

Effective Classroom Environment of Curriculum Ideological and Political Education in Higher Vocational Mathematics: Measurement, Mechanisms, and Mediation

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Abstract: This study developed and validated a 25-item instrument, the Higher Vocational Mathematics Curriculum Ideological and Political Education (HVMCIPE) Classroom Environment Questionnaire, to assess the mathematics classroom environment and its influence on student satisfaction. Through exploratory factor analysis on 139 cleansed samples of first-year science and engineering students, the four classroom environment factors extracted from HVMCIPE show a stable structure and good psychometric qualities. Classroom Learning Climate (CLC) predicted all four satisfaction items significantly. Although Teacher-Student Interaction and Support (TSIS) did not predict satisfaction significantly, it fully mediated satisfaction through Instructional Affinity and Classroom Organization (IACO) and CLC. The implications and suggestions for future research are finally put forward.

Keywords: Classroom environment; Curriculum ideological and political education; Higher vocational institution in China; Mathematics education; Student satisfaction

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1. Introduction

Curriculum ideological and political education (CIPE) has become a national initiative in Chinese higher education. The Ministry of Education's guidelines ^[1] required that CIPE be embedded across classroom teaching, with an emphasis on the idea that science and engineering courses should cultivate scientific thinking and ethical responsibility.

Higher vocational mathematics, as a foundational course for science and engineering programs, provides essential mathematical tools while also cultivating students' reasoning abilities and professional

competencies. However, higher vocational students typically have weak mathematical foundations and low academic self-efficacy^[2], making much of the class time spent on basic comprehension and therefore limited room for CIPE integration. Understanding how students perceive the CIPE classroom environment and how these perceptions influence their satisfaction is critical for evidence-based instructional improvement.

Classroom environment research has established that students' perceptions significantly predict learning outcomes^[3]. Moos's tripartite framework (Relationship, Personal Development, and System Maintenance/Change) has provided foundational architecture for numerous instruments^[4]. Ren's (2013) effective classroom environment model, developed for Chinese higher education English contexts, emphasizes learning behaviors, interpersonal support, and contextual support^[5]. Notably, Yin and Lu developed the University Mathematics Classroom Environment Questionnaire (UMCEQ) for Chinese tertiary institutions, providing an 8-factor framework for general mathematics classrooms^[6]. Nevertheless, the UMCEQ did not capture the CIPE factor, and its competition factor and difficulty factor may be less relevant for higher vocational students, given their weaker mathematical foundations. The present questionnaire was developed primarily within Ren's framework, and then supplemented with items adapted from the UMCEQ to address the specific CIPE context^[6].

This study addresses the dimensional structure of the effective CIPE classroom environment in higher vocational mathematics, and how these dimensions influence student satisfaction.

2. Methods

2.1. Participants

Participants were 139 first-year science and engineering students from a representative high-level vocational university in China, enrolled in Engineering Applied Mathematics courses. Initial collection yielded 418 responses. After screening—including reverse-item consistency checks (Q16 and Q25), response pattern validation, and missing data exclusion—139 valid responses (33.3%) were retained. The sample was 61.2% male and 38.8% female, with diverse prior educational backgrounds (62.6% senior secondary, 37.4% secondary vocational).

2.2. Instrument

The *Higher Vocational Mathematics CIPE Classroom Environment Questionnaire* comprised 28 items (Q9–Q37, excluding reverse-scored Q25) measured on a 5-point Likert scale, designed based on Moos's framework and Ren's (2013) model. Four satisfaction items (Q38–Q41) were averaged to create an overall satisfaction composite (SATIS).

Item analysis using the extreme-group method (upper and lower 27%) confirmed all items possessed adequate discriminative power (critical ratios significant at $P < 0.005$), so no items were eliminated at this stage^[7].

2.3. Data analysis

Analyses used SPSS 22.0. Exploratory factor analysis (EFA) with Varimax rotation examined construct validity. Cronbach's α assessed internal consistency. Multiple regression examined predictors of satisfaction. Mediation analysis employed Hayes's (2018) PROCESS macro (Model 4) with 5,000 bootstrap resamples^[8].

