Development and empirical study of international student satisfaction model of online course learning interaction in chinese universities

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Abstract

COVID-19 has disrupted education internationalisation around the world, making online learning a necessary means of learning. This study proposes an International Student Satisfaction Index Model (ISSM) on the interaction of online international courses in Chinese universities, aiming to investigate the potential factors that affect international students' online learning interaction. Based on the large-scale online course practice in Chinese universities during the pandemic, this study adopted a stratified random sampling method to select 320 international students participating in online courses as a research sample. The model proposed in this study includes four antecedent variables, one target variable, and one outcome variable. This study is quantitative, using SPSS26.0 and AMOS 21.0 to analyse the collected empirical data, and the results verify the nine research hypotheses proposed and the applicability of the online course international students' satisfaction index model (ISSM) proposed. The research results provide strong theoretical and practical support for international students' satisfaction with online course learning interaction, which is conducive to the reform of online courses and improving international students' retention rate in the online course.

Abbreviation
ISSM   International Student Satisfaction Index Model
HEIS   Higher education institutions
SE   Students' Expectation
PQ   Perceived Quality

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PV   Perceived Value
TP   Technical Performance
SS   Student Satisfaction
SL   Student Loyalty

1 Introduction

In recent years, Higher Education Internationalisation has gradually become a global trend, and the scale of international student mobility is also increasing. The study of international student satisfaction has attracted the attention of researchers (Feifei, 2021). However, the COVID-19 pandemic has brought serious challenges to the internationalisation of higher education, with international students unable to enrol normally in the short term. Universities around the world were forced to start moving all academic courses online in the spring of 2020 (Bao, 2020; Hodges et al., 2020), and online learning has become a necessary means of ensuring the normal education activities in colleges and universities during the epidemic (Agyei-waah et al., 2022). An increasing number of higher education institutions (HEIS) are adopting various technological platforms to support online learning in higher education (Yunusa & Umar, 2021).

Online courses have the advantages of personalisation, flexibility, and convenience, which can provide various course learning services for online learners at all times and places (Danchikov et al., 2021; Muljana and Luo, 2019). Therefore, most HEIS have made complete online courses part of the overall university curriculum, encouraging students to complete online courses (Abuhassna et al., 2020). Research by Ali (2020) shows that online learning is a necessary means of coping with future unpredictable circumstances that affect teaching. Even if COVID-19 is alleviated and quarantine policies are lifted, most students still express their willingness to continue their studies in online courses in the future (Danchikov et al., 2021). But, the low retention rate of students taking online courses has been considered a great challenge for educators (Muljana and Luo, 2019). Online education programmes are under pressure to retain students, and HEIS are constantly striving to meet student demand for educational services and find ways to improve student satisfaction to attract and retain both domestic and international students (Kanwar and Sanjeeva, 2022). One of the most important and non-negligible reasons leading to the failure of online learning and the increase in students' dropout rate is the lack of interaction in online courses (Purarjomandlangrudi and Chen, 2020). Baber (2020) concluded that online interaction is one of the important determinants of students' online learning satisfaction. Regarding the research on the satisfaction of students participating in online learning in the future, researchers should focus on the experience and practice of online courses during the pandemic (Baber, 2020).

Based on the previous relevant literature, there are still obvious theoretical gaps, practice gaps, and empirical gaps in the related literature on the development of the international student satisfaction model in the aspect of online course interaction. An obvious theoretical gap is that previous theories on student satisfaction models tend to focus on educational service management, and do not include the new paradigm

of online course research (Kuo et al., 2014; Temizer and Turkyilmaz, 2012; Zhang et al., 2008). The practice gap is that, although the research on online interaction to predict students' satisfaction has been mature, it seems that few researchers focus on the research on students' satisfaction with online course learning interaction (Ngo and Ngadiman, 2021; Wang et al., 2022). The gap in empirical research is that most empirical studies on students' satisfaction in online learning are based on domestic students, and these research results are not necessarily suitable for international students (Kanwar and Sanjeeva, 2022).

The number of international students in Chinese universities has been rising significantly in recent years. In the field of international education services, however, the whole competitiveness of Chinese universities still needs to be improved (Lin et al., 2020). As the main customers of internationalisation courses, whether the learning needs of international students can be met is a research point that deserves high attention. Chinese universities are expecting to play a greater role in the international education market. Based on the large-scale online international courses conducted by Chinese universities during the COVID-19 period, this study focuses on online learning interaction from the perspective of international students, to develop a model of online course interaction satisfaction suitable for international students in Chinese universities. The purpose is to try to fill the research gap in this field, with a view to improve the international students' satisfaction with online course learning interaction, the online course retention rate of international students, and their willingness to continue online learning.

2 Research Theoretical Framework

In this study, the typical customer satisfaction index models and Technology Acceptance Model (TAM) are introduced as the theoretical framework for model development. Through the analysis of supporting theories, this research will draw the enlightenment of scientifically developing a model of international students' satisfaction with online course interaction.

