



Impact of teacher-student interaction on students' classroom well-being under online education environment

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Abstract

The students' classroom well-being of college students has been widely concerned in online education researches. In order to implement effectively online education in colleges and universities, based on person-context interaction theory, this study investigates a theoretical model of the impact of teacher-student interaction, sound richness, sound pleasure, perceived ease of use and perceived usefulness on students' classroom well-being. By surveying 349 college students receiving online education, the research hypotheses are tested by the structural equation model approach. Research results show that: teacher-student interaction, sound richness, sound pleasure, perceived ease of use and perceived usefulness appreciably improve students' classroom well-being, the sound richness and the students' perceived ease of use can moderate the effect of teacher-student interaction on students' classroom well-being. Finally some pedagogical implications are discussed.

Keywords Classroom well-being · Teacher-student interaction · Sound richness, Sound pleasure · Perceived ease of use · Perceived usefulness

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1 Introduction

With the spread of information and communications technology, online courses are becoming more and more common. Online courses have also played an important role in complementing in-person courses during specific periods, such as the Covid-19 pandemic (Serin, 2022; Shen & Prior, 2022). In the meantime, the large-scale transfer of higher education through internet use has also had a profound impact on the education system. Since the 1990s, governments around the world have given attention to the development of online courses in colleges and universities, provided equipment and funds to achieve the consistency of knowledge teaching with traditional face-to-face teaching, and set up teaching platforms on the internet, such as OpenLearn (Ran, 2013; Volery & Lord, 2000). Therefore, online education in colleges and universities is a new growth direction for the higher education (Chand et al., 2021), and teachers should strengthen the digital transformation of teaching.

Despite previous research findings supporting the effectiveness of online teaching (Zhu et al., 2021), this rapid transition to distance learning with teaching online has negatively impacted student learning, participation and mental health (Petillion & McNeil, 2020). Studies by existing scholars have found that online teaching may affect the learning effectiveness of higher education, for instance boredom or emotional changes of students after starting online teaching for a period of time (Kotera et al., 2020), poor time management, isolation from classmates and unclear understanding of teachers' explanation (Syahputri et al., 2020). Students' mental health and well-being have attracted more and more attention for higher education (Ingram et al., 2019; Syahputri et al., 2020). Therefore, the influencing factors of students' well-being during online teaching should be analyzed to improve learning interest and efficiency.

When implementing distance education, the teacher-student interaction is a very important teaching method of the teachers. Actively teacher-student interaction helps to improve teachers' teaching effectiveness (Sieber et al., 2020). The interaction in teaching is the cornerstone of teacher-student relationship and student participation is closely related to teacher's support (Pöysä et al., 2019). Therefore, the interaction can be used as an important factor to analyze students' classroom learning. However, there are few studies on how teacher-student interaction can improve students' well-being in online education, which requires further analysis and exploration. Person-context interaction theory can be used to explain the relationship between the behavior and the psychology (Chan & Tam, 2021). Therefore, based on the person-context interaction theory, this study analyzes the effect of teacher-student interaction on the students' classroom well-being of online education.

From person-context interaction perspective to analyze the classroom well-being of college students in online education, the main objectives of the study are as follows: (1) To use a theoretical model to analyze the impact of teacher-student interaction, sound environment and online classroom system usage on students' classroom well-being; (2) To conduct the survey to test the theoretical framework and verify the model; and (3) To put forward pedagogical suggestions for improving students' classroom well-being.

2 Related literature

2.1 Person-context interaction theory

Person-context interaction theory holds that the person-context situation is an integrated, complex and dynamic situation, in which the individual is an active and purposeful part and people and situations are not two independent entities whose relationship affects each other, and the function and development of individuals are closely related to the social, cultural and environmental characteristics in the person-context situation (Magnusson & Stattin, 1998). These interacting variables act synergistically rather than independently (Xia et al., 2020). This theory has been applied in many psychological studies (Magnusson & Stattin, 2006). Chan & Tam (2021) analyzed people's behavioral expression on climate change by using person-context interaction. Villasana et al. (2016) studied the relationship between adolescents' stress coping styles and resilience. The adaptability of different emotion regulation strategies depends on the context in which they are used (Troy et al., 2013). This theory is also used in educational research. Lau & Nie (2008) used this theory to investigate the relationship between students' classroom goal structure, personal goal and achievement, participation, interest, effort withdrawal and avoidance coping. And people interaction with the environment can also affect health (Wahl et al., 2021) and well-being (Heidemeier & Wiese, 2014; Lin & Chan, 2021).

