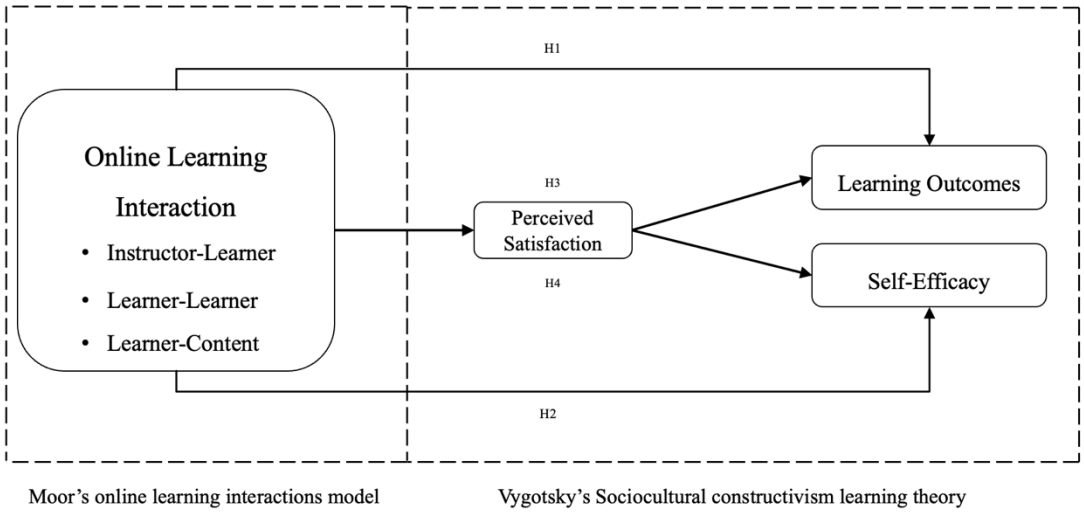

Figure 1 Theoretical Framework

6. Research Methods

The study presents a framework (Figure 1) designed to explore learning outcomes and self-efficacy in online learning. To empirically test this framework, it is crucial to assess learners' perceptions and experiences of online education. A survey research approach aligns with previous methodologies to investigate learning outcomes and self-efficacy.

The quantitative study's sample selection was based on previous research that adopted Krejcie and Morgan's (1970) sample size measurement. This method determines the sample size with a confidence level of 95% and a confidence interval of 5%, indicating that for a population exceeding 100,000, approximately 384 respondents are required. The study aimed to recruit 384 students from Chinese arts colleges through SurveyMonkey over three months to build the original data with a larger sample size for a more substantial statistical power.

The study focused on art students at Chongqing Creation Vocational College in China and employed probability sampling to ensure that each member of the target population had an equal opportunity to be included in the sample. This sampling approach was adopted to enhance the representativeness of the participants in relation to the overall population. More specifically, the study combined stratified sampling with random sampling techniques. Under stratified sampling, the population was first divided into several subgroups based on shared characteristics, and participants were then selected from each subgroup to ensure adequate representation across the population. Random sampling was subsequently applied within each stratum so that every individual had an equal likelihood of selection. This combined procedure strengthened both the representativeness of the sample and the generalizability of the study findings. The process involved dividing students into four categories based on their academic level (freshman, sophomore, junior, and senior) and randomly selecting 96 students from each category, totaling 384 participants.

Items from previous studies could be adapted for measuring different constructs. Specifically, the measurement of online learning interaction was adapted from Kuo et al. (2014), perceived satisfaction was adapted from Pozón-López et al. (2021), learning outcomes were adapted from

Cicek et al. (2021), and self-efficacy was adapted from Latip et al. (2020).

For analyzing the data, it is suggested that partial least squares structural equation modeling (PLS-SEM) be employed, as recommended by Hair and colleagues in 2019. This analytical approach is especially suitable for examining complex conceptual models that involve multiple causal paths, making it well aligned with the proposed relationships among the constructs in the present theoretical framework. Consistent with the procedure recommended by Hair et al. (2019), the analysis should be carried out in two main stages. The first stage centers on assessing the measurement model in order to verify the reliability and validity of the survey instrument. The second stage involves evaluating the structural model, in which the proposed hypotheses are tested through bootstrapping procedures. By following this two-stage process, the study establishes a rigorous foundation for assessing the conceptual framework and determining whether the hypothesized relationships are empirically supported.

