

Article

Exploring the User Acceptance of Online Interactive Mechanisms for Live-Streamed Teaching in Higher Education Institutions

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Abstract: With the advancement of technology and the development of society, live-streamed teaching, characterized by real-time interaction between teachers and students, has emerged as a new form of online education and has rapidly evolved in practice. However, in online live-streamed teaching, there are still various issues, such as insufficient teacher–student interaction and interactive functionalities, that fail to meet learners’ needs. These issues impact the efficiency and user experience of online live-streamed teaching. Currently, scholars mostly examine these issues from the perspective of online teaching system design, paying less attention to exploring the interactive mechanisms from the point of view of user perception. Within the context of Chinese education, based on the technology acceptance model, this study investigated student personality traits, interactive motivations, and platform interactive functionalities, and the aim of this study was to explore the influencing factors and mechanisms of online live-streamed teaching interactions. A total of 281 university students participated in the survey, and the results indicated that the platform’s interactive functionalities significantly and positively predicted perceived usability and perceived ease of use. Moreover, the students’ personality traits significantly and positively predicted interaction motivations and usage attitudes. Furthermore, usage attitudes significantly and positively predicted interactive behavior. A mediation analysis revealed that perceived usability and perceived ease of use mediated the relationship between the platform’s interactive functionalities and usage attitudes. Additionally, interaction motivations mediated the relationship between the students’ personality traits and interactive behavior. We discuss the potential implications and practical significance of the current research findings. The results of this study offer viable strategies for enhancing current online educational practices, aiding educational designers in order to better organize and promote online educational interactions to elevate student engagement and advance the sustainable development of digital education.

Keywords: digital education; online live-streamed teaching; classroom interaction; technology acceptance model; interactive functionalities; personality traits



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1. Introduction

From “Internet+” to the applications of Big Data, cloud computing, and artificial intelligence, online education is currently in the midst of an information technology wave. Online education, based on modern science and technology, has become one of the essential educational methods required for the development of a learning-oriented society [1]. Online education provides teaching to the public, promoting knowledge exchange among learners through abundant educational resources. It transcends temporal and spatial barriers, catering to synchronous and asynchronous learning needs, thereby effectively fostering universal education and lifelong learning [2]. From a sustainability perspective, online education presents an economically efficient educational solution to the limitations of traditional teaching methods. Compared to traditional classroom teaching, online education

reduces the demand for physical infrastructure and instructional resources, thereby minimizing the consumption of forest resources and environmental pollution. This supports the efficient utilization and enhancement of resources while concurrently mitigating carbon emissions, ultimately fostering sustainable educational development and progress [3]. Online education comprises two formats: pre-recorded education and live-streamed teaching. Pre-recorded education involves the real-time recording of instructional visuals and audio using hardware devices; these are promptly transformed into standardized online formats for dissemination to students. This format exhibits a time lag between the teaching moment and the learning experience, ensuring the durability and prolonged accessibility of the educational content. Whilst pre-recorded education means that learners can enjoy a greater flexibility in choosing their study times, the temporal gap between instruction and learning, coupled with the absence of real-time engagement, may lead to a lack of interaction between educators and students. Consequently, this deficiency could result in diminished learner satisfaction [4]. Live-streamed teaching, on the other hand, effectively addresses these limitations. Live-streamed teaching is a novel “Internet+” online educational format conducted on internet platforms, employing real-time broadcasting for the interactive exchange of visual, textual, and auditory information between teachers and students. Its typical characteristics include bidirectional synchronous interaction, timeliness, personalization, and a sense of being present, enabling teaching and learning activities to occur simultaneously in different locations [5]. Especially after the attempts and explorations of various educational organizations during the COVID-19 pandemic, live-streamed education has become a normalized teaching practice in online education. It is predicted that live-streamed education is likely to revolutionize the format of online education, with live courses potentially replacing traditional online courses such as MOOCs, private courses, and online open courses [6].

Online live-streamed teaching interaction refers to the synchronous interactive behaviors conducted among teachers and students, as well as between students themselves (and between teachers, students, and the interface) during the process of live broadcasting instruction [7]. Due to the COVID-19 pandemic, video conferencing tools such as Zoom, Google Meet, and Microsoft Teams have become the mainstream platforms for online education [8]. As a result of this, a plethora of studies have emerged regarding the application of video conferencing systems in the realm of education. Mu’awanah et al. [9] conducted an analysis of Zoom’s interactive learning functionalities within the context of learning the English language, subsequently confirming the valuable role Zoom plays in the pedagogical process. Correia et al. [10] delved into the system functionalities of four extensively utilized video conferencing systems which are relevant to learning, elucidating how these platforms facilitated online education. Zou et al. [11] employed the E-learning usability heuristic approach to assess prominent video conferencing platforms such as Cisco Webex, Microsoft Teams, and Zoom. They revealed that platforms with higher usability ratings consistently featured essential interactive functionalities, including video streaming and real-time communication. Considering the researchers’ geographical and cultural context, this study adopted Tencent Meeting as the subject of their investigation. Tencent Meeting is a real-time and efficient video conferencing tool, akin to Zoom, that is extensively used in the synchronous live-streamed education domain. Notably, it stands out as the most widely employed online education platform in China [12]. In comparison to other online education platforms such as CCtalk, Tencent Meeting distinguishes itself with user-friendly features and straightforward usability [13]. As a result, its selection as the research material for investigating live-streamed education offers a heightened representativeness.