3. Results

3.1. Exploratory factor analysis

The Kaiser-Meyer-Olkin measure (KMO) was 0.918, and Bartlett's test was significant ($P < 0.001$), confirming factorability. Principal component analysis with Varimax rotation extracted four factors with eigenvalues > 1.0 , cumulatively accounting for 68.36% of the variance. Seven items (Q9, Q14, Q15, Q19, Q21, Q32, Q33) were eliminated due to cross-loadings (≥ 0.40 on two or more factors). The remaining 21 items were re-analyzed with KMO = 0.905, yielding a four-factor structure that accounted for 68.89% of the total variance. The four factors were labeled: Perceived Value of CIPE (PV-CIPE, 7 items), Instructional Affinity and Classroom Organization (IACO, 5 items), Teacher-Student Interaction and Support (TSIS, 5 items), Classroom Learning Climate (CLC, 3 items). **Table 1** presents the rotated factor loadings for the final 21-item scale.

Table 1. Rotated factor loadings for the four-factor solution

Factor	Item	Loading
PV-CIPE	Q13: The course cases and the teacher's explanations were naturally connected with social reality and professional backgrounds, as well as conveying quality and values, such as rigor, responsibility, and patriotism.	0.769
	Q11: I appreciated the mathematical cultural heritage and learned its role in technological development.	0.743
	Q31: The CIPE materials in this course reflected contemporaneity and novelty.	0.742
	Q10: I recognized the significant impact of mathematics on professional skills and ethics.	0.723
	Q29: The teacher provided CIPE content in diverse forms like videos, cases, and software.	0.721
	Q12: I perceived the achievements of ancient Chinese mathematics and their important role in national development.	0.715
	Q30: The CIPE materials in this course were closely related to our majors, social life, and technological developments.	0.695
IACO	Q36: There was a module arranged in the class for us to think independently and do exercises.	0.752
	Q37: Various forms of activities were carried out alternately in a class session, such as the teacher's lecture, students' thinking and practice, and teacher-student questions and answers.	0.719
	Q35: The teacher emphasized thinking and analysis, guiding us through questions step by step from the simple to the complex.	0.715
	Q22: The teacher was approachable and respected the students, willing to answer all kinds of questions raised by students.	0.664
	Q34: In class, we use online response tools or collaborative platforms for real-time feedback or group work.	0.637
TSIS	Q17: The teacher guided the class to deeper thinking by analyzing a wrong/incomplete answer from the students.	0.794
	Q18: We were allowed to have a quiet discussion about learning content on the premise of not disturbing others.	0.641
	Q16: The teacher often guided our thinking through questions, and we were allowed to express ourselves and ask questions in class.	0.635
	Q20: We perceived the teacher's values like conscientiousness and responsibility through his/her detailed work, such as grading homework, lesson preparation, and punctuality.	0.614
	Q24: I can conveniently reach the teacher and receive responses online for academic support after class.	0.592
CLC	Q26: Most of our classmates could consciously abide by classroom discipline and not disturb others' listening.	0.747
	Q27: Students with weaker academic foundations were not ridiculed or ignored in the class. Classmates often chose to consult and discuss with each other when encountering difficult problems.	0.747
	Q28: The atmosphere of hard study in our class was strong, despite the various starting levels of the students.	0.703

Note: Factor loadings > 0.40 are shown in the table. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

3.2. Reliability analysis

Cronbach's α coefficients are shown in **Table 2**, all exceeding 0.80, indicating excellent internal consistency.

Table 2. Cronbach's α coefficients for the four dimensions

Dimension	Items	Cronbach's α
PV-CIPE	7	.92
IACO	5	.88
TSIS	5	.82
CLC	3	.85

3.3. Descriptive statistics and intercorrelations

Table 3 presents descriptive statistics and intercorrelations. Mean scores ranged from 4.34 to 4.56, indicating positive perceptions across all dimensions. IACO scored highest ($M = 4.56$), and PV-CIPE and CLC were lowest ($M = 4.34$). All dimensions significantly correlated with satisfaction ($P < 0.01$). Skewness values ranged from -0.811 to -1.158 and kurtosis from -0.608 to 1.831, within acceptable thresholds, indicating approximate normality^[9].

Table 3. Descriptive statistics and intercorrelations

Variable	M	SD	PV-CIPE	IACO	TSIS	CLC	SATIS
PV-CIPE	4.34	.63	1				
IACO	4.56	.49	.695	1			
TSIS	4.55	.48	.660	.668	1		
CLC	4.34	.65	.646	.608	.612	1	
SATIS	4.45	0.48	.884	.852	.839	.853	1

Note: All correlations are significant at $P < 0.01$.