2.2 Teacher-student interaction

The teacher-student interaction is a key part of the education process (Pennings et al., 2018). Positive teacher-student interactions consist of individual needs, the safe and structured environment, and student engagement, which are robust across different learners (Vantieghem et al., 2020). For the influence of teacher-student interaction in learning process, many scholars have carried out the researches and proved that it is positive effects in most of the research results. Teacher-student interaction can actively promote student participation (del Arco et al., 2021; Pöysä et al., 2019), improve students' learning motivation, generate a sense of achievement and self-efficacy (Li & Yang, 2021), enhance student leadership (Zhan et al., 2021), and promote effective teaching in classrooms (Li & Yang, 2021; Weizheng, 2019). At the same time, the interaction between teachers and students will also have an effect on the psychology of students. Teacher-student interaction during online teaching is important for student psychological support (Sieber et al., 2020), and also has an impact on teacher job satisfaction, which affect on teacher-student interaction in turn (Cipriano et al., 2019). Even in student-centered learning platforms, teacher-student interaction and dialogue can still play a good effect (Alghasab et al., 2019). However, relationship effect of teacher-student communication is related to students' adaptability (Pianta et al., 2020). High levels of teacher-student interaction promote effective student outcomes (Howe et al., 2019; LoCasale-Crouch et al., 2018), as less or passive interaction can lead to negative emotions among students. Therefore, it need to be attended to concentrate on the importance of students' autonomy and self-awareness in online teaching (del Arco et al., 2021).

2.3 Student well-being

Well-being is a people's evaluation of the whole state of his life based on self-defined criteria (Diener, 2012). There are many researches on well-being in school among scholars. Most of the previous researches focus on teachers' subjective well-being (Alves et al., 2021; Farhah et al., 2021; Simonton et al., 2022). With the changes in the standards for measuring the traditional education mode and the diversity of cultures, the focus of education and training has shifted from cognitive achievement to happiness, and the discussions on students' well-being have gradually emerged and attracted widespread attention (Rappleve et al., 2020). Dodd et al. (2021) developed the well-being measure of British college students. Van de Velde et al. (2021) also investigated the well-being of students in 110 colleges of 26 countries during COVID-19 pandemic, and analyzed living conditions and mental health level of students.

Existing research on the impact of students' online education well-being mainly focuses on responding to students' needs, self-efficacy, and teachers' positive psychology. No matter online or face-to-face teaching, if students' roles are passive, it will affect students' emotional health (del Arco et al., 2021). Due to the limitation of social connections in online education, students' well-being will be reduced, it is necessary to identify and respond to students' needs in online teaching (Cockerham et al., 2021). In network teaching procedures, the student's attitude towards learning and self-efficacy are the prerequisites for online teaching (Weißenfels et al., 2022). Different experience from face-to-face education learning with a positive attitude will buffer its negative effects in distance education. Students' subjective perception can improve course satisfaction (Zhu et al. 2021). Gamification may improve students' learning motivation and support and promote more successful online learning (Bovermann et al., 2018). However, during online learning, students' autonomy level is usually low, making students' mental health at a moderate level (Aryani et al., 2020), which requires more help from teachers. Positive discipline (Wang & Kuo, 2019), clear communication and active teaching style (Petillion & McNeil, 2020) are the key to solving the disadvantages of distance education faced by students, effectively implementing teaching, and improving student well-being. Mental health is a key factor affecting the efficiency of online learning (Ranadewa et al., 2021). The positive psychological state of teachers will not only make teachers tend to be healthy, but also promote the development of students' psychology (Silamboli & Sujathamalini, 2019). The teaching process should intervene with students from the perspective of psychological science, and teachers can promote students' well-being by supporting students' emotional needs (Ibaraki, 2022; Wang et al., 2021). It is crucial to design an effective online learning experience, but few studies have been conducted from the perspective of college students, so supplementary studies are needed. Although some scholars have attended to concentrate on the environmental influencing factors of students' well-being (Jung et al., 2021), the existing research is still insufficient, and further exploration is necessary.

There were extensive research on student well-being and teacher-student interaction, but most of the researches on student well-being focuses on overall academic well-being, and the study on analyzing online classroom well-being in colleges and

universities is scarce. Although some studies have confirmed that the interaction can promote students' efficiency and enthusiasm in class, there are many case studies and interviews on the impact of classroom well-being, and empirical data tests are lacking. In consideration of the well-being of students in online classrooms of colleges and universities is particular significance in the context of the diversity of classroom forms and the epidemic period of diseases (Shen & Prior, 2022). Therefore, based on person-context interaction theory, this study reveals the effect mechanism of teacher-student interaction on students' classroom well-being, strives to enrich students well-being theory, and provides suggestions for the effective implementation of online education in colleges and universities.

3 Research model and hypotheses

According to person-context interaction theory, the context situation can affect student activities and psychology (Lau & Nie, 2008). Under online education environment, the teacher-student interaction is important for the education process (Sieber et al., 2020), the sound environment (Daliraghadeh & Yilmazer, 2022) and students' technical acceptance of online system (Alsharida et al., 2021) can affect the activities and psychology of students' study. For this reason, the model investigated with the following hypotheses is represented as Fig. 1.