Interactivity is one of the criteria in the user experience evaluation framework, and effective interactive communication is crucial for enhancing the online learning experience [14]. Woo and Reeves [15] pointed out that instructional interactivity is one of the most critical factors in designing online education, as the quality of online teaching depends on instructional interaction [16]. In educational assessment, interactive teaching is a crucial indicator for evaluating teaching quality. However, the current state of online

live-streamed teaching commonly exhibits suboptimal interactivity [17,18], and the lack of teacher–student interaction significantly impacts students’ attitudes towards online learning [19–21]. Furthermore, we must consider that interactivity is not only influenced by the environment, but is also closely related to students’ personality traits [22]. To advance the progress of digital education, create intelligent teaching environments, and enhance the online learning experience for teachers and students, it is crucial to urgently explore the factors that can enhance the teacher–student interaction on online teaching platforms. Therefore, the participants of this study are Chinese university students, and we aim to investigate the influencing factors and mechanisms behind online live-streamed teaching interactions. The ultimate goal of this study is to formulate a user acceptance model for online interactive engagement among university students, thereby providing practical strategies for enhancing the current landscape of online educational interactions and propelling the progression of digital education.

2. Theoretical Background and Hypotheses

2.1. Theoretical Basis

The technology acceptance model (TAM) is a widely applicable model that explains the acceptance and usage behaviors of various information technologies. It is one of the extensively used models in the field of information technology [23]. This model primarily focuses on individual psychological behavior, exploring users’ acceptance and adoption attitudes towards information technology. It particularly emphasizes learners’ or users’ perceived usefulness and perceived ease of use of information systems and how these perceptions influence their willingness to adopt or reject new information technologies. The current model has been well-applied in knowledge management systems, enterprise ERP systems, internet systems, and online shopping systems, becoming a significant analytical foundation in fields such as information systems, information management, and business administration [24,25].

In the digital context, the TAM can be used to explain the acceptance and usage behaviors of various information technologies. It is also widely applied in research on the quality of online learning platforms. For instance, Quadir and Zhou [13] employed the TAM to investigate how students’ perceptions of Tencent Meeting’s distinctive features influenced their perceived ease of use and perceived usefulness of the software, simultaneously analyzing the impact of these factors on learning performance. Alassafi [26] explored the impact of knowledge quality and technological adaptability on learners’ behavioral intentions using the TAM framework. Sukendro et al. [27], utilizing an extended TAM, applied structural equation modeling to analyze the external factors affecting online learning among Indonesian sport students, affirming that the usability and usefulness of learning products could enhance students’ engagement in online learning classes. In the context of online live-streamed teaching, students engage in interactive activities through the use of live broadcasting technologies. The TAM provides a comprehensive theoretical framework that can, to some extent, effectively elucidate the behavior of higher education students towards adopting live-streamed teaching.

This study rigorously adhered to the TAM structure, investigating users’ acceptance of the interactive mechanisms in live-streamed teaching in terms of both objective factors (interactive functionalities) and subjective factors (personality traits). Drawing insights from the application of the TAM and its modified models in various digital contexts, this study extracted perceived usefulness and perceived ease of use as variables at the perceptual level. Additionally, based on the group dynamics theory [28], a set of complex interrelationships influencing usage attitudes and behaviors were identified in the hypothetical model: interactive functionalities, perceived usefulness, perceived ease of use, personality traits, and interaction motivations. These variables collectively formed the user acceptance model of online interaction in live-streamed teaching for university students, as illustrated in Figure 1. In Section 2.2, we will provide detailed explanations of each variable, drawing on previous research findings.

