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Research Paper

Critical Thinking Integration in Thai Secondary Schools: A Mixed-Methods Analysis of Pedagogical Transformation in Northeast Thailand's Educational Landscape[1]

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Abstract:

Background: Thailand's educational system faces mounting pressure to transition from traditional rote learning methodologies to critical thinking-centered approaches. Recent PISA 2022 results revealed Thai students scoring significantly below OECD averages, with particular concerns in northeastern provinces where educational resources remain limited.

Purpose: This mixed-methods study investigates the current state of critical thinking integration in secondary schools across northeast Thailand, examining teacher perceptions, implementation barriers, and student outcomes in the context of 21st-century educational transformation.

Methods: A convergent parallel mixed-methods design was employed across four northeastern provinces (Khon Kaen, Nakhon Ratchasima, Udon Thani, and Roi Et). Quantitative data were collected from 487 secondary school teachers through validated surveys measuring critical thinking teaching practices and self-efficacy. Qualitative insights were gathered through semi-structured interviews with 45 purposively selected educators and focus group discussions with 36 students.

Results: Statistical analysis revealed significant correlations between teacher training exposure and critical thinking implementation ($r = 0.672$, $p < 0.001$). Only 23.4% of teachers demonstrated high confidence in facilitating critical thinking activities, while 76.8% identified cultural barriers as primary implementation challenges. Thematic analysis uncovered five key implementation themes: hierarchical resistance, resource constraints, assessment misalignment, professional development needs, and cultural adaptation strategies.

Conclusions: The study reveals substantial gaps between policy intentions and classroom realities in critical thinking integration. Success requires comprehensive teacher development programs, culturally responsive pedagogical approaches, and systemic reforms addressing assessment practices and resource allocation.

Keywords: critical thinking, educational transformation, Thai education, mixed-methods research, pedagogical innovation, northeast Thailand

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1. INTRODUCTION

Thailand's educational landscape stands at a critical juncture where traditional pedagogical approaches increasingly clash with the demands of a knowledge-based economy and globally interconnected society. The Kingdom's educational system, historically grounded in hierarchical learning structures and memorization-based instruction, faces mounting pressure to develop students' critical thinking capabilities and 21st-century competencies (Aksornkool & Konawarathna, 2021). This challenge is particularly acute in Thailand's northeast region, where economic constraints, rural demographics, and limited educational resources compound the complexities of pedagogical transformation.

Recent international assessments underscore the urgency of educational reform. The Programme for International Student Assessment (PISA) 2022 results revealed troubling patterns in Thai student performance, with scores of 394 in mathematics, 379 in reading, and 409 in science—substantially below OECD averages of 472, 476, and 485 respectively (OECD, 2022). More concerning, Thailand experienced unprecedented declines across all domains, with reading performance dropping approximately 60 points since 2012, representing losses equivalent to more than an entire academic year of learning. These outcomes reflect systemic challenges in developing higher-order thinking skills that extend beyond content memorization to analytical reasoning and creative problem-solving.

The northeastern region of Thailand, comprising 20 provinces and representing approximately one-third of the nation's population, presents unique challenges and opportunities for educational transformation. Characterized by rural communities, agricultural economies, and limited infrastructure, this region has historically experienced educational disadvantages compared to urban centers like Bangkok and Chiang Mai (Panya & Thongsin, 2020). However, the region's strong cultural identity, community cohesion, and increasing connectivity through digital technologies create potential foundations for innovative educational approaches that balance global competency development with local cultural preservation.

Critical thinking, defined as the intellectually disciplined process of actively conceptualizing, applying, analyzing, synthesizing, and evaluating information gathered from observation, experience, reflection, reasoning, or communication, represents a fundamental competency for navigating contemporary challenges (Facione, 2020). In educational contexts, critical thinking encompasses not merely the ability to question and analyze information but also the disposition to engage thoughtfully with complex ideas, consider multiple perspectives, and construct reasoned arguments based on evidence. The integration of critical thinking into classroom instruction requires fundamental shifts in pedagogical approaches, moving from teacher-centered transmission models to student-centered inquiry-based learning environments.

The cultural dimensions of critical thinking implementation in Thai contexts present both challenges and opportunities. Traditional Thai educational culture, influenced by Buddhist principles of respect for authority and Confucian values emphasizing hierarchical relationships, has historically discouraged questioning and debate that are central to critical

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thinking development (Suwannoi & Pasiphol, 2021). Students learn early to respect teacher authority and avoid behaviors that might cause embarrassment or conflict, creating classroom dynamics that can inhibit the intellectual risk-taking necessary for critical thinking development.