3 Typical Customer Satisfaction Index Model Theories

Researchers began to focus on comprehensive research on customer satisfaction in the 1970s (Zhang et al., 2019). The Swedish Customer Satisfaction Barometer (SCSB) model contains five latent variables and six relationships (Fornell, 1992). Compared with SCSB, the American Customer Satisfaction Index (ACSI) model adds a latent variable (Perceived Quality). As shown in Fig. 1, this is mainly to refine the concept of perception to understand whether the customer is quality-driven or price-driven. The European Customer Satisfaction Index (ECSI) model is adjusted based on the ACSI model, as shown in Fig. 2: First, the ECSI model removes the variable of customer complaints, mainly due to the gradual improvement of complaint systems in many countries. Second, the ECSI model also adds the variable of
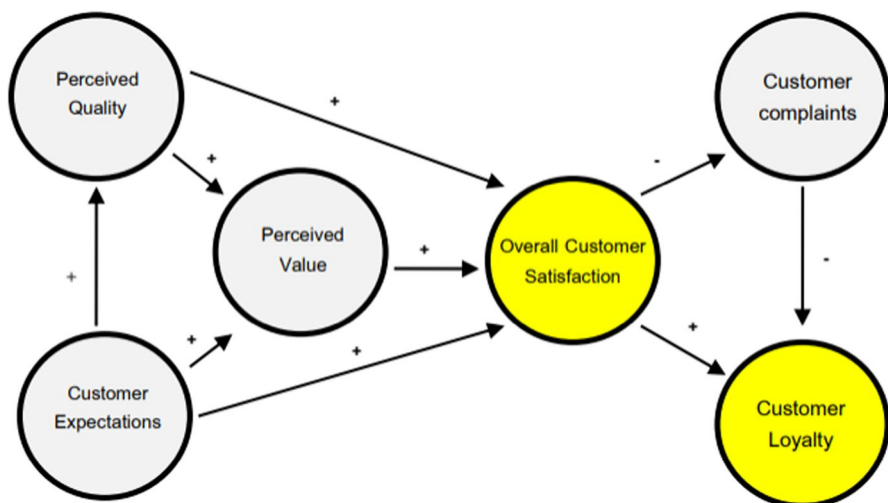
Fig.1 Conceptual framework of the ACSI model.
Source: Jantarakolica et al. (2017)
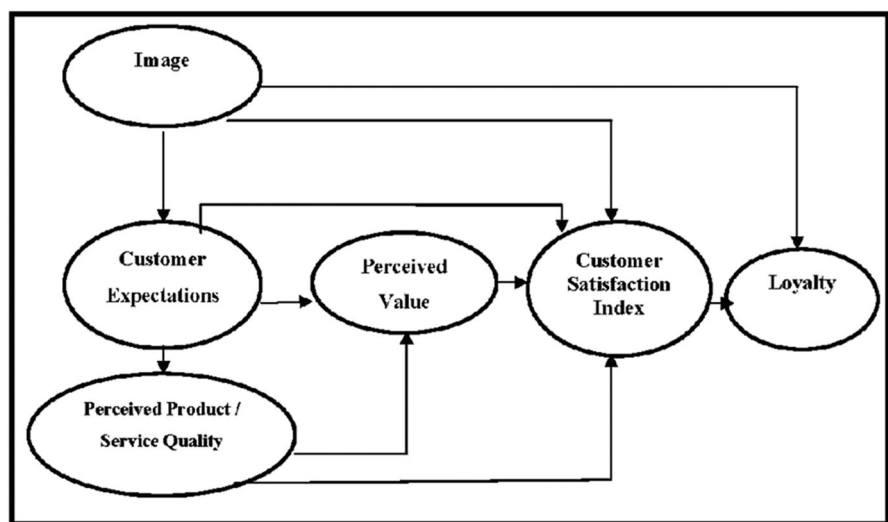
Fig.2 ECSI Model.
*Source:* Johnson et al. (2001)

image. In the ECSI model, the newly added image variable directly affects customers' expectations, satisfaction and loyalty.

The ACSI model, as a more advanced customer satisfaction measurement tool, can more effectively improve customers' satisfaction and loyalty degree (Xue and Yang, 2008). The dimensional design of the ACSI model is more reasonable,

usable, and operable (Han et al., 2021), and it also has significant effects in the field of educational technology (Ji, 2021; Jing & Zhichao, 2021). Martensen et al. (2000) proposed the first ECSI model to evaluate students' satisfaction with Higher Education Service Quality, and this was followed by many other researchers who all began to use the ECSI model to study student satisfaction (Eurico et al., 2018). The above analysis of the SCSB model, ACSI model, and ECSI model provides the following inspirations for this study to build an International Student Satisfaction Model (ISSM) for online course interaction: First, the designs of the three typical customer satisfaction models are relatively simple. The latent variables are marked and have strong operability. Second, the customer satisfaction model is constantly adjusted according to specific changes. The ACSI model adds a latent variable (Perceived Quality) to the SCSB model, and the ECSI model adds an image to the ACSI model, eliminating customer complaints. Third, these three typical customer satisfaction models are all structural variable models, which can not only study the direct effects between variables but also the indirect effects between variables.

4 Technology Acceptance Model (TAM)

Davis et al. (1989) first proposed the TAM to explain the acceptance of information systems. This model was later revised by Straub et al. (1995), and the revised TAM is now widely accepted by most researchers (Li and Li, 2009). TAM is based on the Theory of Reasoned Action (TRA) (Hale et al., 2002), especially for the use of science and technology, which aims to explain most technology use behaviours. As shown in Fig. 3, the TAM assumes that both Perceived Usefulness and Perceived Ease of Use will directly affect the Attitude Towards Using Technology and then indirectly affect the specific user's Behaviour Performance.
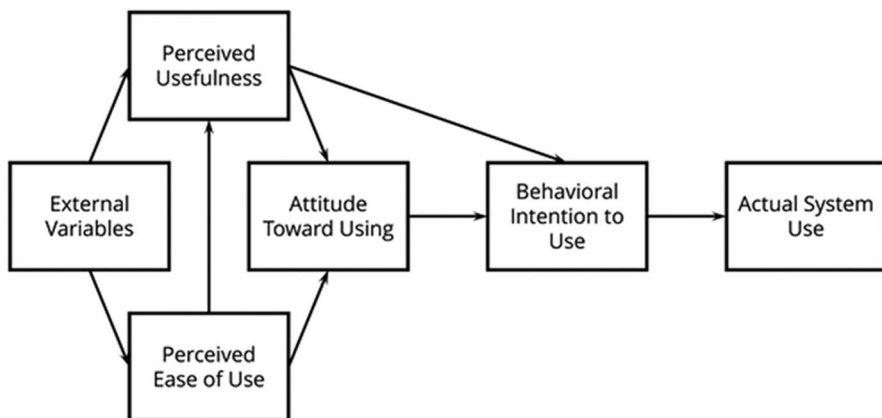
Fig.3 TAM.
Source: Abu-Taieh et al. (2009)