3.1 The effect of teacher-student interaction on students' classroom well-being

The individuals has the intrinsic motivation to satisfy needs, desires, interests, self-growth and well-being in self-determination theory (Srivastava & Gupta, 2022). Studies have shown that the interaction of learners in online MOOC courses has the positive influence on studying engagement (Fang et al., 2019). Classroom partici-

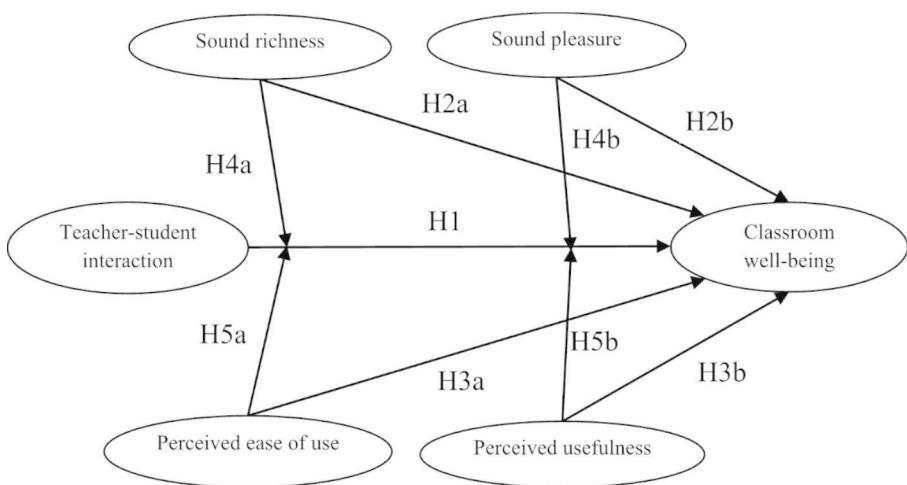


Fig. 1 Research theoretical model

pation also significantly improves students' psychological well-being (Novo et al., 2020). Booker et al. (2018) investigated that high level of social media interaction could affect youth well-being. Positive self-presentation in the online social network will make the individuals pay more attention to their positive psychological qualities and hope to build a positive self-image in social networks, which helps individuals experience more positive emotions and build positive self-concept (Gonzales & Hancock, 2011; Toma & Hancock, 2013), and improve the level of individuals well-being (Kim & Lee, 2011; Park et al., 2009). In classroom teaching, actively teacher-student interaction can stimulate students enthusiasm for learning, and then promote students' learning interest, generate satisfaction, and gain a sense of achievement in classroom, so that students feel well-being in learning. Based on this, the hypothesis is proposed as follows:

H1 Teacher-student interaction positively affects students' classroom well-being.

3.2 The effect of sound environment on students' classroom well-being

Learning environment is very important for learner satisfaction and learning effect (Jung et al., 2021). As the sound is an important situational factor (Solomos, 2018), the study has shown that the sound environment has a positive impact on knowledge obtaining (Dalirnaghadeh & Yilmazer, 2022). The sound environment in the classroom can be reflected as the sounds of the classroom background and the sounds of classroom teaching (Flagg-Williams et al., 2011). In the process of classroom teaching, if the sound situation is engaging and fits in with the teaching content, it can promote students' mastery of knowledge and enhance students' classroom well-being. However, some scholars have found that background noise can also affect students' learning results (Caviola et al., 2021). When the students feel happy about the sound environment, they will form a positive learning state, which will promote the well-being of the classroom. Based on this, the hypotheses are proposed as follows:

H2a Sound richness positively affects students' classroom well-being.

H2b Sound pleasure positively affects students' classroom well-being.

3.3 The effects of perceived ease of use and perceived usefulness on well-being

In the research of mobile study environment, technology acceptance model has good applicability (Alsharida et al., 2021). Shamsi et al. (2021) thought that if the convenience of using the system and the functionality of the system for remote work users were improved, it would help them to master the technical system, and then promote work engagement. Murillo et al. (2021) also found in the study of online learning of college students that students' effective perception and the employ of learning system could actively improve learning effect of college students. Therefore, in the process of classroom teaching, if the students are easy to master the technology of online

learning system, they will develop self-efficacy, which promotes their well-being during learning. Through using online learning tools to perceive learning effect, students will have a sense of satisfaction, which will enhance their learning well-being. Based on this, the hypotheses are proposed as follows:

H3a Perceived ease of use positively affects students' classroom well-being.

H3b Perceived usefulness positively affects students' classroom well-being.

3.4 The moderation of sound environment

Based on person-context interaction theory, people and situations can interact with each other. In the process of online teaching, actively teacher interaction and comfortable sound environment can positively promote students' learning (Chan et al., 2021; Li & Yang, 2021). Previous researches have investigated that in face-to-face teaching, the sound environment and student interaction have an interactive effect (Sekine et al., 2018). According to the attribution theory, positive classroom teacher-student interaction can enhance students' self-awareness, so when the sound environment is poor, increasing the interaction will let students make more internal attributions to the learning effect, and then improve learning well-being. When the sound environment is felt well, students will attribute the learning effect to sound environmental factors, so the effect of interaction is not obvious. Based on this, the hypotheses are proposed as follows:

H4a Sound richness can moderate the effect of teacher-student interaction on students' classroom well-being. When sound richness is felt weak, the teacher-student interaction positively enhances students' classroom well-being; When sound richness is felt strong, the teacher-student interaction hardly affects the improvement of students' classroom well-being.

H4b Sound pleasure can moderate the effect of teacher-student interaction on students' classroom well-being. When sound pleasure is felt weak, the teacher-student interaction positively enhances students' class well-being; When sound pleasure is felt strong, the teacher-student interaction hardly affects the improvement of students' classroom well-being.

