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# Factors influencing students' learning satisfaction and students' learning outcomes in blended learning

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## ABSTRACT

In China, there is a thriving trend of utilizing a unique form of blended learning that combines MOOCs (massive open online courses) and SPOC (Small Private Online Course). However, the evaluation methods used for these blended learning courses have not been adequately developed. The objective and accurate evaluation of blended learning poses a challenge. Therefore, it is imperative to conduct a preliminary study to examine the relationships between various factors, such as the quality of the teaching environment, the quality of teachers' offline teaching, the quality of teachers' online teaching, and their impacts on students' learning satisfaction and learning outcomes in a blended learning setting. This study aims to analyze the factors in blended learning by employing structural equation modeling and interviews with 275 students. The findings of this research contribute to the advancement of student learning evaluation in blended learning by incorporating the evaluation of the teaching environment, the quality of teachers' online teaching, the quality of teachers' offline teaching, student satisfaction, and students' learning outcomes. Furthermore, this study offers a comprehensive analysis of the influence of the teaching environment on the aforementioned factors in blended learning, thereby providing a rationale and robust empirical evidence for the Chinese government's sustained investment in information technology infrastructure in higher education.

**Contribution/Originality:** This paper contributed in showing how to revolutionize the students' learning evaluation through a blended learning approach and by including evaluation of teaching environment and quality of teachers' online learning, it examined the role of blended learning in the advancement the quality of teachers' online as well as offline teaching, student satisfaction, and students' learning outcomes.

## 1. INTRODUCTION

In China, nowadays, colleges and universities courses are generally divided into five categories according to the characteristics of teaching forms, that is, traditional offline courses, online MOOCs, online and offline blended learning curricula born with the "Internet plus teaching," virtual simulation courses, and social practice courses (Wu, 2018). The blended learning curriculum based on MOOCs and SPOC is a new teaching model to solve the traditional teaching model's insufficiency in learning resources; in the meantime, it can also solve MOOCs' insufficient problems of students' lacking help

in classes, lacking learning motivations, lacking supervisions and other fatal issues. It is the most heated direction of China's teaching reform (Wang & Zhang, 2022).

However, for this new teaching model, a new teaching evaluation method needs to be developed. However, there are some problems with the current teaching evaluation: (a). Some schools' evaluation systems have not changed for more than a decade, and the evaluation options are contrary to the characteristics of current education (Zhang, Xu, & Su, 2020). (b). The current teaching evaluation does not consider the teachers' online teaching behaviour. Blended learning needs the corresponding evaluation mechanism to evaluate teachers' online teaching behaviors (Pozdniakov et al., 2022). (c). Teachers' feedback from the existing evaluation system has only abstract scores with few written opinions and lacks a clear and intuitive summary of teaching feedback (Zhang & Leydesdorff, 2021). (d). The existing teaching evaluation has apparent defects in the specific guidance. It cannot point out the problems in teachers' teaching and the corresponding improvement methods according to the data (Rubach, Von Keyserlingk, Simpkins, & Eccles, 2022). (e). The current teaching evaluation does not consider the teaching environment. Bringing the teaching environment into the teaching evaluation will give the school under pressure and be willing to improve the teaching equipment and environment and objectively improve the teaching quality of the whole school.

In light of the aforementioned background, this article endeavors to undertake a preliminary investigation to scrutinize the interrelationships among diverse factors, namely the quality of the teaching environment (QTE), the quality of teachers' offline teaching (OQ), the quality of teachers' online teaching (OTQ), and their influence on students' learning satisfaction (SLS) and learning outcomes (SLO) within the context of a blended learning environment. In particular, a sample consisting of 275 undergraduate students enrolled in blended learning courses at Zhejiang Ocean University is employed. To augment the quantitative findings, qualitative interviews are conducted with the surveyed students and teachers.

## 2. LITERATURE REVIEW

### 2.1. The Quality of Teachers' Online Teaching in Blended Learning

Onah, Pang, and Sinclair (2022) focused on the various aspects of blended usages, such as task strategies, time management, and environment structuring. Their overall average score indicated that the participants did not reach a high level of self-regulation. Consequently, when we evaluate the quality of teachers' online teaching, we should consider what the teacher should do to help students focus on online teaching.

According to Shrivastava and Shrivastava (2023), the most lucrative strategy for online education providers is to create programs recognized by a reputed international university. Therefore, the quality of the online course and whether it could provide a certification should be considered an important variable. Oudbier, Spaai, Timmermans, and Boerboom (2022) thought the activities of students should be separated into two aspects, online activities (Out-of-class activities) and offline activities (In-class activities).

### 2.2. The Quality of Teachers' Offline Teaching in Blended Learning

Cabauatan, Uy, Manalo, and Castro (2021) thought that the teacher's information technology application ability played an extraordinary role in blended learning. Ferriz-Valero, Østerlie, García-Martínez, and Baena-Morales (2022) found that in offline teaching, flipped classrooms benefited Spanish secondary students both in their learning in PE and their motivation towards PE. Furthermore, the flipped classroom has gained good recognition over the last decade.