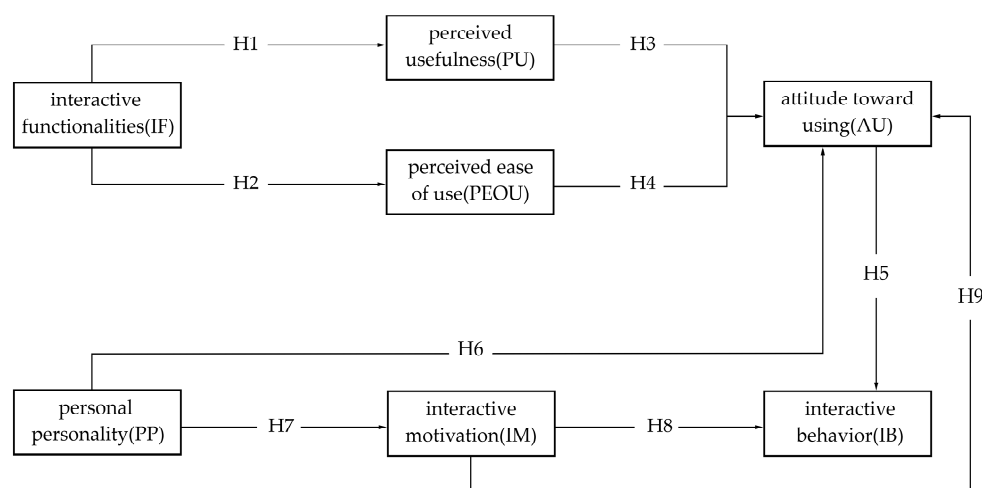


Figure 1. User acceptance model of online interaction in live-streamed teaching for university students.

2.2. Research Hypotheses

2.2.1. Interactive Functionalities of the Platform and Online Teaching Interactions

In the process of online teaching, effective interaction between teachers and students, as well as among students, is a crucial means for reorganizing instructional behaviors and ensuring the quality of online education [29]. Well-functioning interactive features on a teaching platform become particularly crucial in this regard. Interactive functionalities are considered to be a necessary condition for facilitating cognitive interaction or, in certain circumstances, are deemed indispensable [30]. The interactive functionalities of online teaching platforms effectively facilitate meaningful communication and engaging interactions among students, as well as between students and instructors [5]. To assess the interactive functionalities of various platforms, we conducted a comparison between Tencent Meeting and internationally recognized online teaching tools such as Zoom. Zoom offers a diverse array of interactive features such as whiteboards, screen sharing, and online polling, facilitating more dynamic communication and collaboration between teachers and students. On the other hand, Tencent Meeting focuses more on the practicality of remote meetings and online education, offering stable audio and video communication tools suitable for large-scale online teaching. These platforms provide an array of interactive methods. For the sake of research typicality, we selected three fundamental interactive functionalities commonly found on live learning platforms and frequently employed in live classroom settings for examination, namely video-, audio-, and text-based interactions. Within the Tencent Meeting classroom environment, there exist three primary methods for teacher–student interaction. The first entails students inputting and transmitting content through a chat box, which is then displayed on the screen. The second involves teachers posing questions that students answer audibly or discuss with the teacher. Lastly, the third method entails students engaging in communication and collaboration through audio and video interactions. The practicality and user-friendliness of these interactive functionalities profoundly influence online teaching interaction behaviors. For instance, the real-time video functionality of the platform enables instructors to provide high-quality audio and video demonstrations, while also allowing students to view, engage, and connect with both teachers and peers. This, in turn, captures students’ attention and enhances their participation, effectively addressing a significant drawback associated with remote education, that being the lack of interaction and interpersonal contact between students and instructors [31,32]. Students’ understanding of these communication tool functionalities, their utilization, and related factors directly or indirectly impacts their perception of interactive behaviors. Interactive functionalities can facilitate interaction between students and instructors by providing a variety of communication tools. Effective interactive methods can stimulate student engagement and foster in-depth discussions, aiding learners in deep-

ening their understanding of the study material. They also enable instructors to provide timely feedback and guidance, leading to improvements in teaching quality and learning outcomes [33,34]. As learners' learning performance improves, their perceived usefulness also increases correspondingly. Furthermore, the quality of online learning interactions also significantly influences learners' satisfaction with online courses [34]. An intuitively understandable interactive interface design and simple, clear navigation not only lower the learning barrier for learners, allowing them to focus on the study content itself, but also enable them to quickly locate needed functionalities and easily interact with other learners and instructors. From this, it can be inferred that the interactive functionalities of online live-streamed teaching platforms influence learners' perceived usefulness and ease of use. In conclusion, the following hypotheses are proposed:

H1. *Interactive functionalities positively influence perceived usefulness.*

H2. *Interactive functionalities positively influence perceived ease of use.*

2.2.2. Perceived Usefulness and Perceived Ease of Use Mediate the Relationship between the Platform's Interactive Functionalities and Online Teaching Interactions