5 Development of Research Hypotheses

This section will discuss the development of research hypotheses in conjunction with the relevant literature. The previous development of the student satisfaction index model in HEIS has more references to the ACSI model and the ECSI model. Online education also involves technical issues. The stability and ease of use of online technical facilities and platforms may affect students' experience of online education. Online course student satisfaction is not an isolated concept. Like customer satisfaction, online course student satisfaction also has its causal variables, target variables, and outcome variables.

6 Hypotheses about the relationship between student expectations and related variables

Many scholars found that there is a positive correlation between customers' expectations and satisfaction (Ashfaq et al., 2019; Bearden & Teel, 1983). Moslehpour et al. (2018) confirmed that customer expectations directly positively affect satisfaction. However, some researchers have pointed out that customer expectations do not directly affect satisfaction, but are affected by the mediating effect of service quality and perceived value (Tukiran et al., 2021). Researchers in HEIS have introduced some concepts of evaluating customers' satisfaction into the evaluation of students' satisfaction. Some studies show that students' learning expectations have a significant positive impact on students' satisfaction (Polas et al., 2020). However, some scholars believe that students' learning expectations have little effect on students' satisfaction (Rautopuro & Vaisanen, 2000). Alves and Raposo (2007) stressed that there is not only a direct impact but also an indirect impact between students' expectations and satisfaction. Based on the relationship between relevant variables in the ACSI model and ECSI model, combining the above findings of HEIS on student expectations, this study proposes the following hypotheses about student expectations in terms of online course interaction satisfaction:

> H1: Students' expectations directly and positively affect student satisfaction.
> H2: Students' expectations directly and positively affect perceived quality.
> H3: Students' expectations directly and positively affect perceived value.

7 Hypotheses about the relationship between perceived quality and related variables

Parasuraman et al. (1985) empirical research results show that product service quality affects customers' satisfaction, and the perceived value of product service quality directly or indirectly affects customers' satisfaction. Some researchers believe that product service quality and customer satisfaction are independent variables, and the relationship between the two is positively correlated (Sureshchandar et al., 2002).

In the field of higher education, the quality of educational services is positively correlated with students' satisfaction (Annamdevula & Bellamkonda, 2016). Students' perception of the service quality of HEIS directly affects their perceived value (Hu, 2006). Research by Hasan et al. (2008) found that five dimensions of education service quality significantly affect students' satisfaction. There is a significant correlation between students' perception of education service quality and satisfaction (Ham & Hayduk, 2003). Based on the above analysis, combined with the ACSI model and the ECSI model, this study proposes the following hypotheses:

> H4: Perceived quality directly and positively affects perceived value.
> H5: Perceived quality directly and positively affects student satisfaction.

8 Hypotheses about the relationship between perceived value and related variables

Lin et al. (2020) have shown that students' perceived value affects their satisfaction. The findings of Cronin et al. (2000) and Alves and Raposo (2007) show that students' perceived value directly and significantly affects students' satisfaction. Previous studies have also shown that students' perceived quality and expectations (Alves and Raposo, 2007) affect students' satisfaction. This study agrees with the view that students' perceived value drives students' satisfaction, and proposes the following hypothesis:

> H6: Perceived value directly and positively affects student satisfaction.

9 Hypotheses about the relationship between student satisfaction and related variables

Paharia (2019) mentioned that students are the most direct stakeholders of educational services, and they have the right to require higher education institutions to provide educational services of the highest quality and meet their own needs as much as possible. Generally speaking, the more satisfied students are with the educational services provided by the university, the higher their completion rate and loyalty to the school, and the more willing they are to continue their studies (Temizer and Turkyilmaz, 2012; Wong & Chapman, 2022). This study refers to the ESCI model and removes the outcome variable of customer complaints in the ACSI model. The purpose of customer complaints is to express their dissatisfaction with the purchased products or services, and to the relevant firms to seek some kind of compensation (Maxham and Netemeyer, 2002). Considering that the purpose of student complaints is different from that of customers in the business sector, this outcome variable was also excluded from the model in this study. Behaviours that measure student loyalty include student retention and continuing to choose the same university for higher levels of study (Paswan and Ganesh, 2009). Studies by some

scholars have shown that higher student satisfaction tends to show higher loyalty (Paswan and Ganesh, 2009). This study puts forward the following hypothesis:

H7: Student satisfaction directly and positively affects student loyalty.

10 Hypotheses of technical performance and related variables

Liang et al. (2013) believe that, in the TAM, the usefulness and ease of use of online teaching are the two most critical factors. Liu et al. (2014) combined the perceived usefulness and ease of use in the TAM model into the form and performance of the network platform and found that the form and performance of the network platform directly affect online interaction and indirectly affect student satisfaction. Li and Li (2009) referenced the TAM model and constructed a Chinese distance education satisfaction index model. Their research results show that the perception of stability directly affects the perception of human–computer interaction, and the perception of human–computer interaction directly affects the perception of acceptance and student satisfaction. This study focuses on the satisfaction of students participating in online courses. The ease of use and performance stability of online learning platforms may affect the perception of online interaction and may also affect students' satisfaction. Therefore, this study proposes the following hypotheses:

H8: Technical performance directly and positively affects perceived quality.
H9: Technical performance directly and positively affects student satisfaction.