7. Data Analysis

7.1 Measurement Model

The internal consistency reliability of the measurement model was assessed by examining both Cronbach's alpha and composite reliability values. The results demonstrated that all constructs satisfied the recommended threshold of 0.70 for both indices, thereby indicating a satisfactory level of internal consistency reliability (Henseler et al., 2015). These findings suggest that the indicators used to measure each construct were consistent in capturing the same underlying concept. In addition, indicator reliability was established through the examination of outer loadings, with all loading values exceeding the recommended minimum level of 0.60 (Chin, 1998). This result confirms that each observed indicator made an acceptable contribution to its respective latent construct.

Furthermore, convergent validity was evaluated by using the average variance extracted (AVE). The results revealed that the AVE values for all constructs were above the recommended cutoff value of 0.50, as suggested by Fornell and Larcker (1981). This indicates that each construct was able to explain more than half of the variance of its indicators, thus confirming an adequate degree of convergent validity. Taken together, these results provide strong evidence that the measurement model possessed satisfactory reliability and validity, thereby supporting its suitability for subsequent structural model assessment. The detailed outcomes of Cronbach's alpha, composite reliability, outer loadings, and AVE are presented in Table 1.

Following the assessment of reliability and convergent validity, discriminant validity was examined by applying the heterotrait–monotrait ratio of correlations (HTMT), which has been widely recommended as a robust criterion for evaluating the distinctiveness of latent constructs in variance-based structural equation modeling (Henseler et al., 2015). The results, as shown in Table 2, indicated that all HTMT values were below the recommended threshold of 0.85. This finding suggests that the constructs in the study were empirically distinct from one another and that no serious issues of construct overlap were present. In other words, each construct captured a unique aspect of the conceptual framework, thereby strengthening the overall validity of the measurement model. Therefore, the results of the HTMT analysis confirm that satisfactory discriminant validity was achieved, providing additional support for the adequacy of the measurement model for further hypothesis testing and structural analysis.

Table 1 Results Summary for Multi-dimensional Constructs

Multi-dimensional Constructs									
Constructs	**Items**	**Indicator Reliability**	**Internal Consistency Reliability**		**Convergent Validity**	**Constructs**	**Internal Consistency Reliability**		**Convergent Validity**
First-Order		**Outer Loadings**	**CA**	**CR**	**AVE**	**Second-Order**	**CA**	**CR**	**AVE**
		>0.60	>0.7	>0.7	>0.5		>0.7	>0.7	>0.5
Learner-Content Interaction (LCI)	ILI1	0.677	0.798	0.782	0.783	Online Learning Interaction (OLI)	0.898	0.902	0.592
	ILI2	0.854							
	ILI3	0.79							
	ILI4	0.873							
Instructor-Learner Interaction (ILI)	ILI1	0.862	0.761	0.899	0.882				
	ILI2	0.786							
	ILI3	0.793							
	ILI4	0.897							
	ILI5	0.781							
	ILI6	0.889							
Learner-Learner Interaction (LLI)	LLI1	0.784	0.899	0.913	0.761				
	LLI2	0.777							
	LLI 3	0.721							
	LLI 4	0.745							
	LLI 5	0.782							
	LLI 6	0.883							
	LLI 7	0.799							
	LLI 8	0.813							

Table 2 Results Summary for Uni-dimensional Constructs

Uni-dimensional Constructs						
Constructs		**Items**	**Indicator Reliability**	**Internal Consistency Reliability**		**Convergent Validity**
			Outer Loadings	**CA**	**CR**	**AVE**
			>0.60	>0.7	>0.7	>0.5
Perceived (PS)	Satisfaction	PS1	0.782	0.896	0.945	0.715
		PS2	0.856			

	PS3	0.883			
	PS4	0.881			
	PS5	0.831			
	PS6	0.723			
	PS7	0.732			
Learning Outcomes (LO)	LO1	0.742	0.925	0.831	0.679
	LO2	0.912			
	LO3	0.782			
	LO4	0.882			
	LO5	0.834			
	LO6	0.889			
	LO7	0.867			
	LO8	0.793			
	LO9	0.824			
	LO10	0.912			
	LO11	0.823			
Self-Efficacy (SE)	SE1	0.793	0.933	0.887	0.652
	SE2	0.832			
	SE3	0.912			
	SE4	0.771			
	SE5	0.834			
	SE6	0.912			
	SE7	0.872			
	SE8	0.781			
	SE9	0.798			
	SE10	0.891			
	SE11	0.762			

Table 3 Discriminant Validity: Heterotrait Monotrait (HTMT) Criterion

	ILI	**LCI**	**LLI**	**LO**	**PS**	**SE**
ILI						
LCI	0.464					
LLI	0.814	0.523				
LO	0.726	0.278	0.661			

PS	0.331	0.199	0.454	0.262	
SE	0.293	0.132	0.147	0.452	0.162

7.2 Structural Model

Consistent with the procedure recommended by Hair et al. (2021), the structural path relationships were examined using 1,000 bootstrap resamples with a one-tailed test at the 0.01 significance level. The results of the partial least squares bootstrapping analysis are presented in Tables 4 and 5.

