CLASSROOM ENVIRONMENT PERCEPTIONS AND CRITICAL THINKING DEVELOPMENT: A QUANTITATIVE ANALYSIS OF EDUCATIONAL INNOVATION COURSES IN HIGHER EDUCATION

Wenchao Zhang [1*]
Ziyue Wang [2]
Racha Mahakuntha [3]
Ge Wei [4]
Bordin K [5]

[1-5] Innovation College, North-Chiang Mai University
[*] **Corresponding Author, E-mail:** Wenchao.zhang@northcm.ac.th

Abstract: This study investigates the relationship between perceived classroom environment and critical thinking development among college students in educational innovation courses. Grounded in social cognitive theory and constructivist learning principles, we examined whether specific classroom environmental factors significantly predict critical thinking tendencies while controlling for demographic variables. A cross-sectional survey design was employed with 200 first and second-year students from North-Chiang Mai University. Participants completed the revised California Critical Thinking Disposition Inventory (CCTDI) and a culturally adapted Classroom Environment Scale measuring six dimensions: student cohesion, classroom participation, teacher support, inquiry orientation, teaching methods, and equality. Data analysis included descriptive statistics, independent samples t-tests, correlation analysis, and multiple regression modeling using SPSS 21.0.

Critical thinking scores averaged 242.46 (SD = 28.3), indicating moderate levels overall. Significant grade differences emerged ($t = 4.23$, $p < .001$, Cohen's $d = 0.65$), with sophomores scoring higher than freshmen. Gender differences favored males ($t = 2.87$, $p < .01$, Cohen's $d = 0.42$). Classroom environment perceptions correlated positively with critical thinking ($r = .547$, $p < .001$). Multiple regression revealed classroom environment explained 29.8% of variance in critical thinking ($F = 16.84$, $p < .001$), with teacher support ($\beta = .312$) and inquiry orientation ($\beta = .289$) as strongest predictors. Classroom environment significantly influences critical thinking development, particularly through teacher support and inquiry-based approaches. Findings suggest targeted interventions focusing on collaborative learning environments and questioning strategies may enhance students' critical thinking capabilities in higher education contexts.

Keywords: Classroom Environment, Critical Thinking, Educational Innovation, Higher Education

Introduction

Critical thinking represents one of the most essential competencies for success in the 21st century, recognized globally as fundamental to personal development, academic achievement, and societal progress. As educational institutions worldwide prioritize the development of students' analytical and evaluative capabilities, understanding the environmental factors that foster critical thinking has become increasingly crucial for educational research and practice. The classroom environment encompasses the physical, social, and psychological conditions within which learning occurs, including teacher-student relationships, peer interactions, instructional methods, and classroom climate. Contemporary educational theory suggests that these environmental factors significantly influence cognitive development through multiple pathways, yet empirical research examining specific relationships between classroom environmental dimensions and critical thinking remains limited, particularly within Asian higher education contexts.

Recent meta-analytic evidence indicates that classroom environment factors account for approximately 15-25% of variance in student learning outcomes, with effect sizes ranging from moderate to large across different educational contexts. However, most existing research has focused on elementary and secondary education, with limited attention to higher education settings where critical thinking development is particularly emphasized. This gap represents a significant limitation in our understanding of how university-level environmental factors influence the development of analytical and evaluative thinking skills that are essential for academic success and professional competence.

Theoretical Foundation

This study is grounded in Bandura's social cognitive theory, which conceptualizes learning as emerging from dynamic interactions between personal factors, behavioral factors, and environmental factors. Within this framework, critical thinking development occurs through observational learning, self-regulation, and reciprocal environmental influences. The triadic reciprocal causation model suggests that classroom environments shape critical thinking through multiple mechanisms including modeling of analytical thinking behaviors by instructors and peers, reinforcement contingencies for questioning and evaluation, provision of cognitive tools and strategies, and creation of psychological safety for intellectual risk-taking.

Vygotsky's social constructivist theory provides additional theoretical grounding, emphasizing that higher-order thinking emerges through social interaction within the zone of proximal development. Critical thinking develops through collaborative discourse, guided inquiry, and scaffolded problem-solving experiences that challenge existing mental models and promote cognitive restructuring. The classroom environment serves as the primary social context where these developmental processes occur, with specific environmental features such as teacher support, peer collaboration, and inquiry orientation creating opportunities for students to engage in the social construction of knowledge while

developing critical thinking dispositions.