In online teaching interactions, perceived usefulness refers to the value that learners perceive in the interactive functionalities of the educational platform for their learning process and outcomes. Perceived ease of use refers to the convenience and simplicity that learners experience when using the interactive functionalities on the educational platform. In the TAM and its extended versions, perceived usefulness and perceived ease of use have consistently held a central position. Numerous researchers have empirically analyzed perceived usefulness and perceived ease of use and found that they both have a positive effect on individuals' attitudes towards the acceptance and adoption of information technology [35,36]. Researchers believe that the effective use of information systems is determined by factors such as individual behavioral intentions, usage attitudes, and user perceptions. The causal chain "cognition-response-attitude-intention-behavior" is employed to explain, diagnose, and predict users' attitudes and behaviors when confronted with new information systems [35]. In this context, online interaction refers to the behavior of real-time communication, participation, and collaboration between two parties within the system. The group dynamics theory posits that individual behavior is a result of the interaction between the environment and internal psychological factors, and this process represents the mutual adaptation between learners and their environment [28]. For students attending online classes, their ability to persistently engage in live webinars and actively participate in various forms of online interactive communication depends on both individual factors and the resources provided by the platform. Learners' initial learning involvement leads to different perceptions of the learning experience. Positive learning experiences and perceptions generally motivate them to increase their learning involvement and online interactions, while negative experiences and perceptions lead to reduced learning involvement and decreased online interactions. This continuous cycle ultimately reinforces learning behavior or gradually diminishes it.

According to the current research on live-streamed education, a well-designed, user-friendly interface can enhance learners' operational efficiency, enabling them to focus on the content and objectives of communication, thus facilitating smoother engagement in interactive activities. When learners perceive online interactive system resources as clear, straightforward, and easy to use, they are more likely to exhibit a positive attitude towards engaging in online live-streamed education interactions and willingly invest time in participating in such activities. Interactive functionalities can provide effective support and immediate feedback to learners, aiding them in error correction, refining their learning strategies, and enhancing their learning outcomes. Consequently, this enhances learners' perceived usefulness of these interactive functionalities and fosters their engagement in interactive behaviors. When students effectively benefit from online technology and perceive its usefulness, they are more inclined to engage in social and collaborative activities

within the online learning environment, as well as participate in cognitive activities [37–39]. In conclusion, the following hypotheses are proposed:

H3. *Perceived usefulness mediates the effect of interactive functionalities on promoting interactive behaviors on the platform.*

H4. *Perceived ease of use mediates the effect of interactive functionalities on promoting interactive behaviors on the platform.*

H5. *Attitude toward use positively influences interactive behaviors.*

2.2.3. Students' Personality Traits and Online Teaching Interactions

Personality refers to an individual's enduring attitudes towards reality and the habitual behavioral patterns that correspond to them, developed throughout their life experiences [40]. Based on individuals' activity tendencies, researchers commonly categorize people into two types: introverts and extraverts [41]. Extraverted individuals are generally characterized by emotional expressiveness, freedom, liveliness, and strong interpersonal skills. In the classroom, they tend to actively express their thoughts, enjoy group learning, and engage in cooperative problem-solving processes [42]. During online discussions, they often display more cognitive interactions, exhibit curiosity about their surroundings, and adapt easily to changing environments [40]. Students with such personality traits typically hold positive attitudes towards new technologies, products, or services. Introverted individuals are generally characterized by cautiousness, thoughtful deliberation, hesitancy in social interactions, and a preference for reflective thinking and information integration [42]. These introverted learners tend to exhibit a cautious attitude towards new technologies, products, or services.

Recent studies have found that extraverted learners may possess a higher self-efficacy, which can positively influence their attitudes and behavioral intentions towards online learning [21,43,44]. Extraverted learners tend to have higher levels of internet and academic self-efficacy [45] and a stronger perceived confidence in participating in and engaging with online learning activities [46]. As a result, they exhibit a higher propensity for positive attitudes and engagement in online interactions. In conclusion, the following hypotheses are proposed:

H6. *Individual personality traits can influence usage attitudes, with extraversion having a positive impact on usage attitudes.*

2.2.4. The Mediating Role of Interaction Motivation between Students' Personality Traits and Online Teaching Interactions

Motivation refers to the psychological inclination that initiates individual activities, sustains the activities already initiated, and guides these activities towards a specific goal. In online live teaching, interaction motivation refers to the driving force within college students that motivates their engagement in online educational interactions, which is primarily divided into two levels: active interaction motivation and passive interaction motivation, often demonstrated as a strong desire to ask questions, curiosity and interest in the learned knowledge, and a diligent and proactive learning attitude. College students' interactions that they willingly initiate to acquire knowledge, skills, or pursue their interests belong to active interactions; in contrast, passive interactions are those engagements resulting from objective requirements, such as exams or compulsory instructions from teachers, where they have no alternative but to participate. Some studies have indicated that individuals with an extraverted personality exhibit a stronger communication willingness [47]. They are more inclined to actively participate in online live classes by unmuting themselves to interact with the teacher and answering questions, thus demonstrating a higher level of interactive motivation. Extraverted individuals typically seek energy and satisfaction through social interactions. When engaging in online live interactions, they are more

inclined to establish connections with other viewers and hosts, actively participating in social exchanges. Their strong social desire prompts them to take on active roles during online live teaching, thereby increasing their interactions with teachers and fellow students. Recent research has also confirmed that an extraverted personality significantly influences learning motivation [48]. Compared to introverted individuals, students with an extraverted personality exhibit stronger interactive motivations and engage in interactions more frequently. In conclusion, the following hypotheses are proposed:

H7. *Extraverted personality positively influences interactive motivation.*

H8. *Interactive motivation plays a mediating role in the relationship between extraverted personality and interactive behavior.*

H9. *Interactive motivation positively influences usage attitude.*

3. Method

3.1. Participants

A convenient sampling method was employed to distribute questionnaires and conduct surveys among the university student population. This survey primarily utilized online questionnaires. A total of 370 questionnaires were collected and, after excluding invalid responses with extremely short completion times, identical answers for all questions, and those from participants who had not used Tencent Meeting for online live-streamed teaching, 281 valid questionnaires were obtained, resulting in an effective response rate of approximately 75.95%. Based on the statistical analysis of the sample data from this survey, males accounted for 44.16%, while females accounted for 55.84%. The respondents' ages were mainly concentrated between 18 and 27 years old. Among them, undergraduate students constituted 92.57%, and graduate students accounted for 7.43%.

3.2. Instrument Development

Based on relevant scales and the real situation of online learning platforms, the related measured items in the questionnaire were suitably adapted. We set seven variables for the users' online learning platform usage intention model and the items were measured on a 5-point Likert scale with "strongly disagree" at 1 and "strongly agree" at 5. Each variable was evaluated in the questionnaire using one to three measured items. They were adjusted based on previous studies in the field of technology acceptance and primarily derived from validated measurement scales used in previous research [30,35,36,39,49–51]. The specifics of the questionnaire are outlined in Table 1.

Table 1. Construct and items.

Construct	Scale Items	Source
PU	PU1: In-platform online interactive functionalities enhance my learning efficiency. PU2: In-platform online interactive functionalities improve my learning outcomes. PU3: In-platform interactions help me solve learning problems or make the process of problem solving easier.	[36,52]
PEOU	PEOU1: I can quickly find the required features and applications in the platform. PEOU2: The platform's operation is very clear and easy to understand. PEOU3: Using Tencent Meeting for interaction is very easy for me.	[36,52]
AU	AU1: I am willing to use interactive functionalities such as typing, voice, and video during online classes. AU2: I find it very enjoyable to use interactive functionalities such as typing, voice, and video during online classes. AU3: The likelihood of me recommending my classmates/friends/team members to use interactive functionalities in Tencent Meeting is very high.	[35,51]

Table 1. *Cont.*

Construct	Scale Items	Source
IF	IF1: The chat window communication feature is highly user-friendly. IF2: The voice communication feature is highly user-friendly. IF3: The platform's video interaction feature is highly user-friendly.	[30]
PP	PP1: I am willing to actively answer the teacher's questions. PP2: I consider myself always very actively engaged in the classroom.	[49,53]
IM	I am often proactive during online interactions.	[39]
IB	I frequently participate in various forms of online interactions, including typing, voice chat, and video on the platform.	[50,54]

Note: PU: perceived usefulness, PEOU: perceived ease of use, AU: attitude toward using, IF: interactive functionalities, PP: personal personality, IM: interactive motivation, and IB: interactive behavior.

4. Results

4.1. Analysis of Reliability and Validity

The data were first analyzed for their reliability and validity using SPSS 26.0 (IBM, Armonk, NY, USA). Reliability was measured using Cronbach's alpha and combined reliability (CR). For the online live teaching platform usage intention model, the Cronbach's alpha values of the variables ranged from 0.77 to 0.88, and the CR values ranged from 0.78 to 0.88; all were above the standard value of 0.7. This indicates that the scale data were real and reliable and the measured items had a high internal consistency and overall reliability. These findings are summarized in Table 2.

Table 2. Scales for reliability and convergent validity.

Construct	Number of Items	Cronbach's Alpha	CR	AVE
PU	3	0.876	0.877	0.705
PEOU	3	0.818	0.820	0.604
AU	3	0.834	0.834	0.627
IB	1	-	-	-
IF	3	0.773	0.778	0.542
IM	1	-	-	-
PP	2	0.851	0.850	0.740

Note: CR: composite reliability; and AVE: average variance extracted.

We evaluated the validity of the questionnaire by assessing both the content and construct validity. The questionnaire items were either inferred from the relevant references or adapted from mature scales to ensure that they had a good content validity. Structural validity is composed of convergent and discriminant validity; the former requires the AVE values of the variables to be greater than 0.5 and composite reliability (CR) values which are above 0.7. As shown in Table 2, this model's AVE and CR values met the criteria for having a good convergent validity. To fulfill discriminant validity, the square roots of the AVE values of each variable must exceed the correlation coefficients among the variables. As shown in Table 3, the square roots of all the AVE values for the variables were greater than their correlation coefficients, which is an indication of a good discriminant validity.