Table 4 reports the findings for the direct-effect hypotheses, including the path coefficients, standard deviations, t-values, p-values, and confidence intervals for each proposed relationship. The results indicate that Online Learning Interaction had a significant positive effect on Learning Outcomes and Self-Efficacy. Specifically, the path coefficient from Online Learning Interaction to Learning Outcomes was 0.573, while the coefficient from Online Learning Interaction to Self-Efficacy was 0.319. Both relationships were statistically significant at $p = 0.000$, providing strong support for the corresponding direct-effect hypotheses.

Table 5 reports the results of the mediation analysis, in which Perceived Satisfaction (PS) was examined as an intervening variable in the relationship between Online Learning Interaction (OLI) and the two dependent variables, namely Learning Outcomes (LO) and Self-Efficacy (SE). The purpose of this analysis was to determine whether OLI influences these outcome variables indirectly through students' perceived satisfaction with their online learning experience. Mediation analysis is particularly important in this context because it helps clarify not only whether online learning interaction has an effect on student outcomes, but also through which underlying mechanism such an effect may occur.

The findings indicate that the indirect effect of OLI on LO through PS was not statistically significant. Specifically, the path coefficient for the indirect relationship OLI to PS to LO was 0.017, with a p-value of 0.151, which exceeds the conventional significance threshold of 0.05. This result suggests that perceived satisfaction did not function as a significant mediator between online learning interaction and learning outcomes. In other words, although online learning interaction may still exert a direct influence on students' learning outcomes, its effect was not transmitted through the mechanism of perceived satisfaction in this study. Therefore, the relevant mediation hypothesis was not supported. This finding implies that improvements in learning outcomes may depend more directly on the quality, frequency, or effectiveness of online interaction itself, rather than on students' subjective satisfaction with the online learning environment.

In contrast, the mediation analysis revealed a statistically significant indirect effect of OLI on SE through PS. The indirect path OLI to PS to SE produced a path coefficient of -0.032 with a p-value of 0.038, which is below the 0.05 significance level. This result indicates that perceived satisfaction significantly mediated the relationship between online learning interaction and self-efficacy, and thus the corresponding hypothesis was supported. The finding suggests that students' perceptions of satisfaction play an important explanatory role in shaping how online learning interaction relates to their confidence in their own learning abilities. Put differently, online learning interaction appears to influence self-efficacy not only directly, but also indirectly through the extent to which students feel satisfied with their online learning experiences.

Taken together, these results demonstrate that the mediating role of perceived satisfaction is selective rather than universal. While PS did not significantly mediate the relationship between OLI and learning outcomes, it did significantly mediate the relationship between OLI and self-efficacy. This pattern suggests that perceived satisfaction may be more strongly associated with students' psychological and affective responses, such as confidence and belief in their academic capabilities, than with more performance-oriented outcomes such as learning achievement. Accordingly, the findings highlight the importance of distinguishing between different types of educational outcomes when examining mediation effects in online learning research.

Table 4 Direct Effect Hypotheses

Hypothesis					**Bootstrapped**		
					CI	**BC**	
Variable Relationship	**Path Coefficient Beta (β)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	***P* Values**	**5% LL**	**95% UL**	**Decision**
OLI->LO (H1)	0.573	0.018	18.462	0.000	0.597	0.714	Accept
OLI->SE (H2)	0.319	0.031	8.752	0.000	0.232	0.362	Accept

Notes: Significant at p<0.05**, OLI->Online Learning Interaction, LO->Learning Outcomes, SE->Self-Efficacy

Table 5 Summary of Mediation Test Effects

Hypothesis					**Bootstrapped**		
					CI	**BC**	
Variable Relationship	**Path Coefficient Beta (*β*)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	***P* Values**	**5% LL**	**95% UL**	**Decision**
OLI->PS->LO(H3)	0.017	0.013	2.123	0.151	-0.003	0.054	Reject
OLI->PS->SE(H4)	-0.032	0.014	2.173	0.038	-0.042	-0.003	Accept