Deci and Ryan's self-determination theory offers insights into motivational mechanisms linking classroom environment to critical thinking. Environments that support psychological needs for autonomy, competence, and relatedness foster intrinsic motivation and engagement with challenging cognitive tasks. This theoretical perspective suggests that classroom environmental factors influence critical thinking indirectly through motivational pathways, with supportive environments enhancing students' willingness to engage in the effortful cognitive processes required for critical analysis and evaluation.

Literature Review and Research Gaps

The conceptualization of critical thinking has evolved significantly since Dewey's initial formulation of "reflective thinking." Contemporary definitions emphasize both cognitive skills such as analysis, evaluation, and inference, as well as dispositional factors including truth-seeking, open-mindedness, and analyticity that together comprise critical thinking competence. Recent research has increasingly focused on environmental factors that support critical thinking development, with comprehensive meta-analyses finding that instructional interventions emphasizing active learning, collaborative inquiry, and explicit thinking instruction produce significant gains in critical thinking.

Fraser's extensive research program on learning environments has established reliable measurement approaches and documented consistent relationships between classroom climate and academic outcomes. Studies using the Constructivist Learning Environment Survey have found positive correlations between supportive classroom environments and various cognitive outcomes, including problem-solving, creativity, and academic achievement. However, specific research connecting classroom environment to critical thinking remains limited, with most studies examining global environmental effects rather than investigating specific dimensional relationships.

Most existing research on critical thinking and classroom environment has been conducted in Western educational contexts, raising questions about cross-cultural generalizability. Asian educational systems often emphasize different pedagogical approaches and cultural values that may influence environment-thinking relationships. Recent research in Asian contexts has revealed both similarities and differences compared to Western findings, highlighting the need for context-specific research that examines how cultural factors moderate environmental influences on critical thinking development.

Through systematic analysis of existing literature, several important gaps emerge that this study addresses. First, most classroom environment research has examined K-12 settings, with insufficient attention to university contexts where critical thinking is particularly emphasized. Second, previous studies often treat classroom environment as a global construct rather than examining specific dimensional relationships with critical thinking. Third, insufficient research has examined environment-thinking relationships within Asian higher education contexts, limiting understanding of cultural

moderators. Fourth, few studies have examined how environment-thinking relationships vary across different stages of university study. Finally, limited research has systematically integrated multiple theoretical perspectives to explain classroom environment effects on critical thinking.

Research Objectives and Hypotheses

Based on the theoretical framework and literature gaps identified, this study addresses five primary research objectives. The first objective examines the overall level and distribution of critical thinking dispositions among university students in educational innovation courses. The second objective investigates students' perceptions of classroom environment across six dimensions and identifies patterns of environmental strength and weakness. The third objective analyzes demographic differences in critical thinking dispositions and classroom environment perceptions, particularly focusing on grade level and gender variations. The fourth objective determines the strength and pattern of relationships between classroom environment dimensions and critical thinking dispositions. The fifth objective examines the predictive power of classroom environment factors for critical thinking development while controlling for demographic variables.

Based on theoretical predictions and existing empirical evidence, several hypotheses are proposed. First, perceived classroom environment will demonstrate significant positive relationships with critical thinking disposition, with correlation coefficients exceeding moderate effect sizes. Second, among the six classroom environment dimensions, teacher support and inquiry orientation will emerge as the strongest predictors of critical thinking, reflecting their theoretical importance for cognitive development. Third, grade level will significantly moderate the classroom environment-critical thinking relationship, with stronger associations observed among second-year students compared to first-year students, reflecting developmental readiness for environmental influence. Fourth, consistent with previous research in Asian contexts, male students will demonstrate significantly higher critical thinking scores than female students, particularly in analytical thinking and truth-seeking dimensions. Fifth, classroom environment factors will explain substantial unique variance in critical thinking beyond demographic predictors, supporting the theoretical emphasis on environmental influences in cognitive development.

Methods

This study employed a cross-sectional correlational design to examine relationships between perceived classroom environment and critical thinking dispositions among university students. The cross-sectional approach was selected for its efficiency in capturing current perceptions and thinking patterns across different demographic groups, while acknowledging limitations for causal inference. The correlational design enables simultaneous examination of multiple variables and identification of predictive relationships suitable for educational intervention planning. The quantitative approach was

chosen to provide precise measurement of key constructs and enable statistical modeling of complex relationships, though qualitative methods could offer deeper insights into individual experiences.

Participants and Sampling Procedures

The target population comprised undergraduate students enrolled in educational innovation courses at North-Chiang Mai University during the 2023-2024 academic year, totaling 1,247 students. Educational innovation courses were selected as the focus because they explicitly emphasize critical thinking development and employ diverse pedagogical approaches that create variation in classroom environmental factors. Stratified cluster sampling was employed to ensure adequate representation across key demographic variables while maintaining practical feasibility. The stratification variables included grade levels, academic disciplines, and gender distribution to reflect the diversity of the target population.

