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Psychometric validation of the college and university classroom environment inventory in Vietnamese higher education: Evidence from a Confucian cultural context

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Abstract

In the context of global reforms in higher education, creating effective classroom environments has become increasingly important, underscoring the need for valid instruments that capture students' perceptions of learning settings. This study examined the psychometric properties of the College and University Classroom Environment Inventory (CUCEI) in Vietnamese higher education. A quantitative design was employed with 297 undergraduate students from three universities in the Mekong Delta. For cross-validation, the sample was randomly divided into two subsamples for exploratory factor analysis (EFA; n = 150) and confirmatory factor analysis (CFA; n = 147). The findings supported a refined 28-item, seven-factor structure comprising involvement, satisfaction, innovation, personalization, student cohesiveness, individualization, and task orientation. The instrument demonstrated strong internal consistency, with Cronbach's alpha coefficients ranging from 0.81 to 0.92, and the CFA indicated good model fit (CFI = 0.93, TLI = 0.92, RMSEA = 0.05). A higher-order model was not supported, suggesting that classroom environment is better represented as a multidimensional construct. Evidence of convergent and discriminant validity was obtained, while predictive validity was demonstrated through significant associations with dimensions of student engagement, including vigor, dedication, and absorption. Overall, the findings support the CUCEI as a reliable, valid, and culturally appropriate instrument for assessing classroom environments in Vietnamese universities and informing evidence-based educational improvement and future classroom development initiatives.

Keywords: Classroom environment, Confirmatory factor analysis, Higher education, Psychometric validation, Vietnam.

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Contribution of this paper to the literature

This study provides the first psychometric validation of the CUCEI in Vietnamese higher education. It confirms a culturally appropriate seven-factor structure, demonstrates robust reliability and validity, and extends classroom environment research to a Confucian context while supporting evidence-based evaluation of teaching quality and student engagement.

1. Introduction

The learning environment the physical, social, and psychological settings in which education occurs, is recognized as influencing students' academic success, motivation, and well-being in higher education (Johnson & McClure, 2004; Joseph, 2019; MacDonald, Bottrell, & Johnson, 2019). Instead of serving as a mere static setting, it operates as a dynamic framework influenced by student-teacher interactions, peer relationships, teaching methodologies, institutional demands, and emotional and cognitive support (Cayubit, 2022; Hong, 2014; Steinberg, Kulakow, & Raufelder, 2024). Nurturing and well-organized educational settings can foster deep learning and mastery goals, while disorganized or psychologically unsupportive environments may lead to superficial learning strategies (Englund, Stockhult, Du Rietz, Nilsson, & Wennblom, 2023; Han & Xu, 2025). The dynamics of these relationships make the precise evaluation of classroom settings difficult, posing challenges for research and improvement in higher education.

A crucial element is the psychological classroom atmosphere, characterized by students' views on the interpersonal and emotional conditions under which learning takes place. According to self-determination theory, settings that foster autonomy, competence, and relatedness can enhance intrinsic motivation, resilience, and engagement (Ryan & Deci, 2000). Cultural setting might likewise influence these views. In East Asian contexts, where subtle communication and collective harmony are frequently prioritized, classrooms that foster psychological safety and relational responsiveness might be crucial for student engagement (Bao, 2024). At the same time, university classrooms are changing through technology integration, hybrid learning, and new instructional practices. These advancements present both prospects and obstacles, such as digital distraction and academic fatigue (Flanigan, Brady, Dai, & Ray, 2023; Song, Wang, & Zhang, 2022). Thus, tertiary education needs strategies that encompass both physical facilities and the psychological and pedagogical aspects of the classroom environment.

A variety of instruments have been created for higher education settings, such as the University Mathematics Classroom Environment Questionnaire (UMCEQ) (Yin & Lu, 2014), the Smart Classroom Learning Environment Preferences Instrument (SCLEPI) (MacLeod, Yang, Zhu, & Li, 2018), the Distance Education Learning Environments Survey (DELES) (Walker & Fraser, 2005), and the University-Level Environment Questionnaire (ULEQ) (Dorman, 1998).

These tools have produced findings about discipline-specific, technology-mediated, distance, and institutional learning contexts. The UMCEQ has exhibited robust psychometric efficacy and correlations with students' learning methodologies (Yin & Lu, 2014); the SCLEPI evaluates preferences in digitally enhanced educational settings (MacLeod et al., 2018); the DELES was created for remote learning environments (Walker & Fraser, 2005); and the ULEQ investigates university atmospheres (Dorman, 1998). However, their particular aims might restrict their usefulness across varied school situations. A larger option is the CUCEI, established by Fraser, Treagust, and Dennis (1986) for higher education classes. The CUCEI evaluates seven psychosocial aspects: personalization, engagement, student unity, contentment, task focus, creativity, and individual attention. Together, these dimensions represent relational, instructional, and organizational features of classroom experience. The instrument has continued to be used in higher education research internationally (Clark, Kaw, Scott, Kumar, & Yalcin, 2025; Joiner, Rees, Levett, Sitnikova, & Townsend, 2021; Li, Rubie-Davies, & Wu, 2024). Nonetheless, data suggest that classroom-environment metrics may not operate uniformly across different cultures. Research in the Pacific Islands and China suggests that linguistic and cultural differences can influence students' interpretations of CUCEI items and, consequently, its reliability and validity (Doll & Dooley, 2021; Li, 2014). Thus, psychometric properties established in one context cannot simply be assumed to apply in another.

This matter is especially pertinent in Vietnam, where tertiary education is experiencing pedagogical and structural transformation. Vietnamese educational settings have traditionally been shaped by Confucian principles that prioritize hierarchy, collective obedience, and instructor-led teaching (Truong, Hallinger, & Sanga, 2017). Such cultural factors may alter how students comprehend terms such as individualization, innovation, and personalization. Simultaneously, Vietnamese universities are promoting learner-centered teaching and reforms that improve instructional quality (Nguyen, Nguyen, & Pham, 2025; Nguyen, Nguyen, Le, & Phan, 2025; Thao-Do, Bac-Ly, & Yuenyong, 2016). The coexistence of traditional norms and emerging pedagogical expectations makes contextual validation important.

Despite the CUCEI's international use, evidence regarding its factorial validity, reliability, and cultural appropriateness in Vietnamese higher education remains limited. Therefore, the present study examines the psychometric properties of the CUCEI among Vietnamese university students. Specifically, it evaluates the instrument's factor structure, internal consistency, convergent and discriminant validity, and predictive validity in relation to student engagement. The project aims to ascertain if the CUCEI can facilitate the evaluation of Vietnamese educational settings, cross-cultural studies, and data-driven enhancements of psychosocial and instructional circumstances in higher education by offering context-specific validation evidence.