Notes: Significant at p<0.05**, OLI->Online Learning Interaction, LO->Learning Outcomes, SE->Self-Efficacy, PS->Perceived Satisfaction

8. Conclusion

This investigation delves into the dynamics between online learning interaction and its influence on the learning outcomes and self-efficacy of university students in China, with a keen eye on how students' perceived satisfaction levels mediate these effects. By anchoring its inquiry in the principles of social constructivism and Moore's interaction framework, this study meticulously examines the interplay between various forms of digital engagement, namely, the interactions among students, their instructors, and the educational content and their subsequent impact on learning outcomes and self-efficacy. The findings clearly indicate that online learning interactions make a substantial contribution to both academic outcomes and students' confidence in their own learning capabilities. In addition, the study highlights that students' perceived satisfaction with their online learning experience plays a significant mediating role in strengthening self-efficacy. However, this mediating effect was not observed in the relationship between online

learning interactions and learning outcomes.

Through its theoretical lens, this research contributes to the broader conversation on distance learning by reinforcing and expanding upon the existing models concerning online learning interactions. On a practical level, the insights garnered offer a roadmap for educational leaders and policymakers to craft more dynamic and supportive online learning landscapes that accommodate the varied needs of students. This need has become more pressing in light of global challenges such as the COVID-19 pandemic.

8.1 Theoretical Implications

This research develops a framework examining how online learning interaction impacts the learning outcomes and self-efficacy of university students in China, contributing to the broader theoretical discourse of distance education.

This study enriches the existing literature on online learning interactions among Chinese college students by providing theoretical insights into information-driven and human–computer interactive pedagogies. It emphasizes that effective online interaction is not merely a technical feature, but an important pedagogical mechanism that can enhance students' satisfaction, academic achievement, and self-efficacy. In addition, by addressing gaps in previous research, the study offers useful guidance for educators, institutions, and educational technology developers in improving the quality of online learning and promoting the more effective integration of digital technologies in higher education.

Furthermore, the study extends the application of social constructivism and Moore's interaction theory in the context of online education. It emphasizes the importance of instructor–student and student–content interactions, which are often underexplored in these theoretical perspectives. By supporting and broadening these frameworks, the study provides a more comprehensive understanding of how online learning contributes to educational effectiveness and student success.

8.2 Practical Implications

This research advances the understanding of online learning as a strategic approach for improving course accessibility and flexibility in higher education, while also highlighting the educational value of human–computer interaction. It underscores the importance of designing learning systems that respond to students' individual and emotional needs, thereby supporting the effective use of educational resources and promoting balanced cognitive and affective development.

For instructors, the findings provide clear guidance for creating online video content that enhances the learning experience, potentially improving student outcomes. For students, particularly those affected by disruptions like COVID-19, online learning offers invaluable continuity in their education. At an institutional level, online platforms enable the provision of additional courses, thereby broadening students' access to required learning.

By clarifying the ways in which students' engagement in online learning shapes satisfaction, learning outcomes, and self-efficacy, this study offers valuable guidance for instructional designers and educators in the development of high-quality online courses. As a result, the research contributes to the improvement of university education quality and supports the broader advancement of higher education. Moreover, the findings may be extended to different educational

contexts and levels, providing useful implications for the design of more effective online teaching and learning strategies.

8.3 Limitation and Future Research

This research encounters limitations due to various subjective and objective constraints. Primarily, the sample size and scope are confined, as the survey does not encompass a broad segment of Chinese college students, potentially restricting the generalizability of the study's conclusions. Specifically, the study focuses on Chongqing Creation Vocational College students, excluding students from other metropolises like Beijing and Shanghai, which may influence the breadth of grade levels and academic fields considered.

In addition, the variables included in the model may not fully capture the wide range of factors that influence online learning interaction, learning outcomes, and self-efficacy, as these relationships may differ substantially across contexts. The present study primarily focuses on variables that are directly associated with college students' learning outcomes and self-efficacy, which means that other potentially important influences may not have been incorporated. For example, emotional factors such as attitudes, attachment, or related affective dimensions may also play a meaningful role in shaping these outcomes. Consequently, the study may not provide a completely exhaustive account of all the factors that could affect the key variables under investigation.

Data Availability Statements

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Conflicts of Interest

The authors affirm no conflicts of interest.

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