3.5 The moderation of perceived ease of use and perceived usefulness

Based on rational behavior theory, the adoption of learning system is determined by the attitude students want to use and the attitude depends on how well students accept the learning system. Use attitude refers to students' subjective positive or negative feelings when employing the system. Previous online systems research has focused on human-computer interaction and explored the function of perceived ease of use and usefulness on human-computer interaction (Ozkale & Koc, 2020). However,

based on person-context interaction theory, as the contextual factor of the education model, the use of the online education system and the interaction in the teaching process may also have an interactive effect on student classroom well-being. The study has shown that social interaction affects the satisfaction of college students through task-technical coordination of online systems (Al-Maatouk et al., 2020). Therefore, teacher-student interaction can promote students' confidence in achieving specific learning goals. When students are less effective in using the system, the teacher-student interaction will strengthen their mastery of the learning content through communication, increase their satisfaction in the classroom, and thus promote well-being. However, when students use the learning system very conveniently and effectively, the students' learning interest is high and the effect is very good, while teacher-student interaction has no significant effect on improving learning well-being. Based on this, the hypotheses are proposed:

H5a Perceived ease of use can moderate the effect of teacher-student interaction on students' classroom well-being. When students' perceived ease of use is low, teacher-student interaction positively enhances students' classroom well-being, but when students' perceived ease of use is high, teacher-student interaction has little effect on the improvement of students' classroom well-being.

H5b Perceived usefulness can moderate the effect of teacher-student interaction on students' classroom well-being. When perceived usefulness is low, teacher-student interaction positively enhances students' classroom well-being, but when perceived usefulness is high, teacher-student interaction has little effect on the improvement of students' classroom well-being.

4 Methods

The research model and hypotheses were tested empirically by the questionnaire method. Since the purpose of this study is to analyze the impact on students' well-being in online classroom, it is a convenient sampling method to select college students who have participated in online education. In the recent two years, online education form has been widely used in Chinese colleges and universities to teach students. Therefore, online education has a high popularity among students in Chinese colleges and universities, which is representative. The questionnaire was defined and adjusted according to the scale of relevant scholars and expert interviews. The research data used structural equation model and regression analysis to test the hypothesis.

4.1 Participants and procedure

The study was conducted by randomly distributing questionnaires through online survey websites. College students with recent online education experience were selected as participants. All participants were anonymous and voluntary, and those who actively participated and answered seriously were given financial rewards.

The survey was carried out from March to May 2022. There were 423 questionnaires collected in all. Screening items were conducted and 349 questionnaires were validated, which accounts for 82.5% of questionnaires. The statistics characteristics of valid respondents were as follows: There were 162 males (46.4%) and 187 females (53.6%) in the respondents; The respondents were mainly young adults, with those aged 17–22 accounting for 60.5% of the total sample, and those aged 23–25 accounting for 27.2% of the total sample; The course level was from junior college to doctoral courses, involving junior college courses (12%), undergraduate courses (60.7%), master courses (22.3%) and doctoral courses (5.0%), as shown in Table 1. The data can reflect the basic composition of the current online courses in colleges and universities.

4.2 Questionnaire

In this study, the construction of each measurement scale was based on the mature scale developed by previous scholars. The scale of teacher-student interaction referred to the scale of Martin and Rimm-Kaufman (2015) and Kuo et al. (2014). The scale of college students' classroom well-being referred to the scale of Hascher (2012) and Putwain et al. (2020). The scale of the online classroom sound environment refers to the soundscape perception evaluation scale in Yong et al. (2011) and Flagg-Williams et al. (2011), which includes two dimensions, namely "sound pleasure" and "sound richness". The scale of perceived ease of use refers to the scale of Davis (1989). The scale of perceived usefulness refers to the scale of Davis (1989). The items of each scale were contextualized based on the situation of the online classroom. Combined with the in-depth interview of related experts, the questionnaire for this study had been initially formed. Through the pre-inspection, the description of some items in this study was adjusted after investigation, and the final questionnaire was formed under the review of experts. Each item in the questionnaire was measured by a likert 7-level scale, "1" indicating "strongly disagree" and "7" indicating "strongly agree". The final items of the questionnaire are shown in Appendix A.

Table 1 Statistics Characteristics of the Subjects

	Classification	Number	Proportion
Gender	Male	162	46.4%
	Female	187	53.6%
Age	<17	9	2.6%
	17–22	211	60.5%
	23–25	95	27.2%
	>25	34	9.7%
Course Level	Junior college courses	42	12%
	Undergraduate courses	212	60.7%
	Master courses	78	22.3%
	Doctoral courses	17	5%

4.3 Data analysis

In this study, homologous variance analysis, the reliability of the scales and related analysis among variables were tested by SPSS 26.0. Confirmatory factor analysis and structural model analysis were tested by structural equation model software AMOS 22.0.

4.3.1 Homologous variance analysis

Since the measured variables in the study were completed by the same respondents, the homologous variance may occur, which could lead to misleading and confounding study results. Harman method was accepted to make a principal component factor analysis on all items to test the homologous variance of data. Analysis of the data indicated that all the items were divided into six factors with obvious differences. In principal component factor analysis, the proportion of the first principal component in the unrotated state was 32.888%, which meets the requirement of less than 40%, indicating that the homology variance problem of the data was not significant and would not mislead the research results.