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2. Literature Review

2.1. Learning Environment

The educational setting, also referred to as classroom climate, is a complex term that includes the physical, social, instructional, and psychological factors influencing the learning process. Initial studies on classroom environment, like the CUCEI, recognized psychosocial aspects including personalization, engagement, and task focus as significant elements of students' educational experiences (Fraser et al., 1986). Subsequent research revealed that aspects of the classroom environment correlate with cognitive and emotional results in various educational settings (Dorman, 1998; Fraser, 1998). Recent studies have broadened this viewpoint by associating nurturing classroom settings with motivation, engagement, academic success, and more profound learning strategies (Cayubit, 2022; Steinberg et al., 2024). Organized and nurturing settings can promote mastery objectives and profound learning (Han & Xu, 2025), while ambiguity or inadequate assistance may lead to superficial learning techniques (Englund et al., 2023). Engaging and learner-focused methodologies can improve educational results (Meng, Qiu, Liu, & Kong, 2025; Q. Song, 2024); however, inadequately structured digital settings may obstruct learning (Wang et al., 2025).

The psychological aspect of classroom atmosphere is especially pertinent to self-determination theory, which highlights autonomy, competence, and relatedness as essential psychological requirements (Ryan & Deci, 2000). Classroom settings that address these requirements can enhance involvement and engagement while alleviating anxiety (Bao, 2024). Nevertheless, pupils' perceptions of classroom conduct may differ throughout cultures. In collectivist cultures like Vietnam, silence could signify culturally acceptable communication rather than a lack of involvement (Nguyen et al., 2025). While autonomy and peer support are linked to student participation (Hoi, 2024), their interpretations and expressions may vary across cultural contexts (Li, 2014; Li et al., 2024). Furthermore, current research predominantly exhibits correlational characteristics and frequently fails to amalgamate conventional psychosocial frameworks with novel digital learning environments (Fraser, 1998; MacLeod et al., 2018; Walker & Fraser, 2005). Insufficient focus on teacher well-being indicates a necessity for more cohesive and contextually aware interpretations of learning settings (Huang, Richter, Kleickmann, & Richter, 2022).

2.2. College and University Classroom Environment

In higher education, the dynamics of classroom settings are progressively influenced by the interplay of physical, social, psychological, instructional, and digital factors. Conventional research focused on the psychosocial and interpersonal dimensions of classroom dynamics (Fraser, 1998), while contemporary investigations have underscored the significance of technological integration and pedagogical innovation in university learning settings (Flanigan et al., 2023; Song et al., 2022). Technology-facilitated and personalized learning can foster student involvement when it is congruent with effective teaching methodologies and the psychological requirements of learners (Clark et al., 2025; Ryan & Deci, 2000). Nonetheless, technology may also present difficulties. Digital distractions might hinder educational progress, yet excessively stringent measures may diminish motivation if students' independence and connection are neglected (Flanigan et al., 2023). In a similar vein, the overuse or ineffectively applied technology might lead to academic fatigue (Song et al., 2022). Notwithstanding these advancements, the digital, relational, and structural components of university classroom settings are not consistently unified within a cohesive framework (Joiner et al., 2021; MacDonald et al., 2019). Social connections are particularly significant, as the caliber of interactions between instructors and students, as well as among peers, correlates with engagement and the propensity to seek assistance (Ryan & Fong, 2025). These relational aspects may be especially prominent in collectivist environments like Vietnam, where educational engagement has historically prioritized hierarchy, social cohesion, and deference to authority (Maheshwari, 2022; Truong et al., 2017). Nonetheless, empirical data regarding higher education in Southeast Asia is very scarce, and culturally attuned methods for evaluating classroom settings are still evolving. Policy-level factors are seldom included in studies of classroom environments, even though they may significantly influence institutional standards and pedagogical methods.

2.3. Conceptual Framework and Dimensions of the CUCEI

The CUCEI, created by Fraser et al. (1986), is a commonly utilized tool for evaluating the psychosocial atmosphere of higher education classrooms. It defines classroom atmosphere by seven dimensions: customization, engagement, student unity, contentment, task focus, creativity, and individual attention. Collectively, these dimensions encompass relational, instructional, and organizational traits of the classroom experience, offering a systematic framework for analyzing the connections between the classroom environment and student performance (Dorman, 1998; Fraser, 1998). The seven dimensions signify interrelated facets of university education. Personalization denotes the degree to which educators offer tailored attention and foster supportive connections with learners, potentially enhancing intrinsic motivation and communication readiness (Bao, 2024; Ryan & Fong, 2025), and corresponds with the relatedness aspect of self-determination theory (Ryan & Deci, 2000). Participation encompasses active engagement in classroom learning and correlates with heightened student involvement (Cayubit, 2022; Hoi, 2024). Student cohesion pertains to interpersonal connections, teamwork, and reciprocal assistance, which may enhance perseverance and emotional health (Coll, Taylor, & Fisher, 2002; Doll & Dooley, 2021; Nguyen et al., 2025). The educational aspects enhance these relational traits. Task orientation prioritizes clarity, structure, and focus on educational activities, whereas innovation signifies the implementation of diverse and flexible pedagogical methods; both have been associated with engagement and success-related results (Clark et al., 2025; Englund et al., 2023; Han & Xu, 2025; Q. Song, 2024). Individualization signifies prospects for autonomy and learner-centric education, potentially fostering self-regulation and academic self-perception (Steinberg et al., 2024; Wang et al., 2025), although autonomy lacking enough structure could diminish engagement (Flanigan et al., 2023). Satisfaction encompasses students' comprehensive favorable evaluation of their classroom experience and is linked to heightened engagement and diminished burnout (Joseph, 2019; Song et al., 2022). The CUCEI has been utilized in several fields and cultural settings, demonstrating its theoretical and practical relevance (Clark et al., 2025; Joiner et al., 2021; Li et al., 2024). Although other classroom environment measures have taken into account additional considerations such as equity and inclusivity (Fraser, 1998), the CUCEI is still particularly beneficial for analyzing interpersonal and

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instructional aspects in university classrooms. Its application across cultures, however, necessitates empirical confirmation rather than presuming that the original measuring structure works equally in all circumstances.