Table 3. Correlation matrix and discriminant validity.

	1	2	3	4	5
1. PP	0.860				
2. PU	0.433	0.840			
3. PEOU	0.331	0.440	0.777		
4. AU	0.547	0.632	0.522	0.792	
5. IF	0.335	0.391	0.447	0.523	0.736

Note: Scores in bold represent the square root of average variance extracted for a construct.

4.2. Structural Model and Testing of the Hypotheses

We built a structural equation model (SEM) using AMOS 26.0 to examine the framework of the hypothesized model and investigate the association between each variable and the usage attitudes and behaviors of users. Firstly, the model fit was tested with CMIN/DF = 2.704, CFI = 0.931, TLI = 0.915, SRMR = 0.081, and RMSEA = 0.078, demonstrating that the model fit was acceptable. The relationship between the variables was displayed using path coefficients. The size of the path coefficients was indicative of the strength of the influence between different variables, with positive values denoting a positive correlation and negative values indicating a negative correlation. Table 4 presents the results of the parameter estimation and hypothesis testing for the model of the usage attitudes and behaviors of users.

Table 4. Structural model results.

Dependent Variable	Hypothesis	Path	β	p Value	Hypothesis Supported
PU	H1	IF \rightarrow PU	0.586	<0.001 ***	Supported
PEOU	H2	IF \rightarrow PEOU	0.634	<0.001 ***	Supported
AU	H3	PU \rightarrow AU	0.384	<0.001 ***	Supported
	H4	PEOU \rightarrow AU	0.311	<0.001 ***	Supported
	H5	AU \rightarrow IB	0.532	<0.001 ***	Supported
	H6	PP \rightarrow AU	0.244	<0.001 ***	Supported
	H9	IM \rightarrow AU	0.273	<0.001 ***	Supported
IM	H7	PP \rightarrow IM	0.651	<0.001 ***	Supported
IB	H8	IM \rightarrow IB	0.244	<0.001 ***	Supported

Note: *** $p < 0.001$.

The validation results of the structural model demonstrated strong support for our proposed theoretical framework based on the collected user data. Specifically, in the online interactive user acceptance model we proposed, we examined subjective and objective factors. On the one hand, we confirmed that usage attitudes significantly influenced usage behavior (H5, $\beta = 0.532$, $p < 0.001$), thus validating the mediating roles of perceived usefulness and perceived ease of use (H1, $\beta = 0.586$, $p < 0.001$; H2, $\beta = 0.634$, $p < 0.001$; H3, $\beta = 0.384$, $p < 0.001$; H4, $\beta = 0.311$, $p < 0.001$). On the other hand, personality traits and interactive motivations directly impacted usage attitudes (H6, $\beta = 0.244$, $p < 0.001$; H9, $\beta = 0.273$, $p < 0.001$), with personality traits indirectly influencing users' usage behavior through the mediating effect of interactive motivations (H7, $\beta = 0.651$, $p < 0.001$; H8, $\beta = 0.244$, $p < 0.001$). The findings are displayed in Table 4 and Figure 2.

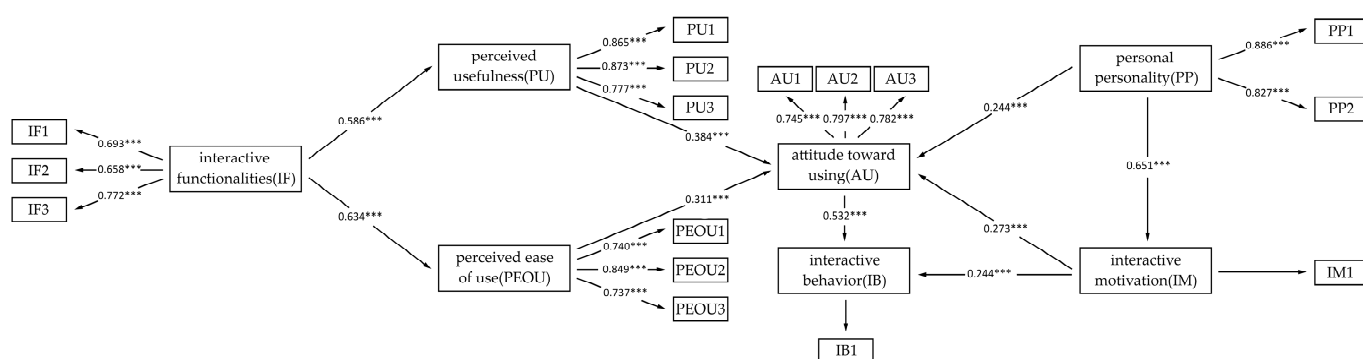


Figure 2. Structural model results. Note: *** $p < 0.001$.