11 Research hypothesis summary and proposed conceptual model

This study summarises the relationship hypotheses between latent variables, as shown in Table 1, including nine research hypotheses. Based on the ACSI model, the ECSI model, and the TAM model, this study reviewed the previous research experience of scholars on customer satisfaction and student satisfaction,

Table 1 Summary of Research Hypotheses

Hypotheses	Explanations
H1	Students' expectations directly and positively affect student satisfaction
H2	Students' expectations directly and positively affect perceived quality
H3	Students' expectations directly and positively affect perceived value
H4	Perceived quality directly and positively affects perceived value
H5	Perceived quality directly and positively affects student satisfaction
H6	Perceived value directly and positively affects student satisfaction
H7	Student satisfaction directly and positively affects student loyalty
H8	Technical performance directly and positively affects the perceived quality
H9	Technical performance directly and positively affects student satisfaction
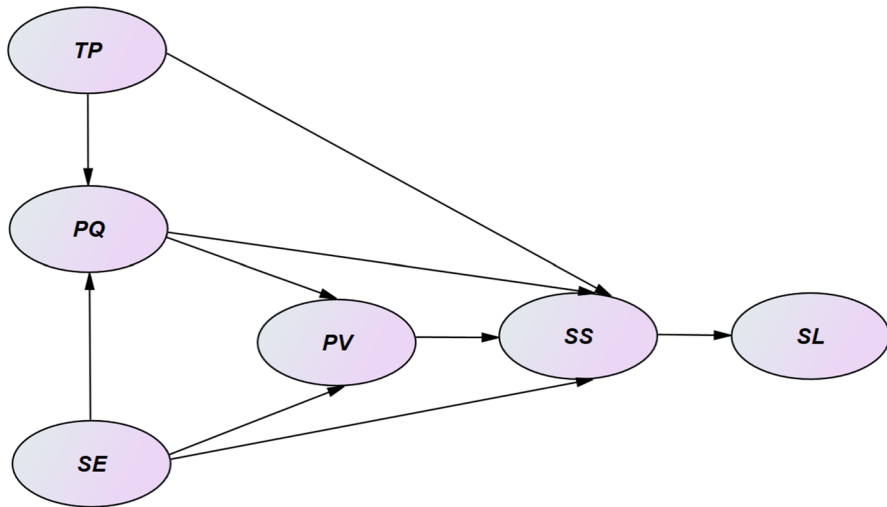
Fig. 4 Proposed conceptual model (ISSM)

combined with the characteristics of online learning and interaction, and put forward an International Student Satisfaction Index Model (ISSM) on the interaction of online international courses in Chinese universities. As shown in Fig. 4, the proposed conceptual model (ISSM) includes six latent variables, namely: Students' Expectation (SE), Perceived Quality (PQ), Perceived Value (PV), Technical Performance (TP), Student Satisfaction (SS), Student Loyalty (SL).

12 Research Questions

Based on the research hypotheses proposed in this study, the following issues need to be addressed in the process of developing a Student Satisfaction Model (ISSM) for online course interaction:

(1) Is there a direct positive effect between the antecedent variables (SE, PQ, PV & TP) and the target variable (SS)?
(2) Is there a direct positive effect between the target variable (SS) and the outcome variable (SL)?
(3) Is there a direct positive effect between the antecedent variables (SE, PQ, PV & TP)?

13 Methodology

13.1 Participants

We considered 320 international students from Zhejiang University of Science and Technology who participated in 100% online courses during the epidemic outbreak, and the duration of online learning was more than half a year.

13.2 Data collection process

First, using the online class time (15 min) of international students, the link of the pre-test questionnaire was shared in the online class interface, and 50 pre-test questionnaires were obtained. Four 4 invalid questionnaires were dropped, 46 valid pre-test data were obtained, and the effective recovery rate was 92%. The second phase of data collection is the empirical research phase. The link to the official questionnaire was shared in the university' s WeChat groups of international students. This study used a stratified sample of international students who participated in online courses during the epidemic. The sample data was stratified according to the length of time international students participate in online courses every day, including four time periods: less than an hour, 1–3 h, 3–5 h, and more than 5 h. The reason for choosing these four time periods is that these four time periods occupy the main statistical period of the online courses conducted every day during the epidemic period of the university. Respondents for this study were required to take at least half a year of fully online courses during the pandemic. After about two months of empirical data collection, 320 international students responded to the questionnaire. In this study, the treatment of outliers (The options for all measurement items are the same, and the answers have obvious regularity) was directly deleted, 20 respondents' responses were deleted, with 300 valid responses, and the questionnaire data recovery effectiveness was 93.75%.

13.3 Development of research instrument

This research refers to the existing mature literature on customer satisfaction and student satisfaction and develops a questionnaire measurement scale. The questionnaire survey scale in this study has 33 measurement indicators, and the measured latent variables have a total of six dimensions. There are four measurement indicators in the technical performance dimension, mainly referring to the questionnaires of Wang (2003) and Li and Li (2009) on the studies of distance education student satisfaction. There are four measurement indicators in the student expectation dimension, and the item setting mainly refers to the research on the interaction model and interaction level of distance teaching (Chen, 2004) and the research on the influencing factors of student satisfaction on online platforms (Guo, 2016). There are 15 measurement indicators in the perceptual quality dimension (Gazza & Matthias, 2016; Jackson et al., 2010; Lin et al., 2012), in which the perceived quality

of teacher-student interaction is mainly set up from five perspectives: questioning, answering, communication and discussion, organisation and management, and teacher evaluation. The setting of the items for the measurement of the perceived quality of the interaction between students and students is carried out from four perspectives: questioning and questioning, collaborative learning, resource sharing, and peer evaluation. Student-content interaction quality perception considers the difficulty, flexibility, and richness of online content. The quality and texture of student-interface interaction are the set of items from the responsiveness, simplicity, and comprehensiveness of the interface. Based on Zhou' s (2018) research on the influencing factors of students' satisfaction in participating in current courses, the items of perceived value include three items: cost-effectiveness, investment degree, and practicality of perceived online interaction. There are four measurement indicators of the student satisfaction dimension (Bhattacherjee, 2001), and the item set is mainly based on the existing SCSI model and ECSI model. Student loyalty is set from three aspects: recommended learning, persistent learning, and priority selection (Bhattacherjee, 2001; Lin et al., 2012).