2.4. Psychometric Validation of the CUCEI

Psychometric investigations of the CUCEI demonstrate both its robustness and the requirement for contextual adaptation. Fraser et al. (1986) observed acceptable internal consistency across the seven subscales, with Cronbach's alpha coefficients ranging from .67 to .90. EFA validated the suggested seven-factor structure, with items generally loading on their intended dimensions while displaying internal coherence and discriminant validity. Subsequent cross-cultural investigations generated more diverse results. In the Pacific Islands, cultural and linguistic variations influenced students' perceptions of some items, resulting in lower-than-expected dependability values. These findings suggest that literal translation alone may not be sufficient, and that adaptation should take into account semantic equivalence, cultural meaning, and local classroom norms. In contrast, Li (2014) observed improved psychometric performance in Chinese tertiary education after removing six poorly functioning items. The updated instrument maintained the seven-factor structure while achieving good reliability, demonstrating that the CUCEI can remain theoretically coherent with suitable cultural adaptation. Southeast Asian evidence lends credibility to this claim. Hadiyanto, Syahril, Arwildayanto, and Sumar (2019) validated the CUCEI at Indonesian universities and found satisfactory factorial validity and internal consistency. These studies collectively demonstrate that the CUCEI has a solid conceptual base, although its empirical performance may differ depending on language, culture, and educational setting. As a result, validation is required in each new setting to ensure that the factor structure, item functionality, and reliability remain acceptable. This is especially essential in Vietnam, where classroom norms, language, and educational traditions differ significantly from the Western environments in which the CUCEI was first established.

2.5. Present Study

Applying the CUCEI in Vietnam necessitates a thorough study of whether the original psychosocial characteristics are consistently perceived and quantified within Vietnamese higher education. While the tool has been utilized globally to assess classroom atmosphere, student learning, engagement, and satisfaction (Coll et al., 2002; Fraser, 1998; Fraser et al., 1986), its applicability cannot be taken for granted, as responses to classroom environment questions are shaped by cultural norms, institutional practices, and educational customs (Doll & Dooley, 2021; Yin & Lu, 2014). Vietnam offers an especially important backdrop for such validation. Confucian traditions have historically influenced classroom interaction by promoting social harmony, hierarchical teacher-student relationships, and respect for authority (Nguyen et al., 2025; Truong et al., 2017). At the same time, ongoing higher education reform promotes learner-centered, interactive, and autonomy-supportive instruction. These overlapping effects may influence how students perceive CUCEI aspects, including personalization, participation, innovation, and individualization. Studies suggest that nurturing environments correlate with motivation, engagement, profound learning, and favorable academic self-conceptions (Cayubit, 2022; Han & Xu, 2025; Hoi, 2024; Meng et al., 2025; Steinberg et al., 2024) yet students' perceptions of autonomy, involvement, and organization are still influenced by cultural contexts (Bao, 2024; Englund et al., 2023; Li, 2014; Li et al., 2024). Previous research in multicultural and tertiary contexts has emphasized the significance of contextual validation when transferring classroom environment instruments across educational systems (Coll et al., 2002; Dorman, 1998; Hadiyanto et al., 2019; Walker & Fraser, 2005; Yin & Lu, 2014). Building on this evidence, the current study assesses the psychometric features of the CUCEI among Vietnamese university students. It investigates whether the original dimensional structure is supported in this setting and evaluates the instrument's dependability and validity. In doing so, the study tackles the inadequate information on the CUCEI in Vietnamese higher education and establishes a foundation for its culturally acceptable usage in future research and institutional assessments.

As a result, substantial cultural and psychometric validation is required before implementing the CUCEI in Vietnamese higher education. This validation must go beyond language equivalency and include empirical tests of factorial structure, dependability, and construct validity in the local context. This is consistent with known methodological recommendations, which emphasizes the need of evaluating construct validity when adapting instruments across groups (Hair, Black, Babin, & Anderson, 2009; Hu & Bentler, 1999; Tabachnick & Fidell, 2018). Also, research on the classroom setting repeatedly shows that local confirmation is more important than direct instrument transfer for useful measurement (Fraser, 1998; Johnson & McClure, 2004; Joiner et al., 2021; MacLeod et al., 2018). Without such processes, there is a risk of confusing culturally influenced response patterns with genuine classroom characteristics, which could lead to incorrect results. Against this background, the current study investigates whether Vietnamese university students accept the CUCEI's original seven-factor structure: personalization, engagement, student cohesiveness, satisfaction, task orientation, innovation, and individualization. Theoretically, this study adds to existing discussions about the cross-cultural stability of classroom environment characteristics produced in Western settings. A tested tool can help with evidence-based teaching, professional development, and quality assurance in a higher education system that is changing quickly due to changes in technology and teaching methods (Clark et al., 2025; Flanigan et al., 2023; Song et al., 2022). It also shows how to make classrooms more engaging and healthier for students in situations where cultural and social factors are important (Joseph, 2019; MacDonald et al., 2019; Ryan & Fong, 2025; Ryan & Deci, 2000). As a result, this study addresses three research questions: Dependability, higher-order structure, and construct validity.

1. Does the Vietnamese CUCEI demonstrate adequate reliability?
2. Does the higher-order CUCE construct hold in the Vietnamese context?
3. Does the CUCEI exhibit satisfactory predictive, convergent, and discriminant validity?

3. Methods

3.1. Participants

In order to conduct a comprehensive psychometric assessment while minimizing the likelihood of capitalizing on random chance, our research employed a stringent split-sample cross-validation methodology (DeVellis, 2017). A sample including 297 undergraduate students from diverse academic fields was obtained through convenience

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sampling from three universities: An Giang University, Dong Thap University, and Tien Giang University, located in Vietnam's Mekong Delta region. In accordance with recognized methodological guidelines for cross-validation in instrument validation, the complete sample (N = 297) was randomly divided into two distinct subsamples: Subsample 1 (n = 150) for exploratory factor analysis (EFA) to investigate the localized factor structure, and Subsample 2 (n = 147) for confirmatory factor analysis (CFA) to validate the derived model. This divided-sample approach offers a rigorous evaluation of the instrument's structural consistency among distinct responder groups. Out of 297 participants, 105 were women (35.35%) and 192 were men (64.65%). The mean age was 21.40 years for females and 21.60 years for men, suggesting a demographically uniform sample regarding age. Before engaging in the study, all participants were provided with comprehensive information regarding the objectives, methodologies, and ethical implications of the research. Involvement was completely optional, and participants were made aware of their entitlement to exit the study at any moment without repercussions. Informed consent in writing was acquired in compliance with institutional ethical review standards. Anonymity and confidentiality were preserved during the research process; no personal identifiers were gathered, and data were securely stored with limited access. Responses were exclusively utilized for scholarly research and displayed in a collective manner to safeguard participant confidentiality. The research achieved an impressive response rate of 97%, indicating robust participation and bolstering the credibility and accuracy of the results.