5. Discussion

5.1. Discussion of the Results

This study systematically examined the factors that affect users' acceptance of the interactive functionalities of live-streamed educational platforms and how they impact

users' online interactive behavior. The current results indicated that, from the perspective of objective factors, interactive functionalities can indirectly influence users' usage attitudes through the mediating roles of perceived usefulness and perceived ease of use, subsequently impacting users' interactive behavior. Perceived usefulness concerns users' perceptions of whether interactive functionalities can genuinely enhance their learning process and academic outcomes. Students who take part in online live-streamed teaching are able to interact with their instructor and classmates in real-time through interactive functionalities to discuss and solve problems, enhancing the depth of their learning. When users recognize that interactive functionalities can effectively enhance their academic outcomes and learning experience, they are naturally more inclined to actively use this feature with the aim of obtaining more pedagogical value. This positive perceived usefulness provides motivation for users to develop a positive attitude toward the use of an online platform. Perceived ease of use emphasizes the ease with which students can operate the interactive functionalities and the user-friendliness of the platform interface. A simple and intuitive interface enables users to familiarize themselves with and use the interactive functionalities of the platform in a small amount of time. When students are able to use these interactive functionalities effectively, they will likely feel that the process of interaction is smooth and effortless, and this perceived ease of use will positively influence their attitudes toward using the platform. This finding is consistent with the Theory of Planned Behavior (TPB) [55]. Similarly, there are a number of findings suggesting that users' perceived usefulness and perceived ease of use of functional technologies determine their attitudes toward using them [35,56,57]. Our findings led to similar conclusions, emphasizing perceived usefulness and perceived ease of use as key factors influencing students' attitudes toward their use of interactive functionalities. The notion that attitudes toward use significantly and positively influence users' actual interactive behaviors is also well established [58,59]. Students' attitudes toward using the platform's interactive functionalities directly determine their willingness to engage in classroom interactions. When students have positive attitudes toward interactive functionalities, they are more inclined to actively participate in interactions and communicate and collaborate with their instructor and peers. Positive interactive behaviors also contribute towards the exchange of knowledge, thereby enhancing the learning process. Additionally, the results of the research analysis supported the hypothesis of the mediating effect, aligning with the findings from the relevant literature on the technology acceptance model. Thus, the dual effects of perceived usefulness and perceived ease of use on students' attitudes toward the use of interactive functionalities are ultimately manifested in the interactive behaviors that shape students' experiences of instructional interaction.

From the perspective of subjective factors, personality traits and motivation for interaction can directly influence users' attitudes towards the use of the interactive functionalities. At the same time, personality traits indirectly affect users' interactive behavior through the mediating role of motivation for interaction. Students' personality traits largely shape their behavioral patterns and preferences. Extraverted students are usually socially energetic and tend to actively participate in interactions. In online live-streamed teaching situations, they are more willing to speak, ask questions, and share their opinions to fulfill their social needs and academic curiosity. On the contrary, introverted students favor independent thinking and introspection; they are more inclined to observe and learn in the classroom than to actively voice their opinions. Differences in attitudes toward the use of interactive functionalities among students with different types of personalities are also consistent with the personality tendencies that characterize introverted and extraverted individuals [40,41]. Interaction motivation is the intrinsic driving force that propels users to engage in interaction. Positive interaction motivation, such as a desire to learn, will encourage users to interact with their instructors and classmates more frequently. Conversely, users who lack interactive motivation show lower levels of motivation in classroom interactions, thus limiting their interactive behaviors. In previous studies [60–62], the idea that motivation in online learning environments influences students' online behaviors has been similarly

presented. However, Weiser et al. discovered that extraverted personality types more frequently engage in social interaction compared to introverted personality types [63]; the direct effect of personality traits on interactive behavior in the study was not significant, but the mediating effect of motivation was required in order to interact. We argue that personality traits shape the nature of users' motivation to interact. Individuals with an extraverted personality type are more likely to generate positive interaction motivation in online live-streamed teaching situations to fulfill their social needs, whereas, due to their personality traits, the interaction motivation of introverted individuals is relatively weak. Therefore, even though personality traits do not directly affect interactive behaviors, the transmission of interactive motivation allows these traits to eventually be expressed in interactive behaviors. This finding emphasizes that interaction motivation is a mediating factor connecting personality and behavior.