4.3.2 Reliability analysis

Reliability refers to the measure of accuracy and reliability, including stability and consistency. In this study, the reliability of the scales was manifested in Table 2. From Table 2, it can be inferred that Cronbach's α coefficients of the latent variable were

Table 2 Results of Reliability Analysis

Latent Variable	Item	Corrected Item-to-Total Correlation	Cronbach's α after Deletion	Cronbach α
Sound richness	SR1	0.783	0.847	0.891
	SR2	0.785	0.845	
	SR3	0.790	0.841	
Sound pleasure	SP1	0.766	0.844	0.884
	SP2	0.780	0.831	
	SP3	0.778	0.832	
Teacher-student interaction	TSI1	0.743	0.819	0.868
	TSI2	0.758	0.805	
	TSI3	0.743	0.819	
Perceived ease of use	PEOU1	0.737	0.870	0.885
	PEOU2	0.795	0.819	
	PEOU3	0.795	0.819	
Perceived usefulness	PU1	0.770	0.812	0.874
	PU2	0.775	0.806	
	PU3	0.729	0.848	
Classroom well-being	CWB1	0.728	0.834	0.871
	CWB2	0.732	0.832	
	CWB3	0.710	0.841	
	CWB4	0.730	0.833	

Table 3 Results of Convergent Validity Test

Latent Variable	Item	Std.	P-Valve	CR	AVE
SR	SR1	0.857	-	0.891	0.731
	SR2	0.855	0.000		
	SR3	0.853	0.000		
SP	SP1	0.821	-	0.884	0.718
	SP2	0.848	0.000		
	SP3	0.872	0.000		
TSI	TSI1	0.819	-	0.868	0.687
	TSI2	0.846	0.000		
	TSI3	0.821	0.000		
PEOU	PE1	0.793	-	0.886	0.722
	PE2	0.868	0.000		
	PE3	0.885	0.000		
PU	PU1	0.851	-	0.875	0.700
	PU2	0.868	0.000		
	PU3	0.790	0.000		
CWB	CWB1	0.790	-	0.871	0.628
	CWB2	0.810	0.000		
	CWB3	0.768	0.000		
	CWB4	0.802	0.000		

Table 4 Results of Discriminant Validity Test

Model	Factor	χ^2	df	χ^2/df	GFI	NFI	CFI	RMSEA
Single-factor	CWB+TSI+SR+SP+PEOU+PU	2375.176	152	15.626	0.543	0.410	0.424	0.205
Two-factor	CWB,TSI+SR+SP+PEOU+PU	2124.626	151	14.070	0.568	0.473	0.488	0.194
Three-factor	CWB,TSI,SR+SP+PEOU+PU	1615.696	149	10.844	0.624	0.599	0.620	0.168
Four-factor	CWB,TSI,SR+SP,PEOU+PU	1099.081	146	7.528	0.711	0.727	0.753	0.137
Five-factor	CWB,TSI,SR+SP,PEOU,PU	603.648	142	4.251	0.817	0.850	0.880	0.097
Six-factor	CWB,TSI,SR,SP,PEOU,PU	178.748	137	1.305	0.948	0.956	0.989	0.030

Note. + indicates that two factors are combined into one factor.

between 0.868 and 0.891 and all of them were more than 0.7, which demonstrates that the coefficients reach the acceptable level, and the scales are reliable.

4.3.3 Confirmatory factor analysis

In this study, confirmatory factor analysis of each indicator was presented in Table 3. From Table 3, it can be found that the factor loading value of each variable is between 0.768 and 0.885, CR value is between 0.868 and 0.891, and AVE value is between 0.628 and 0.731, which reaches the acceptable level, indicating that the scales had appropriate convergent validity. The discriminant validity of each variable was tested by confirmatory factor analysis of each latent variable and their combination, and the

values of each indicator were presented in Table 4. From Table 4, it can be found that the fitting indexes of the six-factor model are following: the value of χ^2/df is 1.305, RMSEA value is 0.030, GFI value is 0.948, NFI value is 0.956, and CFI value is 0.989. The composite indexes were significantly better than the ones of other models, and the six latent variables had good discriminant validity in this study.

5 Results

5.1 Related analysis

In this study, Pearson correlation analysis among variables was tested. The relationships among sound richness, sound pleasure, perceived ease of use, perceived usefulness, teacher-student interaction, and classroom well-being were as shown in Table 5. It can be found that the correlation coefficients were in line with expectations.