3.4. Differences by demographic background

One-way ANOVA analysis revealed no significant differences by gender or prior education on any factor or satisfaction (all $P > 0.05$; see **Table 4**), suggesting classroom perceptions were homogeneous across demographic backgrounds and shaped primarily by classroom experience.

Table 4. Demographic differences (t-values and P -values)

Variable	Gender		Prior education	
	F	P	F	P
PV-CIPE	0.260	0.611	0.317	0.630
IACO	0.588	0.444	0.744	0.377
TSIS	0.670	0.414	0.786	0.390
CLC	0.418	0.519	0.233	0.574
SATIS	0.200	0.655	0.220	0.640

3.5. Multiple regression analysis

The overall model was significant ($F(4, 134) = 60.731$, $P < 0.001$), with the four dimensions accounting for

64.4% of the variance in satisfaction ($R^2=0.644$, Adjusted $R^2=0.634$). **Table 5** presents the regression results.

Table 5. Regression results predicting satisfaction

Predictor	B	Beta	<i>t</i>	<i>P</i>	VIF
PV-CIPE	0.253	0.238	2.945	0.004	2.455
IACO	0.455	0.334	4.222	0.000	2.360
TSIS	-0.001	-0.001	-0.010	0.992	2.214
CLC	0.360	0.346	4.768	0.000	1.988

Note: $F(4, 134) = 60.731$, $P < 0.001$, Adjusted $R^2 = 0.634$.

To examine differential effects across satisfaction subdimensions, separate regression models were estimated for each of the four satisfaction items: Q38 (perceived intellectual growth), Q39 (self-efficacy), Q40 (interest change), and Q41 (learning adaptation). Results are presented in **Table 6**.

Table 6. Regression results for individual satisfaction items

Predictor	Q38 (Intellectual Growth)		Q39 (Self-Efficacy)		Q40 (Interest Change)		Q41 (Learning Adaptation)	
	β	<i>P</i>	β	<i>P</i>	β	<i>P</i>	β	<i>P</i>
PV-CIPE	0.148	0.083	0.323	0.008	0.241	0.116	0.3	0.013
IACO	0.761	0.000	0.458	0.003	0.21	0.275	0.393	0.009
TSIS	-0.088	0.411	-0.005	0.972	0.107	0.578	-0.018	0.905
CLC	0.246	.001	0.426	0.000	0.319	0.018	0.448	0.000
R^2	0.644		0.550		0.281		0.527	
Adjusted R^2	0.633		0.537		0.260		0.512	

Note: coefficients significant are shown in bold.

Classroom Learning Climate (CLC) predicted all four satisfaction items significantly. In predicting Interest Change and Learning Adaptation, CLC had the largest regression coefficients, while in predicting Intellectual Growth and Self-Efficacy, it had the second largest. Meanwhile, CLC was the only significant predictor of Interest Change, which suggested the important role of CLC in raising student interests. Overall, CLC served as the most robust and strongest predictor of student satisfaction.

Instructional Affinity and Classroom Organization (IACO) ranked the second strongest predictor across the four satisfaction items, with the largest coefficients in predicting Intellectual Growth and Self-Efficacy, and the second-largest coefficients in predicting Learning Adaptation.

Perceived Value of CIPE (PV-CIPE) significantly predicted Self-Efficacy and Learning Adaptation, but did not significantly predict Intellectual Growth and Interest Change. Although PV-CIPE signaled the learning value of mathematics, it did not necessarily make students intellectually grow or become more interested.

Teacher-Student Interaction and Support (TSIS) was not significant in predicting any of the four satisfaction items (all $P > 0.40$). As TSIS serves as a common class practice, this result implied TSIS may play its role in an indirect way. Mediation analysis was necessary subsequently.

3.6. Mediation analysis

A parallel mediation model was constructed using Hayes's (2018) PROCESS macro (Model 4) with 5,000 bootstrap resamples^[8]. TSIS served as the independent variable, SATIS as the dependent variable, IACO and CLC as parallel mediators, and PV-CIPE was entered as a covariate to control for potential confounding effects.

As shown in **Table 7**, the total indirect effect was 0.3369 (BootSE = 0.1091, 95% CI = [0.1448, 0.5687]). The specific indirect effect through IACO was 0.1755 (BootSE = 0.0759, 95% CI = [0.0465, 0.3403]), and the specific indirect effect through CLC was 0.1614 (BootSE = 0.0591, 95% CI = [0.0592, 0.2868]). Both bootstrap confidence intervals excluded zero, confirming that both mediators significantly transmitted the effect of TSIS to satisfaction.

