Mechanisms Influencing Undergraduate Classroom Learning Satisfaction: An Empirical Analysis Based on Structural Equation Modeling

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Abstract. Classroom learning satisfaction is an important indicator of undergraduate teaching quality. Using questionnaire data from undergraduate students, this study employs structural equation modeling to examine the effects of teaching resources, teacher–student interaction, teaching affective support, and external environmental support on classroom learning satisfaction. The results show that all four factors have significant positive effects. Teacher–student interaction is the strongest predictor, followed by teaching affective support, whereas teaching resources and external environmental support mainly function as foundational conditions. The findings suggest that improving classroom learning satisfaction requires not only adequate resources, but also stronger interaction mechanisms, more supportive teaching behaviors, and coordinated improvement of the teaching environment.

Keywords: undergraduate classroom; classroom learning satisfaction; teacher–student interaction; structural equation modeling

1 Introduction

With the expansion of higher education and rising expectations for talent cultivation, the quality of undergraduate classroom teaching has become a key issue in higher education reform. Although universities have invested heavily in curriculum development and teaching reform, many classrooms still show limited interaction, relatively uniform teaching methods, and insufficient student engagement [1][3][4]. These problems weaken both teaching effectiveness and students' classroom experience.

Classroom learning satisfaction refers to students' overall cognitive and affective evaluation of the teaching process, learning experience, and related support conditions [1][2]. It does not directly indicate academic achievement, but it reflects students' perceptions of teaching content, instructional organization, classroom climate, interaction quality, and learning support. It is therefore an important lens through which teaching quality can be assessed [2][4].

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Prior studies suggest that student satisfaction is shaped by both instructional provision and classroom process. Teaching resources and course organization affect students' baseline judgments of teaching quality, whereas interaction, teacher support, and learning conditions shape their sense of participation and support [3][4][5][6][10][11]. However, existing studies often emphasize single factors or simple correlations and pay less attention to the structural mechanism through which multiple latent variables jointly influence classroom learning satisfaction.

To address this gap, this study incorporates teaching resources, teacher–student interaction, teaching affective support, and external environmental support into a unified framework and examines their effects on classroom learning satisfaction through structural equation modeling. The study aims to clarify how instructional conditions and classroom processes jointly shape undergraduate students' classroom experience.

2 Theoretical Framework and Research Hypotheses

2.1 The Connotation and Influencing Factors of Classroom Learning Satisfaction

Student satisfaction is generally understood as an overall evaluation formed on the basis of educational services, teaching processes, and learning experiences [2]. In the classroom context, satisfaction is a multidimensional construct jointly shaped by instructional provision, classroom process, and support environment [2][3][4].

Four factors are particularly relevant. Teaching resources provide the content and organizational foundation of instruction; teacher–student interaction represents the core classroom process; teaching affective support captures supportive teaching behaviors; and external environmental support reflects physical and institutional conditions [3][4][5][6][10][11]. Classroom learning satisfaction is thus best understood as the joint outcome of these factors rather than the product of any single variable.

Accordingly, a unified framework is needed to examine the structural relationships among these dimensions.

2.2 Analytical Framework and Validation Strategy

This study constructs an analytical framework centered on teaching resources, teacher–student interaction, teaching affective support, external environmental support, and classroom learning satisfaction. Within this framework, the first four constructs function as exogenous factors, whereas classroom learning satisfaction is treated as the endogenous outcome.

Structural equation modeling (SEM) is adopted because these variables are latent constructs that cannot be directly measured by single observed indicators, and because their relationships may involve simultaneous and parallel effects [8][9]. SEM makes it possible to test both the adequacy of measurement and the structural paths among latent variables within a single framework.

Exploratory factor analysis (EFA) is conducted only for the exogenous latent variables. Since classroom learning satisfaction is the endogenous outcome and is measured

by a small number of items, its adequacy is assessed mainly through the overall structural model rather than through exogenous factor extraction. In this study, EFA therefore serves as a preliminary test of the exogenous measurement structure rather than a mechanical grouping of all latent variables.

2.3 Research Hypotheses and Conceptual Model

(1) Teaching Resources and Classroom Learning Satisfaction.

Teaching resources include the clarity, usefulness, and organization of teaching content as well as teaching materials, cases, and course arrangement. Better prepared and more coherently organized resources generally improve students' judgments of teaching quality and their classroom experience [3][4].

H1: Teaching resources have a significant positive effect on undergraduates' classroom learning satisfaction.

(2) Teacher–Student Interaction and Classroom Learning Satisfaction.

Teacher–student interaction is defined broadly in this study as a classroom interaction construct centered on direct interaction and represented through students' responsive participation behaviors. It includes not only questioning, feedback, and discussion, but also attendance, assignment completion, and classroom concentration as behavioral responses to the interaction process.