5.2 Structural model analysis

Theoretical model was tested and the fitting index are following: the value of χ^2/df is 1.305, GFI value is 0.948, NFI value is 0.965, CFI value is 0.989, TLI value is 0.986, RMSEA value is 0.030. The fitting indexes indicated that fitting relationship between the data and the model was good. The direct effect of the theoretical model was tested, as shown in Fig. 2. Standardized results of path analysis are expressed in Table 6. The direct influence coefficient of teacher-student interaction on classroom well-being is $\beta=0.183$, and the critical ratio is $C.R. = 3.580$, indicating that teacher-student interaction positively affects classroom well-being. The alternative hypothesis of H1 is supported. The direct influence coefficient of sound richness on classroom well-being is $\beta=0.269$, and the critical ratio is $C.R. = 4.410$, indicating that sound richness positively affects classroom well-being. The direct influence coefficient of sound pleasure on classroom well-being is $\beta=0.208$, and the critical ratio is $C.R. = 3.313$, indicating that sound pleasure positively affects classroom well-being. The alternative hypotheses of H2a and H2b are supported. The direct influence coefficient of perceived ease of use on classroom well-being is $\beta=0.163$, and the critical ratio is $C.R. = 2.900$, indicating that perceived ease of use positively affects classroom well-being. The direct influence coefficient of perceived usefulness on classroom well-being is $\beta=0.253$, and the critical ratio is $C.R. = 4.129$, indicating that perceived

Table 5 Correlation Coefficients Between Variables

Variable	Mean	SR	SP	PEOU	PU	TSI	CWB
SR	4.705	0.855					
SP	5.129	0.461**	0.848				
PEOU	5.105	0.121*	0.241**	0.850			
PU	5.129	0.292**	0.332**	0.354**	0.837		
TSI	5.576	0.079	0.082	-0.073	0.151**	0.829	
CWB	5.332	0.438**	0.442**	0.311**	0.456**	0.225**	0.792

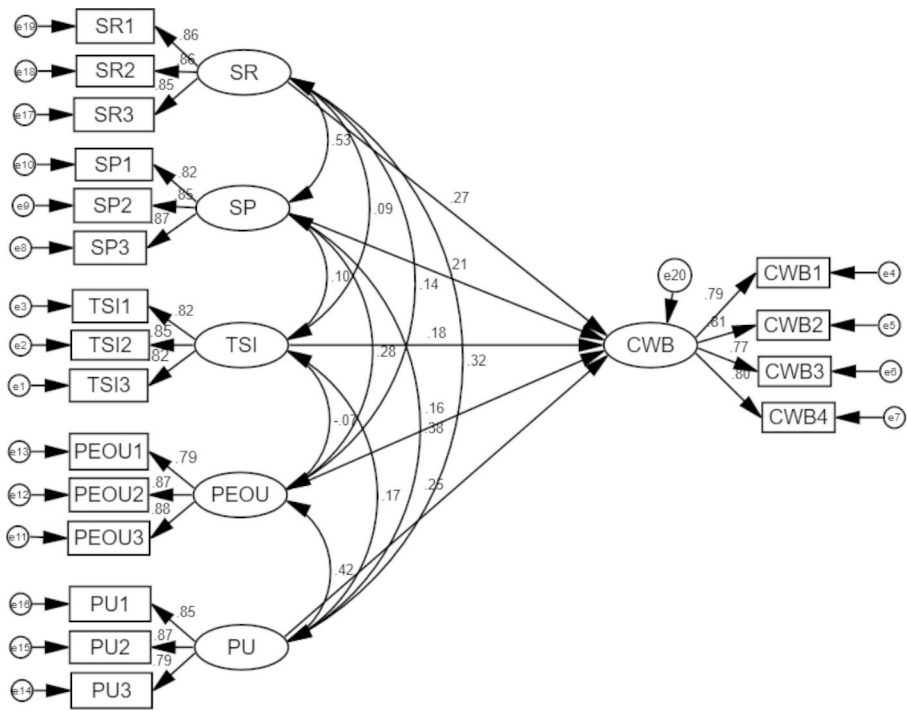


Fig. 2 Direct effect test of theoretical model

Table 6 Standardized Results of Path Analysis

Path	Std.	S.E.	C.R.	P-Value
Teacher-student interaction→Classroom well-being	0.183***	0.051	3.580	0.000
Sound richness→Classroom well-being	0.269***	0.043	4.410	0.000
Sound pleasure→Classroom well-being	0.208**	0.049	3.313	0.000
Perceived ease of use→Classroom well-being	0.163***	0.049	2.900	0.004
Perceived usefulness→Classroom well-being	0.253***	0.056	4.129	0.000

usefulness positively affects classroom well-being. The alternative hypotheses of H3a and H3b are supported.

5.3 Moderating effect test

Sequential test procedure proposed by Wen et al. (2005) to test the moderating effect of sound richness and sound pleasure for teacher-student interaction on classroom well-being. Model 1 regresses classroom well-being on sound richness and teacher-student interaction, and Model 2 regresses classroom well-being on sound richness, teacher-student interaction, and the interaction term of sound richness and teacher-student interaction. In Model 2, it can be indicated that the regression coefficient of classroom well-being on the interaction term of sound richness and teacher-student interaction is -0.068 ($P < .01$), which shows that sound richness significantly moderates the effect of teacher-student interaction on classroom well-being. The alternative hypothesis of H4a is supported. Model 3 regresses classroom well-being on sound pleasure and teacher-student interaction, and Model 4 regresses classroom well-being on sound pleasure, teacher-student interaction, and the interaction item of sound pleasure and teacher-student interaction. In Model 4, it can be found that the regression coefficient of classroom well-being on the interaction term of sound pleasure and teacher-student interaction is -0.009 ($P > .05$), indicating that sound pleasure can not moderate the effect of teacher-student interaction on classroom well-being. The null hypothesis of H4b is supported. The test results are as indicated in Table 7.