5.2. Theoretical and Practical Implications

This study investigated the interaction mechanisms of online education platforms in the context of internet education through the use of the technology acceptance model. It examined the differences in the acceptance of online interaction among university students regarding live-streamed education platforms and explored the factors and behaviors that influence users' use of the interactive functionalities on online education live-streaming platforms. Prior research on the interactive functionalities of online education platforms has predominantly focused on recorded education or the teaching of interactive mechanisms aimed at enhancing students' learning performance. Nevertheless, few studies have focused on exploring the user acceptance of interactive functionalities and actual interactive behaviors in online live-broadcasted education. Therefore, on the basis of relevant theories and previous research, we proposed a user acceptance model to promote the online interactive engagement of university students in online live-streamed teaching environments. This study revealed that platform interactive functionalities influence perceived usefulness, perceived ease of use, and usage attitudes. Moreover, students' personality traits influence their motivations for interaction and usage attitudes. Usage attitudes directly affect interactive usage behavior. Perceived usefulness and perceived ease of use mediate the relationship between platform interactive functionalities and usage attitudes, while motivations for interaction mediate the relationship between students' personality traits and usage behavior. The insights obtained from our study offer a new perspective for a comprehensive understanding of students' online learning behavior. Identifying the factors that influence students' online interactions can also provide educational designers with a scientific foundation for their decision making, enabling them to more accurately design teaching strategies, improve the quality of online education, and promote the sustainable development of online education.

Our findings also provide guidance on practical applications for the development of online live-streamed education, especially in the design of online education platforms and the development of teaching strategies. On the one hand, based on the idea that interactive functionalities influence usage attitudes through the mediating roles of perceived usefulness and perceived ease of use, this suggests that live education platforms should pay more attention to users' subjective feelings and their perceived value of the interactive experience when designing and optimizing future interactive functionalities. Platform providers could innovatively provide personalized interactive options and design customized interactive tools for different disciplines, learning objectives, and student groups to meet diverse teaching needs. They could also make use of data analyses and user feedback mechanisms to continuously optimize the operability of their interactive functionalities and ensure that the interactive experience meets users' expectations. Based on the view that personality traits can influence usage behavior, this could occur through the mediating role of interaction motivation. Teaching strategy makers could flexibly set up interactive sessions in online live classrooms, for example, by providing text communications, group discussions, question–answer interactions, and other forms to stimulate students' motivation to interact

and satisfy the interactive preferences of students with different personality traits. In addition, it is recommended that live education platforms establish a long-term personality analysis mechanism, develop tools for personalized interactive guidance, and ensure that their interactive functionalities include easy-to-accept interactive content and forms to help enhance students' confidence and engagement during interactions.

5.3. Limitations and Future Studies

There are a number of limitations to the present study. First, due to the existence of subjectivity in the study, it is difficult to completely eliminate measurement bias, and selective bias in the selection of the survey population makes the population that completed the questionnaire biased in terms of geography and grade level. Second, the object of the study, Tencent Meeting, is a popular audio and video conferencing tool favored by China's major universities, but it was not primarily designed and developed to support learning, meaning that many of the platform's configurations and operating software are designed primarily for corporate users rather than educators. Therefore, the platform is limited in terms of not creating a learning atmosphere and lacking specific learning functions. Future comparative studies should further explore the differences between various live learning education platforms and their impacts on learning activities. This study only explored the perspective of online live-streamed teaching. While existing online live-streamed teaching platforms are evolving, in the future, a more in-depth study should be conducted to specifically focus on online education platforms in order to explore richer interactive features of teaching. In addition, this study used the technology acceptance model to explore the interaction mechanism of online education platforms and explored the influencing factors and role mechanisms of online live-streamed teaching interactions. However, areas outside of technology acceptance, such as the specific practical ways of applying interactive video conferencing in teaching environments and the impact of interaction on improving learning outcomes, were not further explored. Subsequently, the scope of the study should be expanded in future to delve into the broader applications of interactive video conferencing in teaching and learning. This expansion could involve utilizing grounded theory and building upon empirical information.

Amidst the wave of digitization, the future development of live-broadcasting education presents new opportunities and challenges. Despite the immense potential of live-broadcasting education, this field is currently immature and has not fully leveraged its crucial interactive features. In the future, active exploration of innovative models for interactive live-broadcasting education is necessary for forging new pathways for the sharing of high-quality educational resources.

6. Conclusions

This study explored the influencing factors and mechanisms of online live-streamed teaching interactions, and the results showed that platform interactive functionalities had a significant positive predictive effect on perceived usability and perceived ease of use, and student personality traits had significant positive predictive effects on both interactive motivation and attitudes toward use. Furthermore, attitudes toward use exhibited a significant positive effect on predicting interactive usage behaviors. Further mediation effect tests found that perceived usability and perceived ease of use mediated the relationship between platform interactive functionalities and attitudes toward use, whereas interactive motivation mediated the relationship between student personality traits and usage behavior. On a theoretical level, these findings have important implications for future research on the interactive mechanism of online live-streamed teaching for college students. On a practical level, the results of this study provide a scientific decision-making basis for the designers of educational strategies in colleges and universities to improve the interactive quality of online-streamed teaching in colleges and universities, thus enhancing the quality of teaching. The results could also assist live-streamed education platform providers in optimizing their interactive functionalities and offering personalized interactive support

to enhance students' engagement with live-streamed teaching, improve the usability and ease-of-use of live-streamed teaching platforms, and promote the sustainable development of education.

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