Sample size determination was conducted using G*Power 3.1.9.7 for multiple regression analysis with medium effect size expectations, alpha level of .05, desired power of .80, and eight predictors including six environment dimensions plus two demographic variables. The analysis indicated a minimum required sample of 146 participants, with a target sample of 210 selected to account for potential non-response and provide adequate statistical power for detecting medium effects.

The final sample consisted of 200 participants with an average age of 19.2 years. Gender distribution included 116 females (58%) and 84 males (42%), while grade level distribution comprised 105 first-year students (52.5%) and 95 second-year students (47.5%). Academic disciplines represented included Education (35%), Engineering (28%), Business (22%), and Liberal Arts (15%), with cumulative GPA averaging 3.12. Chi-square goodness of fit tests indicated the sample was representative of the target population on key demographic characteristics, supporting the generalizability of findings within the institutional context.

Instrumentation

Critical thinking disposition was assessed using the California Critical Thinking Disposition Inventory - Chinese Version, based on Facione's conceptualization of critical thinking as comprising both cognitive skills and dispositional factors. The dispositional approach recognizes that effective critical thinking requires not only ability but also the motivation and inclination to engage in critical analysis. The instrument measures seven distinct dispositional factors including truth-seeking, open-mindedness, analyticity, systematicity, critical thinking confidence, inquisitiveness, and cognitive maturity through 75 items rated on a 6-point Likert scale.

Psychometric analysis in the current study demonstrated strong reliability and validity. Internal consistency reached .89 for the overall scale with subscale reliability ranging from .72 to .85. Test-retest reliability over a two-week interval with a subsample of 50 participants yielded a correlation of .84. Confirmatory factor analysis supported the seven-factor structure with acceptable fit indices, indicating that the instrument effectively measures the intended critical thinking dispositions within the Thai

university context.

Given the lack of culturally appropriate classroom environment measures for Thai higher education, a systematic scale development process was undertaken. The development began with comprehensive literature review of existing classroom environment instruments, particularly Fraser's suite of learning environment surveys. An expert panel of five educational researchers with expertise in learning environments and Thai educational contexts reviewed the initial item pool and provided feedback on cultural appropriateness and content validity. Items were modified to reflect Thai university classroom characteristics and cultural norms, followed by pilot testing with 50 students from a similar population.

The final Classroom Environment Scale consists of 36 items measuring six theoretically-derived dimensions. Student Cohesion assesses the extent to which students know, help, and support each other. Classroom Participation measures the level of student engagement and active involvement in learning activities. Teacher Support evaluates the extent to which teachers provide help, guidance, and encouragement to students. Inquiry Orientation examines the emphasis on questioning, investigation, and problem-solving in classroom activities. Teaching Methods assesses the variety and appropriateness of instructional approaches used by teachers. Equality measures fairness in teacher treatment and opportunity distribution among students.

Scoring utilizes a 5-point Likert scale ranging from never to always, with dimension scores computed as mean item ratings and total scale score representing overall environmental quality. Psychometric validation with the full sample demonstrated strong reliability with Cronbach's alpha coefficients ranging from .77 to .85 across dimensions. Content validity was established through expert review with item-level content validity index of .92, indicating strong expert agreement on item relevance and clarity. Construct validity was supported through confirmatory factor analysis showing acceptable fit for the six-factor model, while criterion validity was evidenced through significant correlations with academic engagement and course satisfaction measures.

Data Collection Procedures

All procedures received approval from the North-Chiang Mai University Institutional Review Board with comprehensive ethical safeguards implemented throughout the study. Key ethical considerations included obtaining informed consent from all participants, emphasizing voluntary participation with no academic consequences for non-participation, implementing data anonymization protocols with secure storage procedures, and informing participants of their right to withdraw from the study at any time without penalty.

The recruitment process involved course instructors in educational innovation programs introducing the study during regular class periods, emphasizing the research nature and potential benefits for educational improvement. Students interested in participating attended separate information sessions where research assistants explained study procedures, answered questions, and obtained

informed consent. Data collection involved 50-minute paper-and-pencil questionnaire completion in regular classroom settings, with research assistants monitoring the process, answering clarification questions, and checking for completeness. A brief debriefing provided participants with a summary of research goals and expected timeline for results.

Of 210 students recruited, 200 completed questionnaires yielding a response rate of 95.2%. Ten students either declined participation or provided incomplete responses. This high response rate suggests minimal selection bias and supports the representativeness of the final sample for addressing the research questions.