Sequential test procedure proposed to test the moderating effect of perceived ease of use and perceived usefulness. Model 5 regresses classroom well-being on perceived ease of use and teacher-student interaction, and Model 6 regresses classroom well-being on perceived ease of use, teacher-student interaction, and the interaction terms of perceived ease of use and teacher-student interaction. In Model 6, it can be indicated that the regression coefficient of classroom well-being on interaction term of teacher-student interaction and perceived ease of use is -0.072 ($P < .05$), which shows that moderating effect of perceived ease of use for teacher-student interaction on class well-being is significant. The alternative hypothesis of H5a is supported. Model 7 regresses classroom well-being on perceived usefulness and teacher-student

Table 7 Moderating Effect of SR and SP

	Classroom well-being			
	Model 1	Model 2	Model 3	Model 4
1.Independent variable				
TSI	0.191**	0.487***	0.189**	0.234
2.Moderator variable				
SR	0.310***	0.686***		
SP			0.340**	0.388**
3.Moderating effect				
SR×TSI		-0.068**		
SP×TSI				-0.009
R ²	0.229	0.251	0.231	0.232
ΔR ²	0.229	0.022	0.231	0.000
ΔF	51.268***	10.095**	52.061***	0.130

interaction, and Model 8 regresses classroom well-being on perceived usefulness, teacher-student interaction, and the interaction item of perceived usefulness and teacher-student interaction. In Model 8, it can be found that the regression coefficient of classroom well-being on the interaction term of perceived usefulness and teacher-student interaction is $-.030$ ($P > .05$), which indicates that perceived usefulness has not moderating effect for teacher-student interaction on classroom well-being. The null hypothesis of H5b is supported. The test results are as indicated in Table 8.

6 Discussions

Teacher-student interaction positively affects classroom well-being. It shows that the enhancement of teacher-student interaction can improve students' well-being in class. This conclusion is in line with the findings of some scholars that the interaction can have a positive influence on well-being (Farhah et al., 2021; Sieber et al., 2020). Therefore, in online course education, various means should be adopted to promote the interaction between students and teachers, such as supporting students' emotional needs (Ibaraki, 2022), adopting more flexible communication methods (Petillion & McNeil, 2020), and enhancing students' interest in learning (Bovermann et al., 2018).

Sound richness and sound pleasure positively affects classroom well-being. It shows that students' classroom well-being can be improved by enhancing the sound richness and sound pleasure. This conclusion also verifies the thought proposed by many scholars that the sound environment can have an impact on people's health and positive attitude (Marchand et al., 2014; Ratcliffe, 2021; Zhang et al., 2021). The classroom teaching environment needs a good sound environment, and this study proposes that online teaching would also follow this principle. Therefore, the university should put forward corresponding requirements for students who are teaching online, so as to ensure the quietness of the sound environment in the background of the online classroom and the sound richness in the teaching process, and promote the generation of their classroom well-being.

Table 8 Moderating Effect of PEOU and PU

	Classroom well-being			
	Model 5	Model 6	Model 7	Model 8
1.Independent variable				
TSI	0.248***	0.649**	0.159**	0.301*
2.Moderator variable				
PEOU	0.298***	0.723**		
PU			0.384***	0.554**
3.Moderating effect				
PEOU×TSI		-0.072*		
PU×TSI				-0.030
R ²	0.158	0.168	0.232	0.235
ΔR ²	0.158	0.010	0.232	0.003
ΔF	32.498***	4.243*	52.389***	1.155

Perceived ease of use and perceived usefulness positively affects classroom well-being. It shows that students' classroom well-being can be improved by enhancing the perceived ease of use and perceived usefulness of online teaching system and mastering information communication technology. The research conclusion verifies that technology acceptance model is applicable to the online learning process of college students (Granić & Marangunić, 2019), and the students' technology acceptance of the online teaching platform has an impact on students' classroom well-being. This conclusion promotes the utilization of technology acceptance model in well-being research.

Sound richness significantly moderates the effect of teacher-student interaction on classroom well-being. This indicates that the effect of teacher-student interaction on students' classroom well-being is different under two levels of sound richness in the classroom environment. The conclusion also proves that sound richness can not only directly affect classroom well-being, but also have an effect on the influence of other factors in the teaching system. In order to more vividly express the effect of sound richness moderating the impact of teacher-student interaction on classroom well-being, the moderating effect chart is drawn in this study, which is presented in Fig. 3. From Fig. 3, it can be found that at the low level of sound richness, teacher-student interaction can positively affect classroom well-being, indicating that sound richness and teacher-student interaction complement each other to promote classroom well-being. Sound pleasure can not moderate the effect of teacher-student interaction on classroom well-being. This may be due to the fact that the sound pleasure of online teaching only focuses on the surrounding environment of students in class, so it only directly affects the well-being of the classroom and fails to have an impact on the effect of other factors in the online teaching system. These conclusions can strengthen the sound environment effect mechanism analysis for teacher-student interaction on students' classroom well-being.