### 2.3. Students' Learning Satisfaction in Blended Learning

Abdul Karim, Nasir, Hussain, Mohamed, and Mokhtar (2021) investigated factors associated with students' satisfaction with Learning Management System (LMS) - UNIEC Virtual in blended learning courses. Perceived ease of use (PEOU), facilitating conditions, and interaction are selected as independent variables in their study. Golding and Jackson (2021) discovered that positive emotions and responsiveness were the main factors that affected students' satisfaction during the COVID-19 lockdown.

Mahdy and Ewaida (2022) believed that blended learning was recommended for some introductory courses though the students need to face the effect of COVID-19. Taghizadeh and Hajhosseini (2021) noted that the quality of teaching was more important than the interaction and attitude of the students. They also noted that the satisfaction of blended learning students was related to the various factors evaluated in the study. In 2003, Chang and Fisher (2003) stated that students' learning satisfaction is a crucial factor influencing blended learning programs' success.

### 2.4. The Quality of the Teaching Environment in Blended Learning

After studying the influencing factors of students' learning satisfaction, scholars Wei-Tong and Xiao-Xiao (2018) found that the learning environment has no direct impact on satisfaction but has an indirect impact on satisfaction through the intermediary effect of interaction and learning achievement (Wei-Tong & Xiao-Xiao, 2018). In fact, many researchers will focus on the importance of the learning environment when discussing hybrid teaching design. For example, Wu, Tennyson, and Hsia (2010) pointed out that a high-quality hybrid learning environment can organically integrate online and offline links, further stimulating learners to participate in knowledge construction and collaborative interaction to obtain learners' recognition and improve satisfaction (Wu et al., 2010).

### 2.5. Theoretical Framework

The theoretical framework adopted in this study is the Badrul H. Khan's eLearning framework (Khan, 2000). Khan's framework is one of the best and most comprehensive theoretical e-Learning models, considered suitable for blended learning classes (Morrison, 2003), and since it included all the factors in blended learning it's very suitable for this study. The framework comprises eight factors as Figure 1: pedagogical, technological, interface design, evaluation, management, resource support, ethical, and institutional. Furthermore, according to different research objectives, people can use some factors to build a new framework, which does not need to include all eight factors. At the same time, the criteria of evaluation factors should also be changed according to the actual local teaching conditions and policies (Morrison, 2003). For this study, offline teaching quality stands for pedagogical design and interface design; online teaching quality stands for resource support; teaching environment quality stands for management and technical support; and students' learning outcomes stand for evaluation. Students' satisfaction is also taken into account as a mediator in this study.
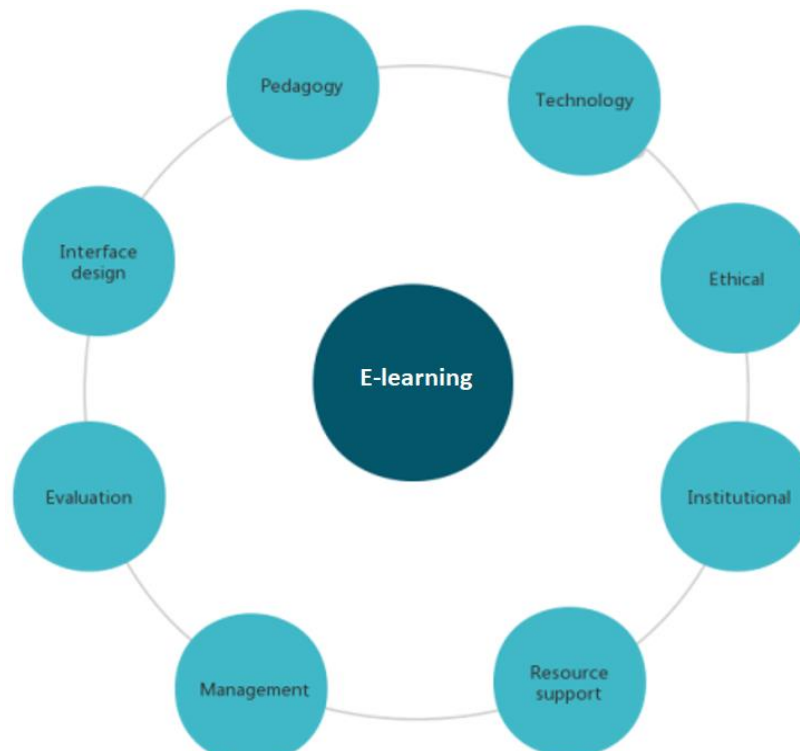


**Figure 1.** Khan's e-learning framework.

## 3. RESEARCH OBJECTIVES AND QUESTIONS

### 3.1. Research Objectives

This study evaluates teachers' teaching behaviors in blended learning courses based on MOOCs. The following are the 3 research objectives (RO):

RO1: To examine the relationships between online teaching quality, offline teaching quality and teaching environment with each other.

RO2: To examine the influence of online teaching quality, offline teaching quality and teaching environment on students' learning satisfaction.

RO3: To examine the influence of online teaching quality, offline teaching quality, teaching environment and students' learning satisfaction on students' learning outcomes.

### 3.2. Research Questions

The research questions posed are to meet the study's objectives and reflect the conceptual framework guiding the study. These Research questions (RQ) were tested in the research:

RQ1: How do the quality of teachers' online teaching (OTQ), the quality of teaching environment (QTE) and the quality of teachers' offline teaching (OQ) correlate?