3.2. Instruments

All instruments were translated into Vietnamese using a rigorous back-translation procedure to ensure linguistic and conceptual equivalence (Brislin, 1970). Two bilingual experts independently translated the original English instruments into Vietnamese, after which two additional experts reviewed the translations to ensure clarity, cultural appropriateness, and content validity. An independent bilingual translator, blinded to the original versions, then conducted back-translation into English. Any discrepancies were systematically examined and resolved through consensus to achieve semantic equivalence. A pilot study was subsequently conducted with a small sample to assess item clarity, comprehensibility, and contextual relevance prior to the main data collection.

3.2.1. Measurement of Classroom Environment Using the CUCEI

The CUCEI (Fraser et al., 1986) measures seven psychosocial dimensions of classroom climate: personalization, involvement, student cohesiveness, satisfaction, task orientation, innovation, and individualization. These dimensions collectively capture relational, instructional, and organizational aspects of the classroom environment. The instrument consists of 49 items, with representative indicators reflecting instructor support, student participation, peer interaction, and task structure. All items were rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), consistent with established survey design practices to enhance response consistency and measurement precision. Prior to factor analysis, item screening was conducted using corrected item–total correlations and Cronbach's alpha coefficients. Following established psychometric guidelines, items with corrected item–total correlations below .30 were removed, as such items are considered weak indicators of the underlying construct and may compromise scale reliability (Hair, Gabriel, da Silva, & Braga Junior, 2019). This procedure is widely recommended in scale development to improve internal consistency and ensure that retained items contribute meaningfully to the construct being measured. In total, 12 items were eliminated at this stage due to inadequate item–total correlations. The majority of these items were negatively worded or reflected unfavorable classroom conditions, which may have introduced measurement error or response bias. This is consistent with methodological guidance suggesting that poorly performing or ambiguous items should be removed prior to factor extraction to achieve a stable and interpretable factor structure (Tabachnick & Fidell, 2018).

3.2.2. The Utrecht Work Engagement Scale (UWES)

The revised version of UWES (Schaufeli, Bakker, & Salanova, 2006) with 9 items was employed to measure students' academic engagement across three core dimensions: Vigor (e.g., "At my learning, I feel strong and vigorous"), Dedication (e.g., "I am enthusiastic about my learning"), and Absorption (e.g., "I feel happy when I am learning intensely"). Each item was rated on a five-point Likert scale ranging from 1 (Never) to 5 (Very often). EFA identified a clear three-factor structure with KMO = 0.79; Bartlett's $\chi^2(36) = 718.53$, $p < 0.001$, with eigenvalues exceeding 1 for each dimension: Vigor = 3.95, Absorption = 1.62, and Dedication = 1.10, collectively explaining 61.37% of the total variance. CFA further validated this structure, yielding strong model fit statistics: $\chi^2 = 32.64$, df = 24, $\chi^2/df = 1.36$, p = 0.000, TLI = 0.98, CFI = 0.97, and RMSEA = 0.05. These findings confirm that the UWES demonstrates sound psychometric properties and is a valid and reliable instrument for assessing academic engagement among Vietnamese higher education students.

3.3. Data Analysis

The present study sought to validate the structure of the CUCEI within the context of Vietnamese universities, with the goal of assessing its reliability and applicability in measuring the CUCE. Item analysis was initially conducted using corrected item–total correlations and Cronbach's alpha. The sample (N = 297) was randomly divided into two subsamples. The first subsample (n = 150) was used for EFA, and the second subsample (n = 147) was used for CFA, following recommendations for cross-validation in scale development studies. The sample sizes of both subsamples, though relatively modest, were theoretically and empirically justified as sufficient. For the exploratory phase (Subsample 1, n = 150), we relied on the methodological framework of MacCallum, Widaman, Zhang, and Hong (1999). Their simulation studies demonstrated that factor analysis on sample sizes between 100 and 150 yields highly stable and congruent factor structures, provided that item communalities are moderate-to-high and the factors are highly overdetermined (i.e., characterized by at least 3 to 4 strongly loading indicators per factor). In this study, preliminary screening reduced the active pool to 37 items, and the final EFA yielded a clean, highly overdetermined structure of exactly four items per factor, with high loadings ranging from 0.58 to 0.89, satisfying MacCallum et al. (1999) criteria. For the confirmatory phase (Subsample 2, n = 147), sample adequacy was evaluated using the Monte Carlo simulation guidelines proposed by Wolf, Harrington, Clark, and Miller (2013). Wolf et al. (2013) demonstrated

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that for models with strong indicators (loadings > 0.65) and no data anomalies (such as Heywood cases or non-convergence), a sample size range of 100 - 150 provides sufficient statistical power (power >= 0.80) even for complex multidimensional structures. Given that our 7-factor measurement model converged smoothly without any mathematical anomalies and achieved excellent empirical fit indices (CFI= 0.93, TLI = 0.92, RMSEA = 0.05), the sample of n = 147 was deemed fully adequate to yield stable and trustworthy parameter estimations.

A rigorous multi-phase validation strategy was adopted, incorporating both EFA and CFA to examine dimensionality, internal consistency, and model fit. In the initial phase, EFA was conducted using principal-axis factoring with promax rotation to uncover the latent structure of the instrument. The analysis adhered to established statistical criteria for adequacy and factor retention: a Kaiser-Meyer-Olkin (KMO) value between .50 and 1.00 was considered indicative of sampling adequacy; Bartlett's test of sphericity was required to be statistically significant ($p < 0.05$), indicating sufficient correlations among variables; factor loadings above 0.50 were retained; and eigenvalues greater than 1.00 were used as the threshold for factor extraction (Hair et al., 2009). Following the EFA, CFA was employed to validate the factor structure and assess model fit. The following goodness-of-fit indices were used as evaluation benchmarks: Chi-square to degrees of freedom ratio ($\chi^2/df \leq 3.00$) (Tabachnick & Fidell, 2018) Goodness-of-Fit Index (GFI≥ 0.90), Comparative Fit Index (CFI≥ 0.90), and Tucker-Lewis Index (TLI≥ 0.90), which indicate an acceptable model fit according to traditional guidelines (Hair et al., 2009; Tabachnick & Fidell, 2018). Additionally, a Root Mean Square Error of Approximation (RMSEA≤ 0.06) was adopted as the threshold for a close fit, and RMSEA≤ 0.08 for an acceptable fit (Hu & Bentler, 1999; Tabachnick & Fidell, 2018). These indices collectively provided a comprehensive evaluation of how well the hypothesized model aligned with the observed data. In the final step, the predictive, convergent, and discriminant validity of the CUCEI were examined by correlating it with relevant measures of student work engagement. Correlation coefficients among factors were calculated, with statistical significance set at $p < 0.05$.