Data Analysis Strategy

Preliminary analyses included comprehensive data screening procedures to ensure data quality and appropriateness for planned statistical analyses. Missing data analysis using Little's MCAR test assessed missing data patterns, while distributional assessment examined normality through Shapiro-Wilk tests, skewness and kurtosis examination, and Q-Q plots. Outlier detection utilized Mahalanobis distance calculation, and assumption testing verified linearity, homoscedasticity, and multicollinearity requirements for planned analyses.

Descriptive statistics provided comprehensive reporting including measures of central tendency, variability indicators, distribution characteristics, and 95% confidence intervals for all point estimates. Bivariate correlations using Pearson product-moment correlations examined relationships between all study variables, with Bonferroni corrections applied for multiple comparisons to control family-wise error rate.

Group comparison analyses employed independent samples t-tests to examine grade-level and gender differences in critical thinking and classroom environment, with effect size calculation using Cohen's d and 95% confidence intervals. Assumption testing included Levene's test for equality of variances to ensure appropriate statistical procedures.

Predictive modeling utilized hierarchical multiple regression analysis with demographic predictors entered first to establish baseline model, followed by classroom environment total score to examine overall environmental effects, then individual environment dimensions to identify specific predictive factors, and finally interaction terms to test moderation hypotheses. Model evaluation criteria included R^2 and adjusted R^2 for variance explanation, F-statistics and significance tests for model comparison, standardized regression coefficients with 95% confidence intervals, and effect size interpretation using established conventions.

Statistical analyses were conducted using IBM SPSS Statistics 28.0 with supplementary analysis using AMOS 28.0 for confirmatory factor analysis. Alpha level was set at .05 for all statistical tests, with effect size reporting following Cohen's conventions and 95% confidence intervals reported for all point estimates and effect sizes.

Results

Preliminary analyses revealed high-quality data suitable for planned statistical procedures. Missing data analysis indicated that 2.3% of data points were missing completely at random, handled through listwise deletion resulting in complete data for all 200 participants. Univariate normality assessment showed acceptable distributions for all variables with skewness and kurtosis values within conventional criteria. Multivariate outlier detection identified five cases with extreme values, but examination revealed valid response patterns with no evidence of careless responding, so all cases were retained in analyses.

Descriptive Statistics and Correlational Analysis

Descriptive analysis revealed that critical thinking scores averaged 242.46 points with a standard deviation of 28.31, indicating moderate levels overall with substantial individual variation. Among the critical thinking dimensions, students scored highest on inquisitiveness and cognitive maturity, while truth-seeking showed the lowest average score. This pattern suggests that students demonstrate intellectual curiosity and appreciation for complexity but may need development in actively seeking accurate understanding regardless of personal preferences. Classroom environment perceptions averaged 92.06 points with a standard deviation of 12.45, indicating generally positive but variable environmental experiences. Teacher support and teaching methods received the highest ratings, while student cohesion showed the lowest average score.

Correlational analysis revealed significant positive relationships between all study variables, supporting the theoretical expectation of interconnected cognitive and environmental factors. The overall classroom environment score correlated significantly with critical thinking at $r = .547$, representing a large effect size and providing strong support for the theoretical prediction of substantial environmental influence on cognitive development. Among environmental dimensions, teacher support showed the strongest correlation with critical thinking at $r = .512$, followed closely by inquiry orientation at $r = .489$. These findings suggest that instructor-mediated factors may be more influential than peer-related factors for critical thinking development in higher education contexts.

The pattern of intercorrelations among critical thinking dimensions ranged from moderate to strong, with correlations between .48 and .85, indicating that the dimensions represent related but distinct aspects of critical thinking disposition. Similarly, classroom environment dimensions showed moderate to strong intercorrelations ranging from .78 to .89 with the total environment score, suggesting that environmental factors tend to co-occur but maintain some independence that allows for dimensional analysis.

Grade-Level Differences

Analysis of grade-level differences revealed significant and practically meaningful differences across multiple measures. Second-year students demonstrated significantly higher overall critical thinking scores compared to first-year students, with a mean difference of 16.67 points representing a

medium-large effect size of Cohen's d = 0.65. This finding provides strong evidence for developmental progression in critical thinking during university study, supporting theoretical expectations of intellectual growth through educational experiences.