The questionnaire measurement scales are all set with closed statements that facilitate statistical analysis. Sarstedt and Mooi (2014) pointed out that such a design can not only reduce the burden of answering the participants but also has a higher response rate (Nardi, 2018). Elliott and Shin (2002) believe that single item measurement is one of the measurement methods of student satisfaction, and researchers mainly use the Likert scale for single item measurement. The questionnaires in this study are all based on the Likert method. The international students participating in the online course are scored according to their real situations and feelings, and the scores are assigned from 1 to 5 points according to the options. The measurement items are shown in Table 2.

13.4 Statistical analysis

In this study, we use SPSS26.0 and AMOS 21.0 to analyse the collected quantitative data, mainly including a descriptive analysis of the respondents' variables, the pre-test analysis of the questionnaire, and model analysis.

14 Results and Analysis

14.1 Demographic characteristics of participants

This study used a frequency test to conduct a descriptive analysis of the respondents' variables (Mishra et al., 2019). From the perspective of "Gender", there are relatively many males in the sample: the sample size is 208, and the proportion is 69.3. From the perspective of "Major", there are relatively many Science and Engineering students in the sample: the sample size is 217, and the proportion is 72.3 (see Table 3). The distribution of the sample data of the surveyed subjects is consistent with the background information of the students in Chinese universities of science

Table 2 Operational definition of latent variables

Latent variable	Operational Definition	Authors
TP	In the process of online course learning, the network is very smooth The performance of online learning platforms has high stability The operation of an online learning platform has strong guidance The online learning platform is easy to operate	Wang (2003) Li and Li (2009)
SE	Before formally entering online learning, I think I can skillfully operate the interactive functions of the media interface Before formally entering online learning, I think my interaction with teachers can meet my expectations Before formally entering online learning, I think my interaction with other learning partners can meet my expectations Before formally entering online learning, I think my interaction with learning resources can meet my expectations	Chen (2004) Guo (2016)
PQ	Teachers often ask questions about the classroom content and give students time to think I have always tried to answer the questions posted by the instructor When I encounter a problem and ask the teacher, the teacher will answer my questions in time There was much interaction between the instructor and me Teachers often participate in our topic discussion in the forums, and express their own views I often attend online learning discussions and answer questions from others or ask my own questions I like to study with other partners and often express my opinions in the study group Other learning partners and I are willing to share learning resources or learning results with each other Online learning partners and I will evaluate each other's learning performance and feedback the evaluation information to others in time Online courses provide playback resources, which is very suitable for my study I can get online learning resources at any time Online course learning resources are rich and diverse, which fully meet my learning needs When I click the button on the learning platform interface, the page is enough to jump over quickly I can quickly find the functions I need and master the operation steps of these functions The interactive function in the online learning interface fully meets my needs for online learning	Gazza and Matthias (2016) Jacksonet al. (2010) Lin et al. (2010)
PV	Compared with traditional courses, online courses can stimulate my learning enthusiasm more Compared with traditional offline courses, online courses require less time and energy Compared with traditional offline courses, the learning results of online courses are more significant	Zhou (2018)

Table 2 (continued)

Latent variable	Operational Definition	Authors
SS	I can skillfully operate the media interface function of online class and have a very pleasant interaction with the media interface I am very satisfied with the interactive process between teachers and students in online learning I am very satisfied with the interaction with other learning partners in the process of online learning The learning resources in online learning can meet my learning needs	Bhattacherjee (2001)
SL	I am willing to recommend the online courses of Chinese universities to my friends I will continue to participate in online courses in the future If possible, I will give priority to the online courses of Chinese universities in my future study	Bhattacherjee, (2001) Lin et al. (2012)

Table 3 Demographic Information (n = 300)

Frequency				
Item	Categories	N	Percent (%)	Cumulative Percent
Gender	Male	208	69.3	300
	Female	92	30.7	
Major	Literature and History	12	4.0	300
	Art & Design	18	6.0	
	Linguistics	20	6.7	
	Science and Engineering	217	72.3	
	Other	33	11.0	
Time	Less than one hour	30	10.0	300
	1–3 h	30	10.0	
	3–5 h	210	70.0	
	More than 5 h	30	10.0	

and technology, and the sample data are in line with reality. Also, from the perspective of "Time", there are relatively as long as 3–5 h in the sample: the sample size is 210, and the proportion is 70.0. This is in line with the 100% online course study implemented by international students during the pandemic.