4. Results

The primary objective of this study is to explore the underlying factor structure of the CUCEI within the Vietnamese educational context, with a focus on evaluating its psychometric validity based on Vietnamese students' perceptions.

4.1. Reliability

Exploratory factor analysis (EFA) was conducted on Sample 1 (n = 150) to examine the underlying factor structure of the CUCEI. Principal-axis factoring with promax rotation was employed, as this approach is appropriate for identifying latent constructs while allowing for correlated factors. The initial EFA was performed on the remaining 37 items following preliminary item screening. Based on established criteria (Factor loadings ≥ 0.50 and adequate communalities), nine additional items were removed due to weak psychometric performance, including low communalities and cross-loadings across multiple factors, indicating limited contribution to the underlying constructs. Specifically, within the Student Cohesiveness (COH) dimension, Items 3, 10, and 24 were excluded due to insufficient communalities. Within Task Orientation (ORI), Items 19, 26, and 40 were removed as they exhibited both low communalities and weak factor loadings. Similarly, within Involvement (INV), Items 23, 30, and 37 were deleted due to weak and inconsistent loadings across factors. Particularly, the majority of the removed items were negatively worded or reflected unfavorable classroom conditions. This pattern is consistent with prior research indicating that negatively phrased items are more susceptible to method effects, reduced shared variance, and unstable factor structures in exploratory factor analysis. The systematic removal of such items is consistent with recommended practices in scale development, as item reduction enhances construct validity, internal consistency, and model parsimony (Carpenter, 2018; Lim, Khatri, Shiva, & Dabas, 2026; Morrison, 2009).

EFA was subsequently conducted on the remaining 28 items using principal-axis factoring with promax rotation (Table 1). The dataset was deemed suitable for factor analysis, as indicated by a Kaiser–Meyer–Olkin (KMO) value of 0.83, reflecting adequate sampling adequacy. Bartlett's test of sphericity was statistically significant ($\chi^2(378) = 2178.09$, $p < 0.001$), confirming that inter-item correlations were sufficient for factor extraction. The analysis revealed a clear seven-factor structure comprising Involvement, Satisfaction, Innovation, Personalization, Student Cohesiveness, Individualization, and Task Orientation. All retained items loaded strongly on their respective factors, with loadings ranging from .58 to .89, indicating both practical significance and satisfactory discriminant validity. The factor structure closely aligned with the theoretical framework, supporting the content validity of each dimension. All extracted factors had eigenvalues greater than 1.0, and the cumulative variance explained reached 59.00%, indicating a satisfactory level of explained variance. These findings suggest that the CUCEI demonstrates a well-defined, interpretable, and robust multidimensional structure, supporting its use as a valid instrument for assessing students' perceptions of the classroom environment. CFA was subsequently conducted on Sample 2 (n = 147) to validate the measurement model (Figure 1). A total of 28 items were retained, with each latent construct represented by four indicators, ensuring a balanced and stable measurement model. The CFA results demonstrated good model fit: $\chi^2 = 461.86$, df = 329, yielding a χ^2/df ratio of 1.46, which is well below the recommended threshold of 3.0. Additional fit indices further supported the adequacy of the model, with TLI = 0.92 and CFI = 0.93, both exceeding the acceptable benchmark of 0.90. The RMSEA = 0.05 also fell within the recommended range (≤ 0.08), indicating good model parsimony and fit. These findings provide strong empirical support for the seven-factor structure of the CUCEI, confirming that it is a reliable and valid instrument for measuring students' perceptions of the university classroom environment within the Vietnamese context.

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Table 1. Factor loadings for the CUCEI.

Items	Factor loading						
	PER	INN	IND	SAT	COH	ORI	INV
PER15: The instructor goes out of his/her way to help students	0.89						
PER22: The instructor helps each student who is having trouble with the work	0.76						
PER8: The instructor talks individually with students	0.74						
PER1: The instructor considers students' feelings	0.72						
INN41: The instructor often thinks of unusual class activities		0.81					
INN27: Teaching approaches in this class are characterized by innovation and variety		0.78					
INN13: New and different ways of teaching are seldom used in this class		0.75					
INN20: The instructor thinks up innovative activities for students to do		0.63					
IND35: Teaching approaches allow students to proceed at their own pace			0.87				
IND21: Students have a say in how class time is spent			0.75				
IND28: Students are allowed to choose activities and how they will work			0.75				
IND7: All students in the class are expected to do the same work, in the same way and in the same time			0.68				
SAT39: Students enjoy going to this class				0.77			
SAT46: Classes are interesting				0.73			
SAT18: After the class, the students have a sense of satisfaction				0.61			
SAT4: The students look forward to coming to classes				0.61			
COH38: Students in this class get to know each other well					0.83		
COH45: Students in this class aren't very interested in getting to know other students					0.72		
COH31: It takes a long time to get to know everybody by his/her first name in this class					0.69		
COH17: Friendships are made among students in this class					0.65		
ORI33: Class assignments are clear so everyone knows what to do						0.71	
ORI5: Students know exactly what has to be done in our class						0.68	
ORI47: Activities in this class are clearly and carefully planned						0.62	
ORI12: Getting a certain amount of work done is important in this class						0.61	
INV16: Students "clock watch" in this class							0.89
INV2: The instructor talks rather than listens							0.72
INV44: The instructor dominates class discussions							0.66
INV9: Students put effort into what they do in classes							0.58
Eigenvalue	8.39	2.56	2.24	1.98	1.65	1.32	1.17
Cum %	28.63	36.20	42.85	48.42	52.65	56.12	59.00

Note: Factor loadings < 0.50 were omitted. PER = Personalization, INN = Innovation, IND = Individualization, SAT = Satisfaction, COH = Student cohesiveness, ORI = Task orientation, INV = Involvement.