RQ2: How do the quality of teachers' online teaching, the quality of the teaching environment, and the quality of teachers' offline teaching influence students' learning satisfaction (SLS)?

RQ3: How do the quality of teachers' online teaching, the quality of teaching environment, the quality of teachers' offline teaching and students' learning satisfaction influence students' learning outcomes (SLO)?

### 3.3. Research Hypothesis

Each research question was tested through a hypothesis, which are listed below:

*RQ1: Hypothesis 1: There are relationships between the quality of online teaching, the quality of the teaching environment, and the quality of teachers' offline teaching.*

*RQ2: Hypothesis 2: The quality of teachers' online teaching, the quality of the teaching environment, and the quality of teachers' offline teaching will influence students' learning satisfaction.*

*RQ3: Hypothesis 3: The quality of teachers' online teaching, the quality of the teaching environment, the quality of teachers' offline teaching, and the students' learning satisfaction will influence students' learning outcomes.*

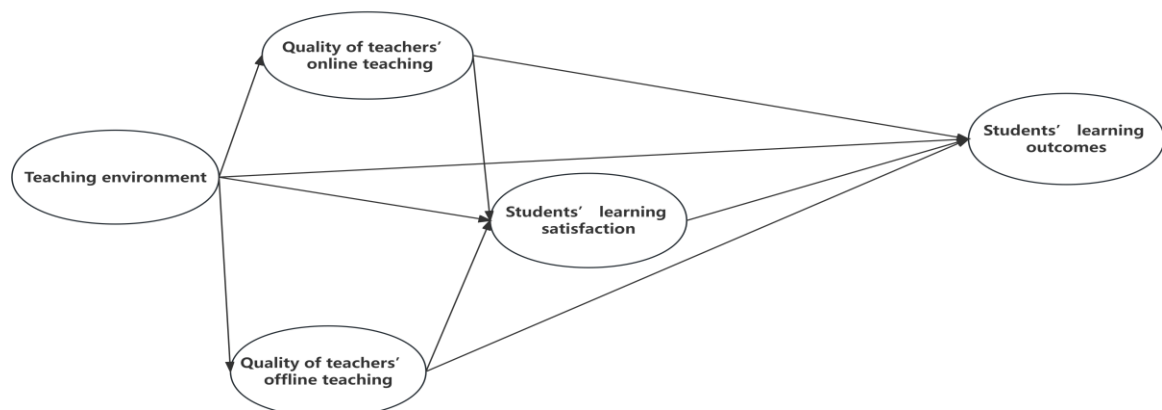The conceptual framework of this study is presented in Figure 2.



**Figure 2.** Conceptual framework.

## 4. DATA AND METHODOLOGY

This section introduces the instruments applied in the study and the data collection features that allowed validation of the hypotheses.

*4.1. Applied Instruments*

The research used Structural Equation Modeling (SEM) to test the hypothesis assumptions and to verify the relationship between factors. Structural Equation Modeling, also called latent variable models (Moustaki, Jöreskog, & Mavridis, 2004), is classified into advanced statistics and belongs to multivariate statistics. The structural equation model combines statistical methods with path and factor analysis to test the relationship between variables. It can then identify the direct effect of these variables and the indirect effect of these independent variables on the dependent variables.

The content of this study involves learning behaviour analysis and teaching evaluation management, when selecting the evaluation scales, this study uses five scales, which are shown in Table 1.

**Table 1.** The scales used in this study.

| Latent variables | Measurement index | Description |
|---|---|---|
| Students' learning outcomes (SLO) | Obtained professional knowledge and clarified their future development plans (SLO1) | Use the Learning outcomes evaluation scale based on Bloom's taxonomy (Wang, 2020) to evaluate the students' learning outcomes. |
| | Improved learning motivation (SLO2) | |
| | Mastered effective learning methods and developed good learning habits (SLO3) | |
| Offline teaching quality (OQ) | The teacher has teaching ideals, professionalism, and teaching pursuit, and loves students, subjects, and the education career (OQ1) | Use the "Guiding standards for undergraduate classroom teaching quality" (Li, 2018) combined with the evaluation scale for teachers' teaching quality used by 30 universities (Yu, 2015) to evaluate the offline-teaching quality. |
| | The teacher possesses the necessary professional and teaching knowledge for the subject being taught. Possess teaching design, implementation, evaluation, reflection, and research abilities in the subject being taught (OQ2) | |
| | The teacher respects the rights, status, and personality of students, cares about their physical and mental health, and promotes their comprehensive development (OQ3) | |
| Quality of teaching environment (QTE) | The projection status of the classroom (QTE1) | Use the evaluation scale of multimedia and smart classrooms to evaluate the offline teaching environment. This scale is extracted from Zhejiang Ocean University's construction project of multimedia classrooms and smart classrooms. Use the evaluation scale of Course platform satisfaction (Wang, 2020) to evaluate the online teaching environment. |
| | The computer performance in the classroom (QTE2) | |
| | The sound effect of the classroom (QTE3) | |
| | Network conditions and platform usability during online learning (QTE4) | |
| Students' learning satisfaction (SLS) | Satisfaction with content setting (SLS1) | Use the evaluation scale of students' satisfaction (Wang, 2020) combined with the "questionnaire on the impact of teacher support behaviour on learner satisfaction in online open Courses" (Jiang, 2018) to evaluate the students' learning satisfaction. |
| | Satisfaction with teaching format (SLS2) | |
| | Satisfaction with class schedule (SLS3) | |
| Online teaching quality (OTQ) | Online courses adhere to cultivating morality and cultivating talents, internalizing ideological and political education into course content (OTQ1) | Use the evaluation scale of the Ministry of Education of China for National first-class online courses (China, 2021b) and blended learning courses (China, 2021a) to evaluate the online teaching quality. |
| | Online courses reflect the achievements of educational reform and research, and have a high level of scientific meaning. (OTQ2) | |
| | The online course content and teaching process configuration are rich and diverse, with reasonable depth and timely updating and improvement of content. Online exams have appropriate difficulty and differentiation (OTQ3) | |