Examination of specific critical thinking dimensions revealed that grade-level differences were consistent across all seven factors, with second-year students scoring higher in every area. The largest differences appeared in open-mindedness and systematicity, suggesting that advanced students develop greater willingness to consider alternative perspectives and more organized approaches to problem-solving. Truth-seeking also showed substantial improvement, indicating that students develop stronger motivation to seek accurate understanding as they progress through their studies.

Classroom environment perceptions also differed significantly by grade level, with second-year students reporting more positive environmental experiences overall. The total environment difference represented a medium effect size of Cohen's d = 0.47, suggesting that advanced students either experience more supportive environments or develop greater appreciation for environmental supports. Dimensional analysis revealed that the largest grade differences occurred in teacher support and inquiry orientation, precisely the environmental factors most strongly related to critical thinking development. This pattern suggests that advanced students may be better positioned to recognize and utilize environmental supports for intellectual growth.

Interestingly, some environmental dimensions showed no significant grade differences, particularly equality and student cohesion. This finding suggests that certain environmental factors may be more stable across academic levels, while others vary with student development or course design. The specific pattern of grade differences in environmental perceptions provides insights into how student development interacts with environmental factors to influence critical thinking growth.

Gender Differences

Gender analysis revealed significant differences in critical thinking that require careful interpretation within cultural and educational contexts. Male students demonstrated significantly higher overall critical thinking scores than female students, with a mean difference of 10.61 points representing a small-medium effect size of Cohen's d = 0.38. While statistically significant, this difference should be considered alongside cultural factors that may influence both critical thinking development and measurement.

Dimensional analysis revealed that gender differences were most pronounced in truth-seeking and analyticity, with males scoring significantly higher in both areas. Truth-seeking differences were particularly large with Cohen's d = 0.52, suggesting that male students in this context may be more inclined to actively seek accurate understanding and challenge existing beliefs. Analyticity differences with Cohen's d = 0.58 indicate that males may demonstrate greater tendency to anticipate consequences and use evidence in problem-solving situations.

Importantly, several critical thinking dimensions showed no significant gender differences,

including open-mindedness, critical thinking confidence, inquisitiveness, and cognitive maturity. This pattern suggests that gender differences are specific to certain aspects of critical thinking rather than representing global differences in thinking ability or motivation. The absence of differences in open-mindedness is particularly noteworthy, as it suggests that both genders demonstrate similar willingness to consider alternative perspectives.

Analysis of classroom environment perceptions revealed no significant overall gender differences, with males and females reporting similar environmental experiences across most dimensions. This finding suggests that any gender differences in critical thinking are not attributable to differential environmental exposure or perception. The lack of environmental differences also indicates that both genders have equal access to supportive classroom conditions, which is important for ensuring equitable educational opportunities.

Environment-Critical Thinking Relationships

Correlational analysis provided strong support for theoretical predictions regarding environmental influences on critical thinking development. The overall relationship between classroom environment and critical thinking reached r = .547 with 95% confidence interval of [.446, .632], representing a large effect size that exceeds conventional thresholds for practical significance. This finding demonstrates that environmental factors account for approximately 30% of variance in critical thinking disposition, indicating substantial but not overwhelming environmental influence.

Dimensional analysis revealed important patterns in how specific environmental factors relate to critical thinking development. Teacher support emerged as the strongest environmental predictor with r = .512, suggesting that instructor relationships provide crucial psychological foundation for critical thinking. Students need to feel intellectually safe, supported in taking cognitive risks, and encouraged to express unconventional ideas. This finding emphasizes the relational aspects of cognitive development and highlights the importance of instructor preparation in supporting student thinking.

Inquiry orientation showed the second-strongest relationship with critical thinking at r = .489, highlighting the role of questioning culture in promoting analytical thinking. Classrooms that encourage investigation, hypothesis generation, and evidence evaluation create cognitive demand for higher-order thinking processes. This finding provides empirical support for problem-based learning approaches and inquiry-centered curriculum design that emphasize active student engagement with complex problems.

Teaching methods, equality, and classroom participation showed moderate correlations with critical thinking, all exceeding r = .40 and representing practically meaningful relationships. These findings suggest that instructional variety, fair treatment, and active student involvement contribute to critical thinking development, though perhaps less directly than teacher support and inquiry orientation. Student cohesion showed the weakest correlation at r = .334, though still statistically significant and practically meaningful.

The pattern of environmental relationships suggests that instructor-mediated factors may be

more influential than peer-related factors for critical thinking development in higher education contexts. This finding may reflect the developmental level of university students, who may be more influenced by expert guidance than peer interaction, or cultural factors that emphasize teacher-student relationships in Asian educational contexts.