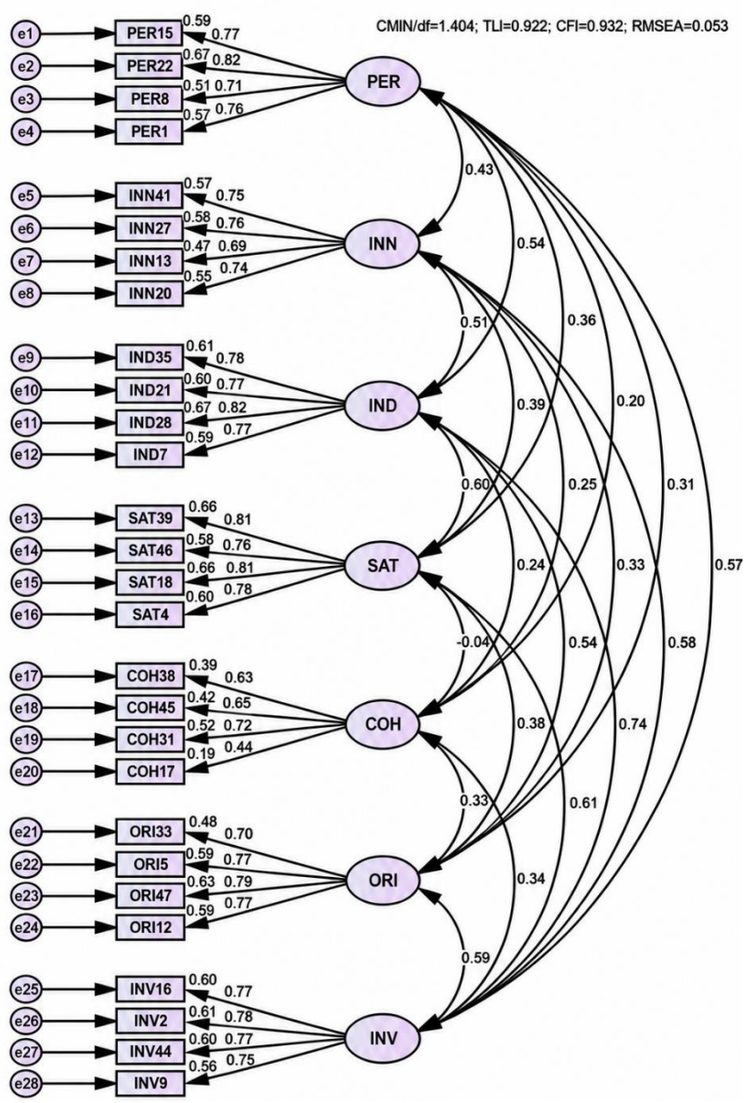


Figure 1. The best fit model of the CUCEI.

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4.2. Order Factor Models

To assess the applicability of a higher-order CUCE construct in the Vietnamese context, two competing models were evaluated: a first-order factor model (Model 1) and a second-order (higher-order) factor model (Model 2) (Table 2). The results do not support the presence of a higher-order structure. Model 1 demonstrated a good fit to the data (TLI = 0.92, CFI = 0.93, RMSEA = 0.05), satisfying recommended thresholds and indicating that the construct is best represented by correlated first-order dimensions. In contrast, Model 2 exhibited poor fit (TLI = 0.54, CFI = 0.57, RMSEA = 0.12), with all indices falling well below acceptable levels, suggesting that the proposed higher-order factor does not adequately explain the relationships among the dimensions. Although both models yielded statistically significant chi-square values ($p < 0.001$), this result is expected given the sample size (n = 147) and the sensitivity of the chi-square statistic. Accordingly, model evaluation prioritized incremental and absolute fit indices. Overall, the findings indicate that CUCE is more appropriately conceptualized as a multidimensional construct in the Vietnamese context, with dimensions operating relatively independently rather than reflecting a single overarching factor.

Table 2. Fit Indices of competing models.

Model	X^2	df	p	TLI	CFI	RMSEA
Model 1	461.86	329	0.000	0.92	0.93	0.05
Model 2	1174.00	350	0.000	0.54	0.57	0.12

4.3. Validity

Descriptive statistics, such as means, standard deviations, Cronbach's alpha coefficients, and inter-factor correlations, were calculated using the complete sample (n = 297) to get reliable estimations (Table 3). The evaluation of construct validity was conducted by convergent, discriminant, and concurrent validity. Due to the lack of evidence for the second-order paradigm, the CUCEI was seen as a multidimensional tool consisting of seven relatively separate subscales instead of a singular comprehensive construct. Consequently, no overarching CUCEI aggregate score was assessed in the validity evaluations. Convergent validity was assessed by analyzing the correlation patterns across the seven CUCEI dimensions: Personalization, innovation, individualization, satisfaction, student cohesiveness, task orientation, and involvement. The subscales exhibited a positive and significant relationship, with the majority of correlations falling within low to moderate ranges. This pattern suggests that the dimensions are interconnected elements of the educational setting while maintaining adequate conceptual individuality. A notably larger correlation was detected between Involvement and Individualization (r = 0.63), which is theoretically justifiable as possibilities for tailored learning may foster increased student involvement. Nevertheless, the general correlation pattern does not suggest significant overlap among the seven dimensions.

Discriminant validity was affirmed by the predominantly moderate inter-factor correlations, which primarily fell between r = 0.13 and 0.49. These results indicate that the seven CUCEI subscales assess distinct facets of students' classroom experiences rather than overlapping representations of a singular construct. This analysis aligns with the CFA findings, in which the correlated seven-factor model was validated, whereas the second-order model exhibited inadequate fit. Consequently, the seven primary dimensions must be analyzed independently. Concurrent validity was assessed by associating each CUCEI subscale with three external aspects of student engagement from the UWES: vigor, absorption, and devotion. Participation exhibited the most robust and persistent associations with engagement, correlating with vigor (r = 0.60), absorption (r = 0.62), and dedication (r = 0.51). Individualization had significant correlations with energy (r = 0.41), absorption (r = 0.48), and devotion (r = 0.54). The other factors—personalization, innovation, satisfaction, student cohesion, and task orientation—exhibited lower but statistically significant positive relationships with the engagement dimensions (r = 0.21–0.46). These associations suggest that more favorable views of particular elements of the classroom milieu correlate with increased student engagement. The results substantiate the credibility of the Vietnamese CUCEI as a multifaceted assessment of the university classroom atmosphere. The data support the independent analysis of the seven subscale scores rather than their amalgamation into a singular total score. The unique yet interconnected subscales demonstrated theoretically significant correlations with student involvement, validating their application in exploring various psychological and pedagogical traits of university classroom settings in Vietnam.

Table 3. Correlations between CUCEI and validity variables.