*4.2. Data Collection*

Currently, the SEM model's statistical verification force and samples are mainly based on MacCallum, Browne, and Sugawara (1996). The proposed RMSEA estimation method refers that if the number of samples is less than 200, it shall also be calculated as more than 200, no matter how many samples should be calculated. If there are more than 200 samples, sampling shall be carried out according to the estimated number of samples.

Schumacker and Lomax (2004) surveyed the literature. They found that $250 \sim 500$ samples were used in many articles, and they also agreed that less than $100 \sim 150$ samples were unstable. Therefore, if there are more than ten variables and the number of samples is less than 200, it is generally considered that the evaluation of parameters is unstable, and the significance test will lack statistical testing power. Moreover, when the number of samples exceeds 500, the chi-square value will be significantly overestimated (Zhang et al., 2020). Therefore, after conducting the process of data cleaning, 275 students who participated in blended learning were selected for sample analysis from Zhejiang Ocean University.

### 4.3. Descriptive Statistics of Samples

This study selected four blended learning courses from Zhejiang Ocean University, namely "Film and Television Photography and Postproduction", "College Physics Experiments", "Modern Educational Technology", and "Physics and World Progress", as research courses. The collected data from study participants included professional courses, introductory public courses, and general elective courses. After screening and removing samples with short answer duration, the specific data description is shown in Table 2:

**Table 2.** Data description of sample basic information.

| Item | Option | Frequency | Percentage (%) | Cumulative percentage (%) |
|---|---|---|---|---|
| Grade | Freshman | 116 | 42.18 | 42.18 |
| | Sophomore | 78 | 28.36 | 70.55 |
| | Junior and senior | 81 | 29.45 | 100 |
| Have you ever attended blended learning courses before studying this course? | Yes | 174 | 63.27 | 63.27 |
| | No | 101 | 36.73 | 100.00 |
| Gender | Male | 136 | 49.45 | 49.45 |
| | Female | 139 | 50.55 | 100.00 |
| Expectations from this course before studying. | Very high | 77 | 28.00 | 28.00 |
| | Relatively high | 157 | 57.09 | 85.09 |
| | General expectations | 40 | 14.55 | 99.64 |
| | Relatively low | 1 | 0.36 | 100.00 |

Table 2 shows that among the 275 students, there are 116 freshmen, 78 sophomores, 77 juniors, and four seniors. Before studying this course, 174 students had participated in blended learning, while 101 students had not participated in any blended learning. According to gender classification, 136 males and 139 females have a similar proportion of personnel. Among the course expectations, 77 students had very high expectations, 157 students had relatively high expectations, 40 said they had general expectations, and only one student had relatively low expectations.

### 4.4. Reliability and Validity Analysis

The standardized load values corresponding to each latent variable range from 0.806 to 0.915, and the corresponding Z values range from 15.72 to 22.599, as shown in the factor load coefficient table of Table 3. Cronbach's corresponding to each latent variable α the coefficients between 0.88 and 0.926 are all greater than 0.85, indicating that the sample data has good reliability. The combined reliability coefficient (CR) values for each dimension are more significant than 0.8 between 0.882 and 0.927, indicating that the measurement questions for each potential variable have internal consistency. The average variance extracted (AVE) values of each dimension are more significant than 0.7 between 0.714 and 0.809, indicating that each size of the measurement model has good convergence validity. The specific data is shown in Table 3.

### 4.5. Scale Discrimination Test

The so-called differential validity refers to the low correlation or significant difference between the latent traits represented by the latent variables and those represented by other latent variables (Li, Wang, & Chen, 2020). The square root value of AVE should be greater than the correlation coefficient between this factor (latent variable) and other factors (latent variable). For Students' Learning Outcomes (SLO), Offline Teaching Quality (OQ）, Quality of Teaching

Environment (QTE), Students' Learning Satisfaction (SLS), and Online Teaching Quality (OTQ), their AVE square root values are 0.866, 0.899, 0.851, 0.868, and 0.845, respectively, which are greater than the maximum absolute values of the inter factor correlation coefficients of 0.602, 0.618, 0.617, 0.717, and 0.717, indicating good discriminant validity. The details are shown in Table 4.