The direct effect of TSIS on satisfaction was -0.0011 ($P = 0.9921$), which was not statistically significant. This indicates that TSIS's influence on satisfaction is fully mediated through IACO and CLC—the effect of teacher-student interaction and support on student satisfaction operates entirely through its enhancement of instructional affinity and classroom organization, and classroom learning climate, with no direct contribution remaining.

Path coefficients revealed that TSIS significantly predicted IACO ($B = 0.385$, $P < 0.001$) and CLC ($B = 0.449$, $P < 0.001$) in the mediator models, and both IACO ($B = 0.250$, $P < 0.001$) and CLC ($B = 0.250$, $P < 0.001$) significantly predicted SATIS in the full model. These results confirm a dual mediating mechanism: supportive teacher-student interaction must be converted into tangible instructional organization and positive peer climate to influence student satisfaction, and this mediating process is both statistically significant and theoretically meaningful.

Table 7. Mediation effects (PROCESS Model 4, Covariate: PV-CIPE)

Effect pathway	Effect	BootSE	BootLLCI	BootULCI
Direct Effect (TSIS → SATIS)	-0.0011	0.1082	-0.2151	0.2129
Total Indirect Effect	0.3369	0.1091	0.1448	0.5687
TSIS → IACO → SATIS	0.1755	0.0759	0.0465	0.3403
TSIS → CLC → SATIS	0.1614	0.0591	0.0592	0.2868

Note: Bootstrap resamples = 5,000. Covariate: PV-CIPE. Confidence intervals that do not contain zero indicate significant indirect effects.

4. Discussion

Overall, the results point to two main takeaways. First, Classroom Learning Climate was the strongest predictor of satisfaction for higher vocational students, followed by Instructional Affinity and Classroom Organization (IACO) and Perceived Value of CIPE (PV-CIPE). This is probably because higher vocational students are more in need of psychological support and therefore more sensitive to the peer environment. This indicates teachers should attend to peer climate and instructional clarity to improve student learning efficiency. Under these conditions, CIPE integration can be more feasible and efficient. Second, although Teacher-Student Interaction and Support (TSIS) did not predict satisfaction significantly, it fully mediated satisfaction through Instructional Affinity and Classroom Organization (IACO) and Classroom Learning Climate (CLC). This suggests that Teacher-Student Interaction needs to translate into better instructional

delivery and a stronger peer climate.

5. Conclusion

This study validated a four-factor instrument for assessing the CIPE classroom environment in higher vocational mathematics and its influence on student satisfaction. CLC and IACO predicted satisfaction the strongest, and TSIS fully mediated satisfaction through IACO and CLC. PV-CIPE significantly influenced Self-Efficacy and learning adaptation, but it did not necessarily make students intellectually grow or more interested. CIPE integration can be more feasible and efficient when CLC and IACO are well established. The findings provide empirical foundations for systemic CIPE implementation in higher vocational mathematics contexts. Future research should employ confirmatory factor analysis with independent samples and longitudinal designs to establish causal direction.

Disclosure statement

The authors declare no conflict of interest.

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Appendix Eliminated Items

Q9. I appreciated the rigorous logic and scientific spirit inherent in mathematics.

Q14. I was inspired by the teacher's exploratory spirit when he/she was solving problems or deriving formulas.

Q15. Besides final exam scores, the course evaluation considered many other aspects, such as our learning effort, thinking processes, normative awareness, and collaborative performance.

Q19. The teacher demonstrated deep and clear understanding of mathematical knowledge.

Q21. The process the teacher analyzed problems revealed rational thinking and scientific spirit as he'd emphasized before.

Q32. The teacher used multimedia equipment (e.g., projections, audio-visual materials) to help us better understand the backgrounds and application scenarios of mathematical knowledge.

Q33. The teacher used multimedia and software tools (e.g., dynamic geometry software, interactive charts) to make abstract mathematical concepts more intuitive and clear.

Satisfaction Items

Q38: This course is very helpful for my intellectual development and personal growth.

Q39: I believe I can apply the knowledge in this course to deal with problems in my further professional studies or daily life.

Q40: I am now more interested in mathematics compared to the beginning of this course.

Q41: I have started to adapt to the higher-vocational-level approach to learning mathematics, which more emphasizes understanding concepts and principles rather than mechanically applying formulas.

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