Variables	No. of items	M	SD	α	PER	INN	IND	SAT	COH	ORI	INV	VI	AB	DE
PER	4	3.03	0.61	0.85	1	0.33**	0.49**	0.28**	0.25**	0.24**	0.48**	0.21**	0.37**	0.46**
INN	4	3.37	0.60	0.83		1	0.44**	0.35**	0.25**	0.27**	0.46**	0.24**	0.35**	0.37**
IND	4	3.34	0.68	0.88			1	0.49**	0.32**	0.43**	0.63**	0.41**	0.48**	0.54**
SAT	4	3.23	0.58	0.84				1	0.13*	0.33**	0.49**	0.33**	0.44**	0.42**
COH	4	3.33	0.60	0.83					1	0.20**	0.40**	0.26**	0.28**	0.28**
ORI	4	3.30	0.58	0.81						1	0.46**	0.27**	0.42**	0.33**
INV	4	3.34	0.68	0.86							1	0.60**	0.62**	0.51**
VI	3	3.10	0.59	0.83								1	0.50**	0.36**
AB	3	3.16	0.62	0.74									1	0.41**
DE	3	3.24	0.63	0.79										1

Note: n = 297, *p < 0.05, and **p < 0.01. PER = Personalization, INN = Innovation, IND = Individualization, SAT = Satisfaction, COH = Student cohesiveness, ORI = Task orientation, INV = Involvement, VI = Vigor, DE = Devotion, AB = Absorption.

5. Discussion

5.1. Factorial Validity and Reliability

The first research question examined whether the Vietnamese CUCEI demonstrates adequate reliability and factorial validity. The findings provide strong support for the adapted 28-item version. The retained items loaded

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clearly onto seven factors, with factor loadings ranging from 0.58 to 0.89, indicating that each item contributed meaningfully to its intended construct. Internal consistency was also satisfactory, with Cronbach's alpha coefficients ranging from 0.81 to 0.88 for the subscales and 0.92 for the total scale. The CFA results further supported the model, with acceptable fit indices. These results indicate that the Vietnamese CUCEI is a reliable and structurally valid instrument for assessing students' perceptions of the university classroom environment. These findings are consistent with the original CUCEI validation by Fraser et al. (1986), which identified seven psychosocial dimensions of higher education classroom climate: personalization, involvement, student cohesiveness, satisfaction, task orientation, innovation, and individualization. They also align with later studies confirming the multidimensional nature of learning environments across university contexts (Dorman, 1998; Fraser, 1998; Hadiyanto et al., 2019). The successful retention of the seven-factor structure suggests that the core theoretical dimensions of the CUCEI remain meaningful in Vietnamese higher education.

However, the deletion of 21 items indicates that the original CUCEI cannot be directly transferred to the Vietnamese context without careful cultural and linguistic adaptation. A substantial proportion of the removed items were negatively worded or described unfavorable classroom conditions, which may have reduced their psychometric performance. In Confucian-influenced educational settings, students are often socialized to maintain respect for authority, preserve social harmony, and communicate indirectly. As a result, they may be reluctant to endorse negatively framed statements about instructors or classroom practices (Nguyen et al., 2025; Truong et al., 2017). This cultural response tendency can lead to attenuated variance and weaker factor loadings, thereby affecting reliability and construct validity. These findings are consistent with prior cross-cultural validation studies. Coll et al. (2002) reported that linguistic and cultural differences can significantly influence how CUCEI items are interpreted, often weakening their psychometric properties in multicultural contexts. Similarly, Li (2014) found that removing culturally incongruent or ambiguously worded items improved the validity and reliability of the CUCEI in Chinese tertiary education. Taken together, the present results both reaffirm the theoretical robustness of the CUCEI framework and highlight the critical importance of localized validation procedures to ensure conceptual clarity, cultural relevance, and measurement accuracy in diverse educational settings.

5.2. Higher-Order Structure

The second research question examined whether the CUCEI could be represented by a higher-order CUCE construct in Vietnam. The results do not support this assumption. The first-order model demonstrated good fit, whereas the second-order model showed poor fit. This indicates that the seven dimensions are better conceptualized as distinct but correlated aspects of classroom environment rather than as indicators of a single overarching construct. This result is consistent with Fraser (1998) view that classroom environment is inherently multidimensional. It also aligns with Dorman (1998); MacLeod et al. (2018), and Walker and Fraser (2005), who emphasized that different dimensions of learning environments often represent separate psychosocial, instructional, and organizational processes. In the Vietnamese context, the lack of support for a higher-order model may reflect the coexistence of traditional teacher-centered practices and newer learner-centered reforms. For example, personalization may be shaped by respect for teacher authority, involvement by students' willingness to speak publicly, and individualization by the extent to which autonomy is culturally accepted. These dimensions are related, but they may not function as manifestations of one unified classroom climate factor. This finding contributes to the literature by showing that cultural context affects not only individual item performance but also the theoretical organization of classroom environment constructs. While some studies treat classroom climate as a broad global construct (Doll & Dooley, 2021), the present results suggest that such an approach may obscure important contextual differences. For Vietnamese higher education, using separate CUCEI subscales is therefore more informative than relying on a single higher-order score.

5.3. Predictive, Convergent, and Discriminant Validity

The third research inquiry investigated if the Vietnamese CUCEI exhibits predictive, convergent, and discriminant validity. Due to the lack of evidence for the second-order model, validity was assessed at the level of the seven CUCEI subscales instead of through an overall CUCEI total score. This methodology aligns with the multifaceted framework recognized in the CFA. Convergent validity was affirmed by the positive and statistically significant correlations among the seven CUCEI dimensions. These connections suggest that personalization, innovation, individualization, contentment, student cohesion, task orientation, and involvement embody interconnected elements of the classroom atmosphere while providing unique insights. Discriminant validity was affirmed by the predominantly low-to-moderate correlations between factors, indicating that the dimensions are related yet distinct. This trend bolsters the understanding of the CUCEI as a multifaceted tool instead of an assessment of a singular, comprehensive classroom environment concept. Evidence supporting predictive validity was demonstrated by substantial positive correlations between the CUCEI subscales and the three qualities of student engagement: vigor, absorption, and devotion. In general, students who expressed more positive views of certain aspects of the classroom environment also exhibited greater levels of engagement. This trend aligns with earlier studies indicating that nurturing educational settings correlate with enhanced motivation, involvement, and academic performance (Cayubit, 2022; Han & Xu, 2025; Hoi, 2024; Meng et al., 2025; Nguyen et al., 2025).

Among the seven subscales, involvement and individualization had notably significant correlations with engagement. Engagement was positively correlated with energy, commitment, and immersion, suggesting that active involvement is particularly crucial for meaningful learning. Personalization showed significant correlations with engagement, especially dedication, indicating that avenues for autonomy, selection, and self-directed learning could enhance students' devotion to their academic pursuits. These results align with self-determination theory, which posits that educational settings that foster autonomy, competence, and connection can boost intrinsic motivation and involvement (Ryan & Deci, 2000). They correspond with studies highlighting the significance of educator assistance, student involvement, and learner-focused teaching in fostering engagement (Bao, 2024; Ryan & Fong, 2025; Steinberg et al., 2024). The results endorse the dependability and authenticity of the Vietnamese CUCEI at the subscale dimension. They align closely with earlier CUCEI studies while expanding the scholarly discourse to encompass a Confucian-influenced higher education framework. Simultaneously, the significant decrease in items

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necessary for attaining a satisfactory factorial solution underscores the necessity of cultural adaptation. The 28-item version preserves the seven initial qualities and offers a succinct, psychometrically validated tool for evaluating certain facets of university classroom settings in Vietnam.