Previous research suggests that high-quality interaction enhances students' understanding, participation, belonging, and engagement, and is strongly associated with satisfaction [4][5][10]. This broad interaction–feedback–participation mechanism is therefore expected to be a key predictor of classroom learning satisfaction.

H2: Teacher–student interaction has a significant positive effect on undergraduates' classroom learning satisfaction.

(2) Teaching Affective Support and Classroom Learning Satisfaction.

Teaching affective support refers to the care, respect, encouragement, feedback, and responsive attention teachers provide in the teaching process. Supportive teaching behaviors improve classroom climate and strengthen students' motivation and sense of being supported [6][7][11].

H3: Teaching affective support has a significant positive effect on undergraduates' classroom learning satisfaction.

(4) External Environmental Support and Classroom Learning Satisfaction.

External environmental support refers to the physical and institutional conditions of classroom teaching, including facilities, course organization, teaching management, and assessment arrangements. Although such factors do not directly participate in classroom interaction, they provide essential guarantees for effective teaching and influence students' overall classroom evaluation [3][4].

H4: External environmental support has a significant positive effect on undergraduates' classroom learning satisfaction.

Accordingly, the conceptual model of classroom learning satisfaction is presented in Figure 1.

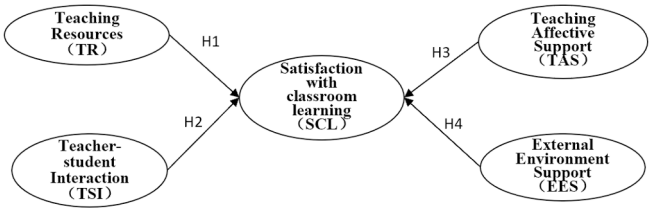

Fig. 1. Conceptual Model for the Analysis of Satisfaction with Classroom Learning.

3 Research Design and Data Collection

3.1 Scale Design

This study developed a questionnaire containing five latent variables: Teaching Resource (TR), Teaching Affective Support (TAS), External Environment Support (EES), Teacher–Student Interaction (TSI), and Satisfaction with Classroom Learning (SCL). The corresponding observed items are reported in Table 1. Together, these dimensions capture instructional provision, classroom process, support conditions, and overall satisfaction.

Teaching Resource measures perceptions of content quality and instructional arrangement; Teaching Affective Support captures supportive and caring teaching behaviors; External Environment Support covers facilities, organization, and assessment; Teacher–Student Interaction measures direct interaction together with responsive participation behaviors; and Satisfaction with Classroom Learning captures students' overall evaluation of the classroom experience.

Consistent with the theoretical framework, teacher–student interaction is operationalized broadly rather than narrowly. This allows the scale to reflect how classroom interaction is expressed both through direct exchange and through students' behaviorally responsive participation.

Table 1. Measurement Scale for Undergraduate Students' Satisfaction.

Latent Variable	Indicator Code	Measurement Item
Teaching Resource (TR)	TR1	Classroom learning has improved my ability to solve specific problems in this discipline or related disciplines.
	TR2	This class has improved my thinking ability and learning ability.
	TR3	The case materials selected by the teacher in class are logically clear and easy to understand.
	TR4	The design of the classroom content is coherent, with logical connections between the different parts.
	TR5	There is too much redundant information in classroom teaching.

Teaching Affective Support (TAS)	TAS1	The teacher is always rigorous in thinking, clear in explanation, and highlights key and difficult points in classroom teaching.
	TAS2	The teacher's classroom language is vivid, lively, and humorous.
	TAS3	The teacher's instructional methods are innovative, flexible, and varied.
	TAS4	The teacher emphasizes the cultivation of students' abilities to analyze and solve problems.
	TAS5	The teacher helps students build a complete knowledge structure.
	TAS6	The teacher encourages students to express their opinions and views freely in class.
External Environment Support (EES)	EES1	The method for submitting assignments after class is convenient and efficient.
	EES2	The teaching environment is quiet and tidy.
	EES3	Teaching equipment (e.g., projectors and audio devices) functions smoothly.
	EES4	The course assessment method is scientific and reasonable.
	EES5	The grouping for classroom discussion is appropriate.
Teacher–Student Interaction (TSI)	TSI1	Students in class participate actively in discussions.
	TSI2	The number of teacher questions in class is appropriate.
	TSI3	The frequency of the teacher's after-class consultation is appropriate.
	TSI4	The teacher grades assignments promptly and provides feedback.
	TSI5	Students actively seek help from the course instructor or peers to solve problems encountered in the course.
	TSI6	Attendance rate (I attend every class on time).
	TSI7	Assignment completion rate (I complete and submit every assignment on time).
	TSI8	I am able to listen attentively in class without distraction and avoid doing things unrelated to the lesson.
Satisfaction with Classroom Learning (SCL)	SCL1	The teaching method of this class is better than I expected.
	SCL2	I regret choosing this course.
	SCL3	I would not recommend this course to my classmates.