14.2 Pre-test analysis of the questionnaire

In this study, 50 pre-test questionnaires were obtained from a university in Zhejiang Province, four invalid questionnaires were excluded (the answers to all questions were the same), and 46 valid pre-test data were obtained, with an effective recovery rate of 92%. SPSS 26.0 was used to conduct a pre-test test. As shown in Table 4, the overall Cronbach's alpha value is 0.955 (> 0.9), and the Cronbach's alpha value of each variable is higher than 0.7, which indicates that the pre-test questionnaire has high reliability (Hair et al., 2011). This study refers to some mature questionnaires about online interactive student satisfaction surveys, and during the pre-test process, the respondents did not question the statement of the items in the questionnaire and the privacy issues involved, which largely ensures that the questionnaire has good content validity. The overall KMO is 0.882 (> 0.7), indicating that the overall validity is good, and the Sig. = 0.000 (< 0.05) of all latent variables, which is suitable for

Table 4 Pre-Test Reliability and Validity

Latent Variable		TP	SE	PQ	PV	SS	SL	Overall
Cronbach's alpha		0.705	0.824	0.969	0.758	0.867	0.798	0.955
KMO		0.701	0.778	0.892	0.689	0.814	0.769	0.801
Bartlett's Test of Sphericity	Sig	0.000	0.000	0.000	0.000	0.000	0.000	0.000

factor analysis (Eisinga et al., 2013). In the following model analysis, this study conducted a strict reliability and validity test on the measurement model.

15 Model Analysis

15.1 Overall Model Fit Analysis

Some researchers emphasise that the overall fit of the model plays an important part in the model evaluation, and the fit of the model needs to be tested before the path analysis (Kline, 2015). The evaluation indicators used in this study include χ^2/df (Chi-Square/Degree of Freedom), RMSEA (Root Mean Square Error of Approximation), GFI (Goodness of Fit Index), CFI (Comparative Fit Index), NFI (Normed Fit Index), and TLI (Tucker-Lewis' s coefficient). The fitting indicators of the ISSM model proposed in this study are shown in Table 5: χ^2/df = 1.271, which meets the ideal standard of less than 2 (Bentler, 1992); RMSEA = 0.03, which meets the standard of less than 0.05 (Jöreskog and Sörbom, 1993); GFI = 0.902, CFI = 0.977, NFI = 0.902, TLI = 0.975, with all in line with the ideal standard of greater than 0.9 (Lavasani et al., 2010). The above indicators show that the ISSM model has a good fitting ability for empirical data.

15.2 Evaluation of Measurement Model

Before formal data analysis, this study first conducted a rigorous evaluation of the measurement model, including evaluation of internal consistency, convergent validity, and discriminant validity (Abuhassna et al., 2020; Hassan et al., 2020; Lin et al., 2020). The internal consistency is mainly assessed using Cronbach's alpha (CA) and Composite Reliability (CR) (Hair et al., 2011). The CA value (see Table 6) of each variable is above 0.8 (> 0.7), which indicates that the internal consistency of this measurement model is good (Abuhassna et al., 2020; Lin et al., 2020). This study also further examines the intrinsic quality of the proposed ISSM using the CR. The CR value (see Table 6) of each latent variable exceeds the critical value (0.7), indicating that internal consistency is satisfied (Hair et al., 2019). Convergent validity is mainly measured by three parameters: the factor loading value of the measurement item, the extraction value of the average variance (AVE) of each variable, and the composite reliability (CR) of each variable. The results of the confirmatory factor analysis (CFA) of this measurement model are shown in Table 6, the factor loading values of all items is > 0.7, the AVE value is > 0.5, and the CR value is > 0.8. All

Table 5 Summary of Model Overall Goodness Fit Indicators

Common indicators	χ^2	df	χ^2/df	GFI	RMSEA	CFI	NFI	TLI
Judgement Standard	-	-	< 2	> 0.9	< 0.05	> 0.9	> 0.9	> 0.9
Value	611.45	481	1.271	0.902	0.03	0.977	0.902	0.975

Table 6 Reliability & Convergent Validity of Measurement Model

Latent Variable		Items	Factor loading	AVE	CR	CA
TP		TP1	0.807**	0.648	0.88	0.88
		TP2	0.842**			
		TP3	0.775**			
		TP4	0.793**			
SE		SE1	0.829**	0.65	0.881	0.881
		SE2	0.82**			
		SE3	0.835**			
		SE4	0.736**			
PV		PV1	0.792**	0.68	0.864	0.864
		PV2	0.834**			
		PV3	0.847**			
SS		SS1	0.756**	0.59	0.852	0.851
		SS2	0.781**			
		SS3	0.749**			
		SS4	0.787**			
SL		SL1	0.734**	0.633	0.838	0.836
		SL2	0.857**			
		SL3	0.792**			
PQ	TSI	TSI1	0.79**	0.597	0.881	0.881
		TSI2	0.758**			
		TSI3	0.756**			
		TSI4	0.798**			
		TSI5	0.761**			
	SSI	SSI1	0.753**	0.635	0.874	0.874
		SSI2	0.81**			
		SSI3	0.808**			
		SSI4	0.814**			
	SCI	SCI1	0.876**	0.751	0.9	0.9
		SCI2	0.849**			
		SCI3	0.874**			
	SII	SII1	0.784**	0.679	0.864	0.861
		SII2	0.846**			
		SII3	0.84**			

parameter values satisfy the convergent validity reference value, which proves that convergent validity is good (Hair et al., 2011, 2017).

Hair et al. (2016) believe that the overlap between different constructs can be tested by assessing discriminant validity. The value of the diagonal line (square root of AVE) in Table 7 is greater than the value of the same column (correlation coefficient value), which indicates that this measurement model is confirmed to establish discriminant validity (Fornell and Larcker, 1981; Lin et al., 2020). However,

Table 7 Discriminant Reliability of Measurement Model

Pearson Correlation & Square Root Value of AVE

| Latent Variable		TP	SE	PV	SS	SL	PQ			
							TSI	SSI	SCI	SII
TP		0.805								
SE		0.531**	0.806							
PV		0.447**	0.54**	0.825						
SS		0.521**	0.558**	0.527**	0.768					
SL		0.185**	0.155**	0.076	0.108	0.796				
PQ	TSI	0.301**	0.369**	0.287**	0.302**	0.023	0.773			
	SSI	0.426**	0.427**	0.391**	0.447**	0.09	0.335**	0.797		
	SCI	0.408**	0.451**	0.405**	0.392**	0.054	0.346**	0.377**	0.867	
	SII	0.434**	0.415**	0.384**	0.388**	0.134*	0.344**	0.37**	0.392**	0.824

Henseler et al. (2015) believed that this evaluation method lacked idiosyncratic and sensitivity, and advocated the use of the heterotrait-monotrait criterion (HTMT) to further evaluate discriminant validity. The HTMT values of all latent variables in the proposed measurement model are less than 0.9 (see Table 8), which is in line with the HTMT standard proposed by Henseler et al. (2015).