**Table 3.** Table of factor load factors for the scale.

| Latent variables | Measurement index | Non-standard load factor (Coef.) | Standard error (Std. error) | Z | p | Standard load factor | Cronbach's α | CR | AVE |
|---|---|---|---|---|---|---|---|---|---|
| Students' learning outcomes (SLO) | SLO1 | 1 | - | - | - | 0.858 | 0.899 | 0.9 | 0.751 |
| | SLO2 | 0.94 | 0.05 | 18.87 | 0 | 0.896 | | | |
| | SLO3 | 0.902 | 0.052 | 17.39 | 0 | 0.844 | | | |
| Offline teaching quality (OQ) | OQ1 | 1 | - | - | - | 0.915 | 0.926 | 0.927 | 0.809 |
| | OQ2 | 0.929 | 0.041 | 22.599 | 0 | 0.894 | | | |
| | OQ3 | 0.898 | 0.04 | 22.256 | 0 | 0.888 | | | |
| Quality of teaching environment (QTE) | QTE1 | 1 | - | - | - | 0.806 | 0.901 | 0.913 | 0.725 |
| | QTE2 | 1.224 | 0.069 | 17.835 | 0 | 0.911 | | | |
| | QTE3 | 1.042 | 0.066 | 15.72 | 0 | 0.829 | | | |
| | QTE4 | 1.034 | 0.063 | 16.418 | 0 | 0.855 | | | |
| Students' learning satisfaction (SLS) | SLS1 | 1 | - | - | - | 0.873 | 0.9 | 0.901 | 0.753 |
| | SLS2 | 1.018 | 0.05 | 20.403 | 0 | 0.903 | | | |
| | SLS3 | 0.969 | 0.055 | 17.544 | 0 | 0.826 | | | |
| Online teaching quality (OTQ) | OTQ1 | 1 | - | - | - | 0.815 | 0.88 | 0.882 | 0.714 |
| | OTQ2 | 1.089 | 0.069 | 15.819 | 0 | 0.837 | | | |
| | OTQ3 | 1.015 | 0.06 | 16.847 | 0 | 0.881 | | | |

**Table 4.** Differentiation validity of latent variables: Pearson correlation and AVE square root value.

| | Students' learning outcomes (SLO) | Offline teaching quality (OQ) | Quality of teaching environment (QTE) | Students' learning satisfaction (SLS) | Online teaching quality (OTQ) |
|---|---|---|---|---|---|
| Students' learning outcomes (SLO) | 0.866 | | | | |
| Offline teaching quality (OQ) | 0.565 | 0.899 | | | |
| Quality of teaching environment (QTE) | 0.476 | 0.413 | 0.851 | | |
| Students' learning satisfaction (SLS) | 0.602 | 0.565 | 0.617 | 0.868 | |
| Online teaching quality (OTQ) | 0.587 | 0.618 | 0.540 | 0.717 | 0.845 |

**Note:** The diagonal blue numbers represent the AVE square root value.

## 4.6. Model Fit of the Scale

The chi square degree of freedom ratio of the scale $\chi^2/df$ is 2.775 less than 3, GFI is 0.900, which exactly meets the standard. RMSEA is 0.080<0.10, RMR is 0.028<0.05, and CFI, NFI, and NNFI also meet the model fitting indicators. The details are shown in Table 5:

**Table 5.** Model fitting index.

| $\chi^2$ | df | $\chi^2/df$ | GFI | RMSEA | RMR | CFI | NFI | NNFI |
|---|---|---|---|---|---|---|---|---|
| - | - | <3 | >0.9 | <0.10 | <0.05 | >0.9 | >0.9 | >0.9 |
| 260.814 | 94 | 2.775 | 0.900 | 0.080 | 0.028 | 0.955 | 0.931 | 0.942 |

**Note:** GFI: Goodness-of-fit index.
RMSEA: Root mean square error of approximation.
RMR: Root mean square residual.
CFI: Concept fit index.
NFI: Normed fit index.
NNFI: Non-normed fit index.

*4.7. Structural Equation Model Analysis and Correction*

The final test results of the structural equation model and the parameter test values before and after the revision of the hypothesis model are shown in Table 6. Among them, the test values of quality of teaching environment (QTE) → students' learning outcomes (SLO) do not meet the significance criteria (The CR value of 0.644 falls below the threshold of 2, the P value of 0.519 exceeds the significance level of 0.01), indicating that the quality of teaching environment has no significant direct impact on students' learning outcomes. Therefore, this study deleted this path and tested the revised model again. After correction, the CR values of the influence relationship between each factor are greater than 2, and the P values are significant at the 0.01 level. Specifically, these results indicate that the quality of the teaching environment will have a positive impact on the quality of offline teaching and online teaching, so RQ1 hypothesis 1 is confirmed by the research result. The offline teaching quality, the online teaching quality, and the teaching environmental quality will also have a positive impact on students' learning satisfaction, which means that RQ2 hypothesis 2 is confirmed by research result. The offline teaching quality, the online teaching quality (OTQ), the quality of teaching environment (QTE), and students' learning satisfaction will also have an impact on students' learning outcomes, which means RQ3 hypothesis 3 is also confirmed by the research result.