Predictive Modeling

Hierarchical multiple regression analysis provided detailed insights into how environmental factors predict critical thinking development while controlling for demographic characteristics. The analysis progressed through three steps, with demographic predictors entered first, total classroom environment added second, and individual environmental dimensions included third to identify specific predictive factors.

The initial demographic model including grade level and gender explained 8.7% of variance in critical thinking, with both predictors showing significant effects. Grade level emerged as a stronger predictor than gender, consistent with the larger effect sizes observed in group comparison analyses. This baseline model establishes the importance of developmental and individual difference factors in critical thinking while providing a foundation for examining environmental contributions.

Addition of total classroom environment in the second step dramatically improved model performance, increasing explained variance to 34.7% and representing an additional 26.0% of unique variance attributable to environmental factors. The large R^2 change and significant F-test indicate that environmental factors provide substantial predictive power beyond demographic characteristics. The environmental predictor showed a standardized coefficient of $\beta = .534$, indicating strong influence on critical thinking development.

The final model including individual environmental dimensions explained 38.9% of total variance while identifying specific environmental factors most important for critical thinking prediction. Teacher support emerged as the strongest predictor with $\beta = .312$, followed closely by inquiry orientation with $\beta = .289$. These findings confirm the correlational analysis and provide evidence that instructor-mediated factors are primary environmental influences on critical thinking development.

Interestingly, several environmental dimensions that showed significant correlations with critical thinking did not achieve significance in the multiple regression model, including teaching methods, equality, classroom participation, and student cohesion. This pattern suggests that these factors may influence critical thinking indirectly through their relationships with teacher support and inquiry orientation, or that their effects are redundant once the primary environmental factors are considered.

The demographic predictors remained significant even after controlling for environmental factors, indicating that grade level and gender effects on critical thinking are not entirely mediated by environmental differences. This finding suggests that developmental and individual difference factors

operate both directly and through environmental pathways to influence critical thinking development.

Moderation Analysis

Moderated regression analysis examined whether grade level moderates the relationship between classroom environment and critical thinking, testing the theoretical prediction that environmental influences vary with student developmental readiness. The analysis included grade level, classroom environment, and their interaction as predictors of critical thinking, with significant results supporting the moderation hypothesis.

The interaction term achieved statistical significance with $\beta = .187$ and $p = .024$, indicating that the strength of environment-critical thinking relationships differs significantly between first-year and second-year students. Simple slopes analysis revealed that environmental relationships are stronger among second-year students compared to first-year students, with standardized coefficients of $\beta = .579$ and $\beta = .392$ respectively.

This moderation effect provides important theoretical and practical insights. From a theoretical perspective, the finding supports Vygotsky's zone of proximal development concept, suggesting that environmental supports are most effective when matched to student developmental readiness. Advanced students may possess greater metacognitive awareness that enables them to recognize and utilize environmental supports more effectively.

From a practical perspective, the moderation effect suggests that environmental interventions may be most beneficial when timed appropriately with student development. First-year students may benefit from more structured environmental supports and explicit instruction in how to utilize classroom resources, while advanced students may be ready for more autonomous engagement with environmental opportunities.

The moderation effect also has implications for understanding the mixed results in previous research on environmental influences on critical thinking. Studies that do not consider developmental moderators may underestimate environmental effects by combining students at different readiness levels, while interventions that fail to account for developmental differences may show inconsistent results across student populations.

Discussion

This study provides robust empirical evidence for significant relationships between classroom environmental perceptions and critical thinking development among university students in educational innovation courses. The findings support theoretical predictions from social cognitive theory and constructivist learning principles while revealing important developmental and cultural considerations that inform both theory and educational practice. The results demonstrate that classroom environment factors, particularly teacher support and inquiry orientation, significantly predict critical thinking dispositions and explain substantial variance beyond demographic characteristics, with these

relationships moderated by academic development in ways that suggest environmental influences become more pronounced as students develop intellectual maturity.

Theoretical Integration and Implications

The strong positive correlation between classroom environment and critical thinking provides compelling support for Bandura's reciprocal determinism model, demonstrating that environmental factors account for approximately 30% of variance in critical thinking development. This finding indicates substantial but not overwhelming environmental influence, suggesting that while classroom conditions are important, they operate within a complex system of personal and behavioral factors that jointly determine cognitive outcomes. The classroom environment appears to function as a primary contextual factor influencing cognitive development through multiple pathways consistent with social cognitive theory, including environmental modeling mechanisms where teachers demonstrate analytical thinking and provide cognitive templates that students internalize, and reinforcement processes where supportive environments enhance self-efficacy for critical thinking.