15.3 Structural Model Empirical Results and Analysis

This study uses path modelling analysis to test the nine proposed research hypotheses. Figure 5 and Table 9 show that the nine hypotheses in ISSM proposed in this study have been confirmed. Students' Expectations positively influence international Student Satisfaction ($\beta = 0.185$, $p < 0.05$). Students' Expectations significantly and positively affects the Perceived Quality of online interactions ($\beta = 0.481$, $p < 0.001$). Student Expectations positively affected the Perceived Value of online interactions ($\beta = 0.274$, $p < 0.05$). Perceived Quality of online interaction significantly and positively affects the Perceived Value of online interaction ($\beta = 0.471$, $p < 0.001$). The Perceived Quality of online interaction has a

Table 8 HTMT of Measurement Model

HTMT

Latent Variable	TP	SE	PV	SS	SL	PQ
TP						
SE	0.531					
PV	0.447	0.540				
SS	0.521	0.558	0.527			
SL	0.185	0.155	0.076	0.108		
PQ	0.653	0.692	0.611	0.636	0.125	
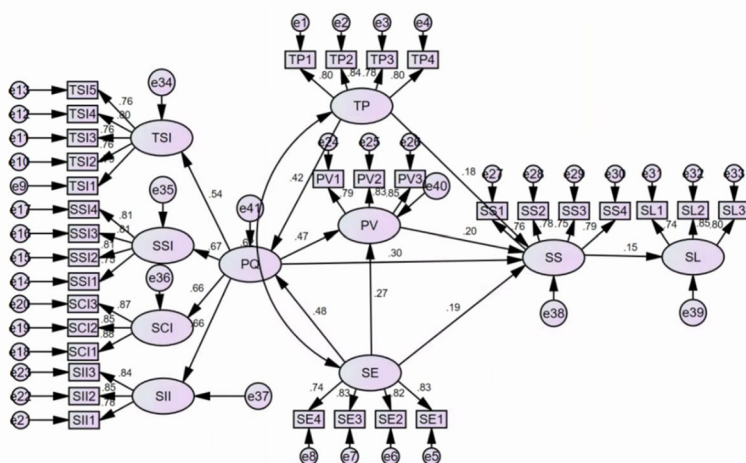
Fig. 5 Findings for the ISSM Path analysis

Table 9 Testing results of the Hypothesis

H	Independent	Path influence	Dependent	β	P	Result
H1	SE	->	SS	0.185	0.047	Supported
H2	SE	->	PQ	0.481	0.000	Supported
H3	SE	->	PV	0.274	0.007	Supported
H4	PQ	->	PV	0.471	0.000	Supported
H5	PQ	->	SS	0.302	0.037	Supported
H6	PV	->	SS	0.2	0.014	Supported
H7	SS	->	SL	0.147	0.029	Supported
H8	TP	->	PQ	0.417	0.000	Supported
H9	TP	->	SS	0.182	0.038	Supported

positive impact on Student Satisfaction ($\beta = 0.302$, $p < 0.05$). Online Perceived Value positively affects international Student Satisfaction ($\beta = 0.2$, $p < 0.05$). International Student Satisfaction positively affects Student Loyalty ($\beta = 0.147$, $p < 0.05$). Online Technical Performance significantly and positively affects the Perceived Quality of online interactions ($\beta = 0.417$, $p < 0.001$). Online Technical Performance positively affects international Student Satisfaction ($\beta = 0.182$, $p < 0.05$). In addition, the path relationship in the structural equation model is mainly represented by standardised coefficients, and the larger the coefficient, the higher the importance of the causal relationship (Li and Li, 2009). The research results show that compared with Student Expectations ($\beta = 0.185$), Perceived Value ($\beta = 0.2$), and Technical Performance ($\beta = 0.182$), Perceived Quality ($\beta = 0.302$) had the greatest impact on Student Satisfaction.

16 Discussion

Based on the large-scale online courses carried out by Chinese universities during the epidemic, this study focuses on online interaction and develops the International Student Satisfaction Index Model (ISSM) on the learning interaction of online courses in Chinese universities. The empirical findings confirmed the nine proposed research hypotheses. The research results show that international students' expectations positively influence international student satisfaction with online learning interaction, which is consistent with the results of researchers such as Rolfe (2002) and Polas et al. (2020). Researchers and practitioners of online course education in colleges and universities need to consider students' expectations of online interaction in advance. The second and third hypotheses of this study were also confirmed. Student expectations of online learning interaction significantly positively affect the perceived quality (Alves and Raposo, 2007; Tukiran et al., 2021) and perceived value, which is consistent with previous research by Alves and Raposo (2007). The fourth and fifth research hypotheses explore the relationship between the perceived quality of online interactions, perceived value, and international student satisfaction. The perceived quality of online interactions significantly and directly affects perceived value (Hu, 2006) and student satisfaction (Ham & Hayduk, 2003). The sixth research hypothesis explores the relationship between perceived quality and student satisfaction. The perceived quality directly and positively influences international student satisfaction, indicating that the greater the value of the educational service quality the international students perceive, the more satisfied they are with service quality (Alves and Raposo, 2007; Cronin et al., 2000). The seventh research hypothesis further explores the relationship between the target variable (SS) and the outcome variable (SL). The results confirm that student satisfaction significantly positively affects student loyalty to online courses, which is consistent with previous studies (Alves and Raposo, 2007; Paswan and Ganesh, 2009). The eighth and ninth research hypotheses focus on the impact of online interactive technology performance on students' perceived quality and satisfaction. The results show that technology performance significantly positively affects these two variables (Li et al., 2019). The stability and operability of technical performance should attract the attention of online course researchers (Saade et al., 2007). The empirical results of this study also show that perceived quality has the greatest impact on student satisfaction (Hasan et al., 2008), indicating that perception of online course interaction quality is the strongest predictor of the target variable (SS).