*4.8. Analysis of Overall SEM Model Effects*

Based on the previous model revision and verification, the final structural equation model for the impact analysis of the teaching environment is shown in Figure 3.
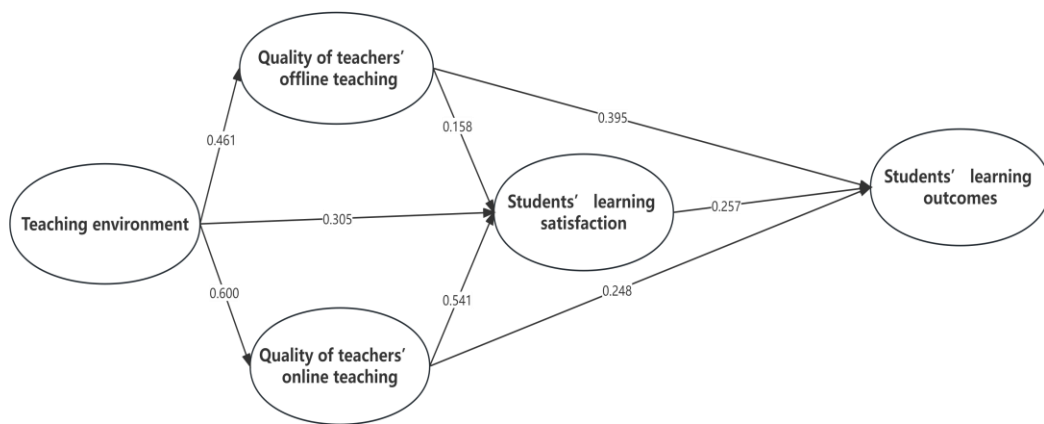


**Figure 3.** The final structural equation model.

The effect size of the structural equation model for the impact analysis of the teaching environment is shown in Table 7. The direct effect has been identified in Figure 3. The effect of the quality of teaching environment(QTE) on offline teaching quality(OQ), online teaching quality(OTQ) and students' learning satisfaction(SLS) are 0.461, 0.600 and 0.305 respectively; The quality of teaching environment(QTE) has no direct impact on students' learning outcomes(SLO), but through its intermediary effect on offline teaching quality(OQ), online teaching quality(OTQ) and students' learning satisfaction(SLS), the indirect effect size value of teaching environment quality(QTE) on students' learning outcomes(SLO) is 0.511.

This study focuses on the current two important indicators for evaluating teaching effectiveness: students' learning satisfaction and students' learning outcomes. The total effect size of quality of teaching environment (QTE), offline teaching quality (OQ) and online teaching quality (OTQ) on students' learning satisfaction (SLS) are 0.702, 0.158 and 0.541, while the total effect size of quality of teaching environment (QTE), offline teaching quality (OQ) and online teaching quality (OTQ) on students' learning outcomes (SLO) are 0.511, 0.436 and 0.387.

**Table 6.** Summary table of model regression coefficient.

| X→Y | Non standardized regression coefficient | | SE | | z (CR) | | p | | Standardized regression coefficient | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Before correction | Revised | Before correction | Revised | Before correction | Revised | Before correction | Revised | Before correction | Revised |
| OQ→SLS | 0.146 | 0.146 | 0.045 | 0.045 | 3.255 | 3.244 | 0.001 | 0.001 | 0.159 | 0.158 |
| OQ→SLO | 0.426 | 0.427 | 0.066 | 0.065 | 6.423 | 6.622 | 0.001 | 0.000 | 0.393 | 0.395 |
| OTQ→SLS | 0.567 | 0.566 | 0.066 | 0.066 | 8.537 | 8.529 | 0.000 | 0.000 | 0.541 | 0.541 |
| OTQ→SLO | 0.300 | 0.305 | 0.114 | 0.114 | 2.621 | 2.678 | 0.009 | 0.007 | 0.244 | 0.248 |
| QTE→OQ | 0.416 | 0.417 | 0.057 | 0.057 | 7.306 | 7.323 | 0.000 | 0.000 | 0.460 | 0.461 |
| QTE→OTQ | 0.477 | 0.478 | 0.053 | 0.053 | 9.054 | 9.075 | 0.000 | 0.000 | 0.599 | 0.600 |
| QTE→SLS | 0.254 | 0.255 | 0.053 | 0.053 | 4.795 | 4.801 | 0.000 | 0.000 | 0.305 | 0.305 |
| QTE→SLO | 0.049 | - | 0.076 | - | 0.644 | - | 0.519 | - | 0.050 | - |
| SLS→SLO | 0.264 | 0.301 | 0.127 | 0.117 | 2.080 | 2.577 | 0.037 | 0.010 | 0.224 | 0.257 |

**Table 7.** Effect size of structural equation model for teaching environment impact analysis.

| | Independent variables / Dependent variables | Quality of teaching environment (QTE) | Offline teaching quality (OQ) | Online teaching quality (OTQ) | Students' learning satisfaction (SLS) |
|---|---|---|---|---|---|
| Standard direct effect | Offline teaching quality (OQ) | 0.461 | | | |
| | Online teaching quality (OTQ) | 0.600 | | | |
| | Students' learning satisfaction (SLS) | 0.305 | 0.158 | 0.541 | |
| | Students' learning outcomes (SLO) | | 0.395 | 0.248 | 0.257 |
| Standard indirect effect | Students' learning satisfaction (SLS) | 0.397 | | | |
| | Students' learning outcomes (SLO) | 0.511 | 0.041 | 0.139 | |
| Standard total effect | Offline teaching quality (OQ) | 0.461 | | | |
| | Online teaching quality (OTQ) | 0.600 | | | |
| | Students' learning satisfaction (SLS) | 0.702 | 0.158 | 0.541 | |
| | Students' learning outcomes (SLO) | 0.511 | 0.436 | 0.387 | 0.257 |

*4.9. Discovery and Exploration*

Based on the conclusions of the above quantitative analysis, this study conducted qualitative interviews with over 80 students and 5 teachers who participated in blended learning and also in the questionnaire. The followings are the interview conclusions obtained based on 3 research hypotheses.