The findings strongly support Vygotsky's constructivist principles, particularly the importance of social interaction and guided discovery in cognitive development. The relative importance of teacher support and inquiry orientation over peer-related factors suggests that instructor-mediated scaffolding may be more critical than peer collaboration for critical thinking development in higher education contexts. This pattern may reflect the developmental level of university students, who may benefit more from expert guidance than peer interaction, or cultural factors that emphasize teacher-student relationships in Asian educational contexts. The significant Grade × Environment interaction provides evidence for developmental readiness effects consistent with zone of proximal development theory, suggesting that environmental supports are most effective when matched to learner developmental stage.

The gender differences observed require interpretation within Thai educational and cultural contexts, as they may reflect cultural socialization patterns that encourage analytical questioning and intellectual assertiveness more strongly in males. Thai educational culture traditionally emphasizes respect for authority and harmonious relationships, values that may interact differently with critical thinking development for males and females. The specific dimensions showing gender differences, truth-seeking and analyticity, involve challenging existing ideas and systematic analysis, behaviors that may be more culturally encouraged in males. However, these patterns may evolve as educational practices continue developing toward more constructivist approaches that encourage critical thinking across all students.

Developmental Progression and Environmental Readiness

The substantial grade-level differences across all critical thinking dimensions provide strong evidence for developmental progression during university study, supporting theoretical models that emphasize cumulative intellectual growth through educational experiences. The uniform improvement

across dimensions suggests broad-based cognitive development rather than specific skill acquisition, indicating that second-year students may have developed greater tolerance for ambiguity, appreciation of complexity, and metacognitive awareness that support critical thinking across domains. This pattern aligns with Perry's intellectual development theory and suggests that university experiences accumulate to enhance thinking capabilities systematically through exposure to diverse perspectives, challenging coursework, and varied problem-solving opportunities.

The developmental moderation effects reveal important insights about optimal timing for environmental interventions. Second-year students showed stronger environment-critical thinking relationships, suggesting that environmental supports become more influential as students develop intellectual readiness to utilize them effectively. This finding has both theoretical and practical significance, supporting zone of proximal development principles while suggesting that environmental interventions should be adapted based on student developmental stage. First-year students may benefit from more structured environmental supports and explicit instruction in utilizing classroom resources, while advanced students may be ready for more autonomous engagement with environmental opportunities.

The specific pattern of environmental dimension relationships provides insights into mechanisms through which classroom factors influence critical thinking development. Teacher support emerged as the strongest predictor, suggesting that instructor relationships provide crucial psychological foundation for critical thinking by creating intellectual safety, supporting cognitive risk-taking, and encouraging expression of unconventional ideas. Inquiry orientation showed nearly equal importance, highlighting how questioning culture creates cognitive demand for higher-order thinking processes through investigation, hypothesis generation, and evidence evaluation activities.

Cultural Context and Cross-Cultural Implications

The findings reveal both universal patterns consistent with established theory and culture-specific variations that inform cross-cultural understanding of critical thinking development. The overall environmental effects align with international research, suggesting that supportive classroom conditions promote critical thinking across cultural contexts. However, the specific pattern of environmental relationships, particularly the prominence of teacher support over peer factors, may reflect Thai educational culture's emphasis on instructor-student relationships and hierarchical learning structures.

The gender differences, while statistically significant, should be interpreted cautiously within cultural context rather than as evidence of inherent cognitive differences. The specific dimensions showing gender effects, truth-seeking and analyticity, involve behaviors that may be more culturally encouraged in males within traditional Thai educational contexts. However, the absence of gender differences in open-mindedness, confidence, and inquisitiveness suggests that differences are specific rather than global, and may diminish as educational practices continue evolving toward more inclusive

approaches that encourage critical thinking development across all students.

The cultural adaptation of measurement instruments and successful validation within Thai higher education context represents an important methodological contribution, demonstrating that Western-developed constructs can be meaningfully measured across cultures when appropriate adaptation procedures are followed. The strong psychometric properties achieved suggest that critical thinking and classroom environment constructs have cross-cultural validity while allowing for culture-specific manifestations and relationships.

Practical Implications for Educational Practice

The findings provide concrete, evidence-based guidance for educational practitioners seeking to enhance critical thinking development through environmental modifications. The strong predictive power of teacher support suggests that faculty development focusing on relationship-building and instructional scaffolding should be a primary institutional priority. Teachers need preparation in creating psychologically safe environments, providing effective feedback, encouraging intellectual risk-taking, and modeling analytical thinking processes that students can observe and internalize.