3.2 Data Collection

Data were collected through the Wenjuanxing platform in two stages. A pilot survey was conducted on March 15, 2025, yielding 95 responses, and the wording of several items was revised based on participant feedback. The formal survey was conducted from May 4 to June 18, 2025, and produced 410 valid questionnaires, with an effective response rate of 88.6%. The sample covered both genders, multiple grade levels, and several majors, providing a reasonable basis for structural model testing.

As shown in Table 2, the valid sample was dominated by first- and second-year students and included disciplinary diversity across transportation, applied economics, biomedical engineering, electronic information, environmental science and engineering, and other majors.

Table 2. Basic Information of the Valid Survey Sample.

Category	Option	Frequency	Percentage (%)
Gender	Male	171	41.7
	Female	239	58.3
Grade	First year	190	46.3
	Second year	131	32.0
	Third year	73	17.8
	Fourth year	16	3.9
Major	Transportation	154	37.56
	Applied Economics	123	30.00
	Biomedical Engineering	48	11.71
	Electronic Information	21	5.12
	Environmental Science and Engineering	21	5.12
	Other majors	43	10.49

4 Factor Analysis of Exogenous Latent Variables and Structural Model Fitting

4.1 Reliability Testing and Suitability for Factor Analysis

Cronbach's alpha coefficients for all latent variables exceeded 0.70, the KMO value was 0.963, and Bartlett's test of sphericity was significant ($p < .001$), indicating that the data were suitable for factor analysis and subsequent SEM estimation. All corrected item–total correlations were above 0.30. These results suggest satisfactory internal consistency and preliminary measurement adequacy.

4.2 Exploratory Factor Analysis of Exogenous Latent Variables

Because classroom learning satisfaction was treated as the endogenous outcome latent variable, EFA was conducted only for the exogenous latent variables and the results are shown in Table 3. This procedure was intended to test the relative independence and convergence of the observed indicators for teaching resources, teaching affective support, external environmental support, and teacher–student interaction.

Four factors were extracted, explaining 73.501% of the cumulative variance. Most observed indicators loaded clearly on their expected dimensions, with loadings above the conventional threshold and without serious cross-loadings. TR5 showed a weak loading and cross-loading and was therefore removed from the subsequent SEM analysis to improve convergent validity.

Table 3. Results of Exploratory Factor Analysis for Exogenous Latent Variables.

Item	Factor1	Factor2	Factor3	Factor4
TR1	0.813	-0.037	0.201	0.112
TR2	0.836	0.009	0.151	0.071
TR3	0.877	0.025	0.058	0.107

TR4	0.877	0.027	0.087	0.113
TR5	-0.062	0.612	0.132	0.135
TAS1	0.035	0.896	0.080	0.155
TAS2	0.073	0.868	0.110	0.130
TAS3	0.075	0.884	0.116	0.146
TAS4	0.026	0.890	0.145	0.153
TAS5	0.046	0.898	0.095	0.101
TAS6	0.044	0.858	0.027	0.070
EES1	0.449	0.035	0.815	0.062
EES2	0.248	0.003	0.707	0.158
EES3	0.234	0.009	0.665	0.058
EES4	0.249	0.061	0.835	0.210
EES5	0.067	0.149	0.797	0.136
TSI1	0.110	0.088	0.203	0.785
TSI2	0.321	0.040	0.022	0.861
TSI3	0.069	0.020	0.005	0.857
TSI4	0.399	0.029	0.176	0.852
TSI5	0.199	0.006	0.120	0.796
TSI6	0.174	0.134	0.530	0.679
TSI7	0.222	0.174	0.564	0.699
TSI8	0.114	0.109	0.166	0.774

Extraction method: Principal component analysis; Rotation method: Orthogonal rotation with Kaiser normalization. The solution converged after six iterations.

4.3 Initial Model Fitting and Model Modification

The initial SEM showed that all four structural paths were statistically significant, as shown in Table 4; however, the overall fit of the model was poor ($\chi^2/df = 6.481$, SRMR = 0.162, RMSEA = 0.116, CFI = 0.862, TLI = 0.846). Therefore, the model required theoretically guided revision before substantive interpretation.

Table 4. Correlation Coefficients Among Latent Variables.

Path	Estimate	Standardized Error	C.R.	P
TR --> SCL	0.259	0.048	5.393	***
TAS --> SCL	0.223	0.048	4.598	***
TSI ---> SCL	0.251	0.049	5.111	***
EES ---> SCL	0.208	0.051	4.077	***

Model modification followed both statistical evidence and theoretical logic. As shown in Table 5, correlated residuals were added between TSI6 and TSI7 because both reflect responsibility-related learning engagement, and between CS2 and CS3 because both are reverse-worded items capturing negative course evaluation.