Regarding RQ1 and research hypothesis 1: "The quality of the teaching environment will have an impact on the quality of online and offline teaching", all respondents hold a positive attitude. Specifically, it is reflected in the following viewpoint: Student 1 believes that the quality of offline and online teaching presentations is directly determined by the teaching hardware facilities, projectors playing the most prominent role. Projectors with insufficient lumen may not even display PowerPoint courseware properly. Student 2 believes that the teaching environment will also have a psychological impact on teachers and students, and good teaching equipment will provide users with a comfortable psychological experience, which can better carry out educational and teaching activities. Student 3 believes that the teaching environment can affect students' learning motivation. If the teaching environment is not ideal, then whether it is online or offline teaching, students' learning enthusiasm will be affected.

Teacher 1 believes that the network quality and page aesthetics in online teaching, as well as the sophistication of video production, will directly affect students' learning efficiency and experience. The teaching environment in offline teaching will also subtly affect students' learning status and motivation level. Students will learn more actively in well-equipped smart classrooms, and the teaching effect will be more excellent. Teacher 2 believes that some teaching behaviours completely rely on certain teaching equipment, such as group discussions and other teaching activities, which must be carried out in corresponding smart classrooms.

However, the impact coefficient of the teaching environment on online teaching is slightly higher than that of offline teaching. Student 4 believes that the offline teaching effect depends on the teaching style of teachers, so the offline teaching environment will not have too much impact on it. However, if there is a lack of a smooth network or error reporting on the platform during online teaching, it will immediately make them lose interest in attending classes. Student 5 believes that online teaching requires a good network environment, and at the same time, online teaching needs to attract students' attention while not allowing them to be attracted to content outside of the teaching. Offline teaching mainly needs to create a quiet and comfortable environment, allowing students to engage in immersive learning, which means that the learning style of the class and the teaching of the teacher may have a greater impact. Student 6 believes that in online teaching, students' self-control is limited, and links to web pages and pop-up game windows will attract their attention. Student 7 believes that the barrage in online videos can affect their learning, high-quality barrage triggers students' thinking, and vulgar barrage affects students' learning mood, leading to distraction. Therefore, if the teaching platform is not formal, it will seriously interfere with students' learning. The relevant literature also confirms these views. Li, Liu, and Zhang (2021) believe that university leaders need to attach importance to the teaching informatization construction, strengthen investment in software and hardware, and actively apply for financial support from relevant education departments to improve the construction of our school's information-centered teaching, which mainly includes the construction of teaching equipment and online platforms (Li et al., 2021). Regarding RQ2 and research hypothesis 2: "The quality of online teaching, the quality of teaching environment, and the quality of offline teaching will affect students' learning satisfaction." The vast majority of respondents believe that these three factors will affect learning satisfaction. Since "the quality of offline teaching and the teaching environment can affect student satisfaction" is a common-sense recognition hypothesis, this study will no longer elaborate on the content and conclusions of relevant qualitative interviews but only on the impact of online teaching quality on student satisfaction. Student 8 believes that innovative teaching methods will attract more attention from students. Improving the quality of online teaching and providing interesting and thought-provoking online teaching content can stimulate students' learning motivation to a greater extent, thereby enhancing their learning outcomes. Student 9 believes that online learning students are prone to slacking off, such as less teacher supervision during online teaching, which can affect students' learning efficiency. Student 10 believes that the interaction between teachers and students in online teaching is not intuitive, perceptible, and effective offline. If students' online learning problems remain unresolved, it will seriously affect their learning