Perceived ease of use significantly moderates the effect of teacher-student interaction on classroom well-being. This illustrates that teacher-student interaction could affect differently students' classroom well-being at two levels of perceived ease of use for online study system. This conclusion also proves that perceived ease of use for online study system can not only directly affect the classroom well-being, but also have an effect on the influence of other factors in the teaching system. To more vividly express moderating effect of perceived ease of use for teacher-student interaction on classroom well-being, the moderat-

Fig. 3 Moderating effect of sound richness

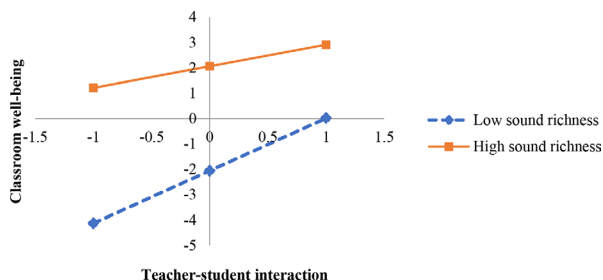
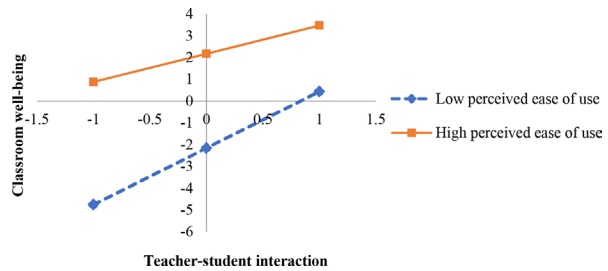


Fig. 4 Moderating effect of perceived ease of use



ing effect chart is drawn in this study, which is presented in Fig. 4. From Fig. 4, it can be found that, at the low level of perceived ease of use, teacher-student interaction has a more significant impact on classroom well-being, indicating that perceived ease of use for online study system and teacher-student interaction complement each other and promote classroom well-being. Perceived usefulness has not moderating effect for teacher-student interaction on classroom well-being. This may be due to the fact that the student's perception of the usefulness of the online teaching system is more focused on the learning effect, so it only directly affects the classroom well-being, and fails to affect the effects of other factors in the online teaching system. These conclusions can connect the technology acceptance model with the well-being, and supplement the existing research on the motivation of students' classroom well-being.

7 Conclusions and implications

7.1 Research conclusions

Taking the college students receiving online education as the participants, this study analyzed the influence mechanism of teacher-student interaction on classroom well-being with empirical method, and mainly drew four conclusions. (1) Teacher-student interaction positively affects students' classroom well-being. (2) Sound richness and sound pleasure positively affects students' classroom well-being, and to improve sound richness and sound pleasure can significantly promote students' classroom well-being. (3) Students' technical acceptance of the learning system positively affects classroom well-being, and high level of perceived ease of use and perceived usefulness can promote students to improve classroom well-being. (4) Sound richness and perceived ease of use negatively moderates the impact of teacher-student interaction on students' classroom well-being.

7.2 Pedagogical implications

Teacher-student interaction should be emphasized in online education. In the context of the epidemic and the popularization of information and communications technology, online education has become an important form of college education. Teachers should strengthen communication with students in the teaching process,

develop students' interest and happy frame of mind in classroom learning, and improve their self-efficacy and learning ability, so as to bring students a positive learning experience and effect.

The sound environment of online education is an important learning situational environment. Creating the comfortable auditory environment for students in online education is very important, such as paying attention to improving the vividness and richness of the class sound environment, and keeping surroundings quiet, harmonious and pleasant, so as to make the effect of online education better.

Online education should focus on cultivating students' technical acceptance of the learning system. The online learning system is an important medium of online education, which will affect students' well-being of the classroom. Therefore, on the one hand, the optimization of the system should be strengthened to make it easy for students to master and use; On the other hand, the students' ability to use should also be improved, so as to promote the students' learning experience.

8 Appendix A

Questionnaire Items

Latent variable	Item	
Sound richness	SR1	I perceive the sound of the class to be vivid.
	SR2	I perceive the sound of the class to be rich.
	SR3	I perceive the sound of the class to be interesting.
Sound pleasure	SP1	I perceive the listening environment to be quiet.
	SP2	I perceive the listening environment to be harmonious.
	SP3	I perceive the listening environment to be pleasant.
Teacher-student interaction	TSI1	I get feedback from the teacher.
	TSI2	The teacher conducts effective classroom management.
	TSI3	I have a voice in classroom activities.
Perceived ease of use	PE1	I find the devices and applications for online learning very easy to use.
	PE2	Learning with an online learning platform is easy for me.
	PE3	When I learn online, the interaction with the platform is clear and easy to understand.
Perceived usefulness	PU1	Using online learning platform makes my study easier.
	PU2	Using online learning platform will save me a lot of time.
	PU3	Online learning platform can improve my learning effect.
Classroom well-being	CWB1	I feel very satisfied with my teacher's teaching.
	CWB2	I feel very happy in class.
	CWB3	The teacher's teaching makes me very confident in learning.
	CWB4	The teacher's teaching enables me to constantly surpass myself and achieve more achievements.

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

Declarations

Ethics approval Not applicable.

Conflict of Interest The authors declare no conflict of interest.

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