TR5 and TAS1 showed insufficient representational power and were excluded from the revised model. These adjustments improved the measurement model without changing the substantive theoretical framework.

Table 5. Model Modification Indices.

Path	M.I.	Std E.P.C.
TSI7<--> TSI6	203.721	0.192
CS3 <--> CS2	238.673	17.455

After modification, the fit improved substantially ($\chi^2/df = 1.890$, SRMR = 0.048, RMSEA = 0.046, CFI = 0.925, TLI = 0.916), indicating that the revised model achieved acceptable statistical fit and could be used for interpretation. The final model estimation results are shown in Figure 2.

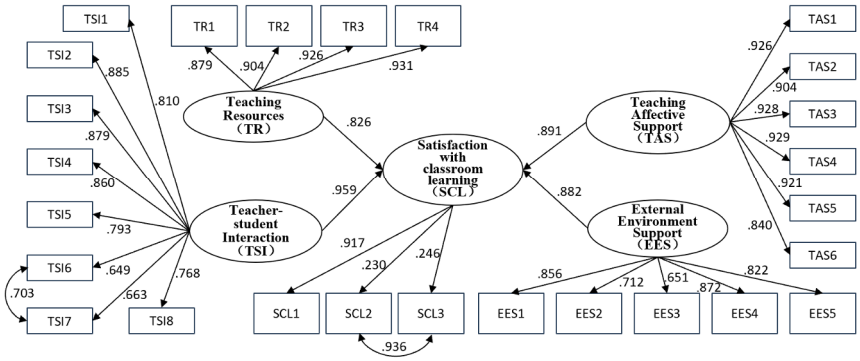

Fig. 2. Final model estimation results.

5 Results Analysis and Discussion of the Mechanism

The revised SEM indicates that teaching resources, teaching affective support, teacher–student interaction, and external environmental support all have significant positive effects on classroom learning satisfaction, but with different strengths. Their influence ranks as follows: teacher–student interaction, teaching affective support, external environmental support, and teaching resources.

(1) The Central Role of Teacher–Student Interaction.

Teacher–student interaction has the strongest effect, suggesting that undergraduate students' classroom evaluations are shaped less by one-way knowledge transmission and more by responsiveness, participation, and the sense of being attended to during the learning process. Under the broad operationalization adopted here, this construct reflects both interaction quality and students' behavioral engagement.

This finding is consistent with prior research showing that interaction quality is strongly associated with student satisfaction in higher education [10] and that classroom interaction can serve as a key mechanism linking learning experience and satisfaction [10][11].

(2) The Important Role of Teaching Affective Support.

Teaching affective support has the second strongest effect. Teachers' care, respect, feedback, and communication therefore play an important role in shaping how students experience the classroom.

This result aligns with research on relational pedagogy and affective teacher–student relationships, which highlights the importance of supportive teaching behaviors for engagement and satisfaction [6][11].

(3) The Foundational Role of Teaching Resources.

Teaching resources also have a significant positive effect, but their relative influence is weaker. This suggests that, under conditions where basic instructional resources are already available, resources function more as a necessary foundation than as the primary source of variation in students' classroom satisfaction.

(4) The Supportive Role of External Environmental Support.

External environmental support has a moderate effect, indicating that facilities, classroom organization, and institutional arrangements are important enabling conditions but do not by themselves generate high satisfaction unless they are accompanied by strong classroom processes.

The implication is that improvements in teaching quality should not be equated simply with better facilities; they must also involve improvements in interaction and support within the classroom itself.

6 Conclusion

This study constructed and tested a structural equation model of classroom learning satisfaction in undergraduate teaching. Using 410 valid questionnaires, it shows that teaching resources, teaching affective support, teacher–student interaction, and external environmental support all positively influence classroom learning satisfaction, with teacher–student interaction emerging as the strongest determinant.

The results indicate a shift from a condition-oriented understanding of teaching quality toward a process- and relationship-oriented perspective. Improving classroom learning satisfaction therefore requires not only adequate resources, but also stronger interaction mechanisms and more supportive teacher behaviors.

Practically, universities should strengthen classroom interaction design, improve teachers' capacity for feedback and affective support, and continue to optimize course organization, facilities, and assessment arrangements.

The findings should be interpreted as structural associations rather than strict causal effects. The study is limited by its single-university sample, cross-sectional design, and broad operationalization of teacher–student interaction. Future research could employ longitudinal data, multi-institutional samples, and more refined interaction dimensions to test the robustness of the mechanism reported here.

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