satisfaction. Student 11 believes that the quality of teaching can affect students' mentality. For example, suppose a student feels they haven't learned anything after listening to a class. In that case, they may subconsciously feel that the teacher's teaching is not good, so they simply don't listen, which affects their learning motivation and results. Student 12 believes teachers will provide diverse and personalized learning resources for online teaching. These excellent learning resources may stimulate students' learning motivation, and students may actively learn these learning materials after class. Therefore, stimulating students' learning motivation also greatly affects their learning outcomes. Student 13 believes that students' online learning is a spontaneous behaviour, and the feedback of online teaching quality to students is, "Do I have the desire to listen to this class?" "Did I understand this class and learn anything?" These are all closely related to students' satisfaction, so they will significantly impact. Student 14 believes that most teachers are accustomed to imparting knowledge to students in the classroom and have no experience in online teaching. The designed MOOCs or SPOC content may not be suitable for online self-directed learning. In contrast, the quality of some online courses that have been carefully designed and certified as national first-class courses will be suitable for online teaching. Teacher 3 believes that: 1). Online classes can attract students' attention by asking questions, playing small videos, playing games, and other methods, stimulating students' learning interest and motivation; 2). Each micro class should inform students of the objectives to be learned in this class so that students can clarify the teaching objectives and difficult points; 3). The teachers should also timely consolidate and train the learned knowledge points while also testing the results of students' learning to improve teaching quality. Teacher 4 believes that learning situation analysis is very important, and different teaching resources should be selected for students. Some professional courses need to be specially recorded by their school teachers to produce videos that are completely suitable for their students' learning. The relevant literature also confirms these views. Gao, Yang, and Cai (2022) compared the different methods used by teachers in online teaching and found that students attach great importance to interactivity, and highly interactive teaching results in relatively higher scores (Gao et al., 2022). Shi, Pu, and Qu (2023) found that the course content, teaching ability, task value, and system characteristics in online courses significantly positively impact learning satisfaction (Shi et al., 2023). The quality of online teaching by teachers has a significant impact on students' learning satisfaction, which is similar to the research results of multiple scholars (Shuang & Yao, 2020; Sun, Tsai, Finger, Chen, & Yeh, 2008; Wu & Yang, 2016; Zhang & Yang, 2011). Regarding RQ3 and Research hypothesis 3: The quality of online teaching, the quality of the teaching environment, the quality of offline teaching, and students' learning satisfaction will affect students' learning outcomes. Previous research has shown that the quality of online teaching, the quality of the teaching environment, and the quality of offline teaching can affect students' learning satisfaction. Therefore, whether students' learning satisfaction will affect students' learning performance is the only qualitative interview which needs to be conducted. The result is that all respondents agree that students' learning satisfaction can affect students' learning outcomes.

Among them, student 15 believes that there is a positive correlation between students' level of learning satisfaction and their motivation to engage in learning. He argues that when students are highly satisfied with their learning experiences, they are more likely to be motivated to actively participate in the learning process. As a result, their learning outcomes are expected to demonstrate significant improvement. On the other hand, if students have lower levels of satisfaction with their learning experiences, they may lack interest in learning and this can negatively impact their academic performance to some extent. Student 16 believes that high learning satisfaction represents a high-quality satisfaction of students' needs for teachers, learning environment, learning content, and learning forms. Students with high learning satisfaction will have a greater interest and stronger learning motivation. Interest can drive students to conduct in-depth exploration and research. They will be more willing to actively engage in subject learning and make more efforts for learning. Therefore, teachers should also pay attention to communicating more with students, understanding their satisfaction with learning. They can refine it to a certain aspect to take timely adjustment measures and achieve more effective teaching. Student 17 believes that satisfaction directly affects students' engagement and motivation in class and further affects their learning outcomes. Teachers should always observe students' movements during the teaching process, start from the learning situation, and design courses that satisfy students. Teacher 5 believes students' satisfaction with learning comes from various aspects such as the learning environment, learning methods, learning content, learning resources, and the teacher's teaching level. On the

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one hand, learning satisfaction reflects students' enthusiasm for learning. On the other hand, it also reflects the quality of teaching, thereby improving learning outcomes.

## 5. CONCLUSION AND LIMITATIONS

From the data analysis and interview results, we can draw some conclusions as followings:

1. The quality of teachers' online teaching significantly differs from that of teachers' offline teaching. They play different roles in influencing the students' learning outcomes. Schools should have different evaluation methods and standards for blended and face-to-face courses.

2. Although there is a classic saying in the Chinese higher education industry: "The so-called university is not necessarily referred to as a building but as a master." However, currently, domestic universities need more attention and evaluation of the quality of the teaching environment, which has led to the subordinate status of the educational technology centers in universities that manage teaching equipment. The ageing of teaching equipment needs to receive timely feedback and updates. For students, professors with rich academic output in universities may not directly teach their courses or have an impact on their learning experience. However, the quality of teaching equipment will directly affect their learning satisfaction and indirectly affect their learning outcomes. Therefore, adding this factor to the learning evaluation scale should be considered so that students can express their feedback on the school's teaching environment

3. The quality of online teaching will directly impact students' learning satisfaction and learning outcomes. Therefore, when evaluating teaching, it is also necessary to consider adding online teaching quality as a new evaluation content to the learning evaluation scale to evaluate such issues.

At present, blended learning is a hot subject in the teaching reforms of colleges and universities in China. Nevertheless, how to reasonably evaluate a new teaching model is a crucial factor in determining the success of the teaching model. This study analyzes the impact of teachers' offline teaching quality, online teaching quality and the teaching environment on students' learning satisfaction and students' learning outcomes. Based on the above conclusions, this article suggests adding students' evaluations of teaching equipment and environment at the end of each semester. Include students' evaluations of the quality of online teaching in courses that adopt blended learning, and at the same time, school management should also check the quality of courses used in online teaching by reviewing the level of online courses used in blended learning courses (whether it is a provincial-level first-class course or a national first-class course). The follow-up research will further increase the diversity of samples and carry out the different analyses of gender, grade, primary and learning expectations based on the samples to analyze the differences between different types of students in blended learning.

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