17 Conclusion and Future Research

In this study, the empirical research results verify the adaptability of the proposed International Student Satisfaction Index Model (ISSM) in Chinese universities in terms of online course learning interaction and explain the antecedent variables

(SE, PQ, PV, TP) on the target variable (SS). The four antecedent variables (SE, PQ, PV, TP) all directly and positively affect the target variable (SS), and the Perceived Quality (PQ) of interaction has the greatest impact on Student Satisfaction (SS). The relationship between the antecedent variables (SE, PQ, PV, TP) is also confirmed, with SE and TP significantly positively affecting PQ, Both SE and PQ significantly positively affect PV. The target variable (SS) significantly positively affects the outcome variable (SL). From this result, it can be seen that, in improving the online course retention rate of international students in colleges and universities, it is necessary to pay more attention to student satisfaction and to focus on the perceived quality of online interaction. At the same time, students' expectations, perceived value, and technical performance of online interaction before class cannot be ignored, which will affect students' final satisfaction with online courses. Based on the large-scale online course practice during the epidemic, the ISSM model developed by this research is innovative and fills the gap in the current research on student satisfaction with online courses to a certain extent.

This study also has certain limitations. The empirical data were collected from a university in Zhejiang Province, China, which may affect the generalisability of the developed model (ISSM). In addition, the gender, major, and length of online study of international students may moderate the model. In future research, this study will expand the scope of validation of the model, taking into account the influence of factors such as student gender, major, and online learning time on the model.

Appendix

Dear student:

Hello! I am doing a research on how to effectively improve the international student satisfaction towards interaction online courses learning. I really need to know your learning needs and opinions of online courses during the epidemic, which is of great significance to you and this research. Therefore, please truthfully fill in each option in the questionnaire according to your actual learning situation and real ideas. This volume is anonymous. All information you fill in is limited to this study and will not be used for other purposes. Thank you very much for your support and cooperation!

Note: the interaction in this questionnaire refers to the interaction between international students and various elements of online learning in online courses.

Part 1: Demographics

1–3:
     1. Please enter the following demographic information:
     Your gender:
     A. Male B. Female
     2. Your major:
     A. Science and Engineering B. Linguistics.

C. Literature and history D. A&D E.Other

3. How long do you study online every day during the epidemic:

A. Less than one hour B. 1–3 h C. 3–5 h D. More than 5 h

Part 2: This part was measured by a Likert 5-point scale. Please read and respond to each question or statement carefully and select the answer that most reflects your expectations, opinions, or beliefs.

1. In the process of online course learning, the network is very smooth.

  1.Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  2. The performance of online learning platforms has high stability.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  3. The operation of the online learning platform has strong guidance.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  4. The online learning platform is easy to operate.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  5. Before formally entering online learning, I think I can skillfully operate the interactive functions of the media interface.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  6. Before formally entering online learning,I think my interaction with teachers can meet my expectations.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  7. Before formally entering online learning,I think my interaction with other learning partners can meet my expectations.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  8. Before formally entering online learning,I think my interaction with learning resources can meet my expectations.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  9. Teachers often ask questions about the classroom content and give students time to think.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  10. I have always tried to answer the questions posted by the instructor.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  11. When I encounter a problem and ask the teacher, the teacher will answer my questions in time.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  12. There was much interaction between the instructor and me.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  13. Teachers often participate in our topic discussion in the forums, and express their own views.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

  14. I often attend online learning discussions and answer questions from others or ask my own questions.

  1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

15. I like to study with other partners and often express my opinions in the study group

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

16. Other learning partners and I are willing to share learning resources or learning results with each other.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

17. Online learning partners and I will evaluate each other's learning performance and feedback the evaluation information to others in time.

18. Online courses provide playback resources, which is very suitable for my study.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

19. I can get online learning resources at any time.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

20. Online course learning resources are rich and diverse, which fully meet my learning needs.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

21. When I click the button on the learning platform interface, the page is enough to jump over quickly.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

22. I can quickly find the functions I need and master the operation steps of these functions.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

23. The interactive function in the online learning interface fully meets my needs for online learning.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

24. Compared with traditional courses, online courses can stimulate my learning enthusiasm more.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

25. Compared with traditional offline courses, online courses require less time and energy.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

26. Compared with traditional offline courses, the learning results of online courses are more significant.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

27. I can skillfully operate the media interface function of online class and have a very pleasant interaction with the media interface.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

28. I am very satisfied with the interactive process between teachers and students in online learning.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

29. I am very satisfied with the interaction with other learning partners in the process of online learning.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

30. The learning resources in online learning can meet my learning needs.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

31. I am willing to recommend the online courses of Chinese universities to my friends.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

32. I will continue to participate in online courses in the future.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

33. If possible, I will give priority to the online courses of Chinese universities in my future study.

1. Strongly Agree 2. Agree 3. Neutral 4. Disagree 5.Strongly Disagree.

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