The findings of this study have important implications for teaching practice, institutional policy, and ongoing educational reform. First, the validated CUCEI provides Vietnamese universities with a reliable and contextually appropriate diagnostic tool for evaluating classroom environments, thereby enabling data-driven improvements in teaching quality and student experience. This supports current higher education reforms in Vietnam that emphasize learner-centered and quality-enhanced instruction (Nguyen et al., 2025; Thao-Do et al., 2016). Moreover, consistent with prior research highlighting the role of classroom climate in shaping learning outcomes (Fraser, 1998; Johnson & McClure, 2004), the CUCEI offers a structured means of monitoring and improving psychosocial learning conditions. Second, the multidimensional structure identified in this study suggests that targeted, dimension-specific interventions are more appropriate than generalized strategies. For example, enhancing personalization and involvement may be particularly effective in promoting student engagement and motivation, as these dimensions are closely linked to interaction, participation, and relational support (Cayubit, 2022; Ryan & Fong, 2025). At the same time, strengthening task orientation and innovation can foster structured, goal-oriented, and adaptive learning environments, especially in technology-enhanced classrooms (Clark et al., 2025; MacLeod et al., 2018; Song, 2024). This aligns with prior findings that well-structured and innovative environments support deeper learning approaches and academic achievement (Englund et al., 2023; Han & Xu, 2025).

Third, the results underscore the importance of culturally responsive pedagogy. In Confucian-influenced contexts such as Vietnam, where social harmony, respect for authority, and indirect communication are emphasized, fostering active participation requires careful pedagogical balance (Nguyen et al., 2025; Truong et al., 2017). Instructors must simultaneously support autonomy and maintain culturally appropriate classroom dynamics. This is consistent with research showing that the effectiveness of classroom environments depends on how students interpret autonomy, support, and interaction within their cultural context (Bao, 2024; Li, 2014). Consequently, institutions should invest in professional development initiatives that equip instructors with strategies to create psychologically supportive, inclusive, and culturally attuned classroom environments, which are known to enhance student well-being and engagement (Joseph, 2019; MacDonald et al., 2019; Ryan & Deci, 2000). Finally, the CUCEI has significant potential for quality assurance and policy evaluation, particularly as higher education systems adapt to digital transformation and emerging challenges. With increasing integration of technology in teaching, issues such as digital distraction, disengagement, and academic burnout have become more prominent (Flanigan et al., 2023; Song et al., 2022). The CUCEI can provide actionable insights into how classroom environments evolve in response to these changes and can inform institutional strategies aimed at improving both teaching effectiveness and student outcomes. This is particularly relevant in light of research emphasizing the need to align digital innovation with students' psychological needs and learning preferences (Joiner et al., 2021; Wang et al., 2025).

This study demonstrates that the CUCEI is a reliable, valid, and culturally adaptable instrument for assessing classroom environments in Vietnamese higher education. While the original seven-factor structure is largely supported, the absence of a higher-order construct highlights the importance of conceptualizing classroom climate as a multidimensional and context-dependent phenomenon. These findings are consistent with prior research emphasizing the complexity of learning environments (Dorman, 1998; Fraser, 1998) while extending the literature by demonstrating how cultural context shapes both measurement and interpretation. By situating the findings within the broader body of research, this study confirms the cross-cultural applicability of the CUCEI while reinforcing the necessity of context-sensitive validation. The results contribute to theory by deepening understanding of how classroom environment constructs operate in collectivist educational systems and contribute to practice by offering a concise and empirically validated tool for improving teaching and learning. More broadly, the study highlights a critical principle in educational measurement: effective instrument use requires not only statistical validation but also careful cultural adaptation to ensure that constructs remain meaningful, interpretable, and relevant across diverse educational contexts.

6. Conclusion

This research investigated the factorial configuration and psychometric characteristics of the CUCEI within Vietnamese higher education. The results endorse a sophisticated 28-item, seven-dimensional framework that includes participation, satisfaction, innovation, personalization, student cohesiveness, individualization, and task orientation. Both EFA and CFA validated the instrument's multidimensional framework, while assessments of reliability and validity indicated commendable psychometric efficacy. Crucially, the higher-order model lacked validation, suggesting that the classroom environment ought to be understood through seven interconnected yet separate dimensions instead of a singular comprehensive concept. Connections between the CUCEI subscales and student involvement reinforce the practical significance of these dimensions in comprehending students' classroom experiences. The results enhance research on classroom environments by illustrating that the CUCEI may be modified for application in Vietnamese higher education, provided that suitable cultural and psychometric validation processes are implemented. The elimination of various elements underscores the significance of cultural and linguistic awareness when Western-developed instruments are utilized in educational frameworks shaped by Confucian values, collectivism, and structured teacher-student dynamics. The enhanced CUCEI could serve as a valuable diagnostic instrument for educators and administrators to assess particular aspects of the classroom environment and guide initiatives aimed at bolstering student-centered pedagogy and involvement. Numerous constraints must be recognized. Initially, the use of a convenience sample from three colleges in the Mekong Delta constrains the applicability of the results to the broader Vietnamese higher education landscape. Subsequent research ought to encompass larger and more varied samples spanning different areas, types of institutions, and fields of study. Secondly, the divided samples employed for Exploratory Factor Analysis and Confirmatory Factor Analysis were somewhat limited. Despite the robust factor loadings, acceptable internal consistency, and favorable CFA fit indices endorsing the derived structure, validation using more extensive national samples is essential to ascertain its stability. Third, the research depended solely on student self-reports, which could be influenced by personal perception and response bias. Subsequent investigations ought to integrate supplementary data, such as educator

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assessments, classroom observations, and qualitative interviews. Fourth, the cross-sectional framework inhibits causal inferences about the connections between classroom atmosphere and student involvement; longitudinal studies would yield more robust evidence on these associations over time. Ultimately, the elimination of 21 original CUCEI elements could diminish the comparability with research employing the full instrument. Subsequent investigations ought to explore if culturally tailored or rephrased iterations of these items can enhance contextual pertinence while maintaining conceptual parity. The enhanced CUCEI offers a viable foundation for additional study and evaluation of classroom environments in Vietnamese higher education.

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