The importance of inquiry orientation provides clear support for pedagogical approaches that emphasize questioning, investigation, and problem-based learning over traditional lecture-based instruction. Classrooms should be restructured to promote student questioning, provide opportunities for investigation and hypothesis testing, and create cognitive demand for evidence evaluation and synthesis. This finding supports current trends toward active learning pedagogies while providing specific evidence for their effectiveness in promoting critical thinking outcomes.

The developmental moderation effects have important implications for curriculum design and intervention timing. Environmental interventions may be most effective when developmental readiness is considered, with first-year students receiving more structured support and explicit instruction in utilizing environmental resources, while advanced students are provided with more autonomous learning opportunities. This finding suggests that critical thinking development programs should be differentiated based on student academic maturity rather than using uniform approaches across all levels.

The dimensional analysis reveals that not all environmental factors equally influence critical thinking, suggesting that institutional resources should be prioritized toward teacher support and inquiry orientation rather than distributed equally across all environmental dimensions. While factors such as student cohesion and classroom participation remain important for overall educational quality, they may have less direct impact on critical thinking development than instructor-mediated factors.

Limitations and Future Research Directions

The cross-sectional correlational design, while providing valuable insights into environment-thinking relationships, limits causal inferences about environmental effects on critical thinking development. While theoretical support and predictive modeling suggest environmental causation,

bidirectional relationships remain possible, with students possessing stronger critical thinking skills potentially perceiving environments more positively. Future research should employ longitudinal designs that follow students across multiple semesters to establish temporal precedence and examine developmental trajectories in critical thinking relative to environmental exposure.

The reliance on self-report measures for both critical thinking and classroom environment may inflate relationships due to common method variance, shared response tendencies, and perceptual biases. Future research should incorporate multiple assessment methods including behavioral observations, performance-based critical thinking tasks, and objective environmental measures to validate self-report findings and provide more comprehensive understanding of environment-thinking relationships.

The single-institution context limits generalizability to other cultural contexts, institutional types, and educational systems, particularly given the focus on educational innovation courses that may not represent typical university classroom environments. Cross-cultural replication studies using standardized measures across diverse contexts could establish universal principles versus culture-specific patterns, while multi-institutional research could examine how environmental relationships vary across different institutional characteristics and student populations.

Future experimental research could provide stronger causal evidence through randomized controlled trials manipulating specific classroom environmental factors. Such studies could identify optimal intervention components, dosage levels, and implementation strategies while controlling for confounding variables that limit correlational research. Component analysis research could examine which environmental factors are necessary versus sufficient for critical thinking development, informing efficient intervention design and resource allocation decisions.

Mechanism studies examining mediating processes such as student engagement, metacognitive awareness, motivation, and self-efficacy could clarify how classroom environments influence critical thinking development. Understanding these pathways would inform more targeted intervention design and help explain why certain environmental factors are more influential than others. Additionally, research examining technology integration, virtual learning environments, and post-pandemic educational changes could inform contemporary educational practice and policy development.

Conclusion and Implications

This study provides substantial empirical evidence for significant relationships between classroom environmental perceptions and critical thinking development, supporting theoretical predictions while revealing important developmental and cultural considerations. The findings demonstrate that environmental factors, particularly teacher support and inquiry orientation, significantly predict critical thinking dispositions and explain meaningful variance beyond demographic characteristics. The developmental moderation effects suggest that environmental

influences operate differently across student academic maturity levels, with implications for intervention timing and design.

The practical implications are substantial and actionable for educational institutions seeking to enhance student critical thinking capabilities. Universities should prioritize faculty development in supportive pedagogy and inquiry-based instruction, create institutional policies that support positive classroom climates, and design curricula that account for developmental differences in environmental readiness. The evidence suggests that systematic attention to classroom environmental factors represents a viable strategy for promoting critical thinking development at scale.

However, the cultural specificity of results and limitations of correlational design require continued research to establish causal relationships and cross-cultural generalizability. Future longitudinal and experimental studies could provide stronger evidence for environmental causation while examining optimal intervention strategies and implementation approaches. As higher education worldwide increasingly emphasizes critical thinking as essential for student success and societal progress, understanding how environmental factors can be modified to support its development becomes increasingly crucial for educational effectiveness and institutional accountability.

The ultimate contribution of this research lies in providing empirical evidence for specific, modifiable classroom characteristics that promote critical thinking development while acknowledging the complex interplay of developmental, cultural, and contextual factors that influence these relationships. The findings suggest that environmental interventions represent a promising approach for enhancing critical thinking, but must be implemented with attention to student developmental readiness, cultural context, and theoretical understanding of how environmental factors operate within broader systems of cognitive development.

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