However, deeper examination reveals potential compatibility between Thai cultural values and critical thinking principles. Buddhist emphasis on mindfulness, reflection, and understanding the nature of reality aligns with critical thinking's focus on careful observation, analysis, and evidence-based reasoning (Chantarasombat, 2020). Similarly, Thai cultural values of community cooperation and collective problem-solving can support collaborative critical thinking activities when appropriately structured and facilitated.

The COVID-19 pandemic has accelerated awareness of the need for educational transformation, as traditional instructional methods proved inadequate for online and hybrid learning environments. Teachers and students in northeast Thailand, like their counterparts globally, were forced to adapt rapidly to digital learning platforms that demanded greater self-direction, technological literacy, and adaptive thinking skills (Thongsin et al., 2021). This experience highlighted both the limitations of traditional approaches and the potential for innovative pedagogical practices when supported by appropriate resources and professional development.

Research on critical thinking development in Southeast Asian contexts reveals mixed results, with some studies suggesting cultural barriers to implementation while others demonstrate successful integration when approaches are culturally adapted and systematically implemented (Ku & Ho, 2020). The key appears to lie in finding pedagogical approaches that honor cultural values while creating opportunities for students to develop analytical and evaluative thinking skills within familiar and meaningful contexts.

Teacher preparation and professional development emerge as critical factors in successful critical thinking integration. Research consistently demonstrates that teachers who lack experience with critical thinking instruction often revert to familiar transmission-based approaches even when policy mandates emphasize innovative practices (Changwong et al., 2018). This pattern is particularly pronounced in contexts where teachers themselves were educated through traditional methods and have limited exposure to alternative pedagogical approaches.

The economic implications of educational transformation extend beyond individual student outcomes to encompass regional and national competitiveness. Thailand's economic development strategy, embodied in the Thailand 4.0 framework, emphasizes innovation, creativity, and high-value industries that require precisely the analytical and creative thinking skills that traditional educational approaches fail to develop (Sirisookslip et al., 2020). The northeastern region's economic development potential, particularly in agricultural innovation, renewable energy, and digital technologies, depends substantially on developing human capital with advanced cognitive capabilities.

This study addresses critical gaps in understanding how critical thinking integration occurs in practice within Thai educational contexts, particularly in regions facing resource

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constraints and cultural challenges. While previous research has examined critical thinking development in Thai higher education settings, limited empirical investigation has focused on secondary education implementation, especially in rural and semi-urban contexts where the majority of Thai students receive their education.

The research questions guiding this investigation emerged from the recognition that successful educational transformation requires understanding both the barriers that impede change and the strategies that enable successful implementation. By employing a mixed-methods approach that combines quantitative assessment of teacher practices and attitudes with qualitative exploration of lived experiences and cultural dynamics, this study aims to provide comprehensive insights into the current state of critical thinking integration and practical pathways for improvement.

2. LITERATURE REVIEW

2.1 Theoretical Foundations of Critical Thinking in Education

Critical thinking's integration into educational practice draws from multiple theoretical foundations that inform both its conceptualization and pedagogical implementation. Contemporary frameworks position critical thinking as a complex cognitive process involving analysis, evaluation, inference, interpretation, and explanation skills that can be developed through appropriate instruction and practice (Facione, 2020). The theoretical understanding has evolved from early conceptualizations focusing primarily on logical reasoning to more comprehensive models that incorporate metacognitive awareness, dispositions, and contextual factors.

Bloom's revised taxonomy places critical thinking skills—analysis, evaluation, and creation—at the highest levels of cognitive engagement, suggesting that these abilities represent the most sophisticated forms of learning (Anderson & Krathwohl, 2001). This hierarchical conceptualization has influenced educational practice by emphasizing the importance of moving beyond knowledge recall and comprehension to engage students in higher-order thinking activities. However, recent scholarship has questioned purely hierarchical models, arguing instead for interconnected approaches that recognize the complex interactions between different cognitive processes.

The dispositional aspects of critical thinking have gained increasing attention from researchers and educators who recognize that technical skills alone are insufficient for effective critical thinking (Facione et al., 2019). Critical thinking dispositions include truth-seeking, open-mindedness, analyticity, systematicity, critical thinking confidence, inquisitiveness, and maturity of judgment. These dispositions represent habits of mind that motivate individuals to apply critical thinking skills consistently and effectively across diverse contexts.

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Vygotsky's social constructivist theory provides important insights into critical thinking development, emphasizing the role of social interaction and cultural mediation in cognitive development (Vygotsky, 1978). From this perspective, critical thinking develops through collaborative engagement with others, guided participation in culturally meaningful activities, and gradual internalization of thinking processes initially encountered in social contexts. This theoretical foundation supports pedagogical approaches that emphasize collaborative learning, peer discussion, and scaffolded instruction.

2.2 Critical Thinking in Asian Educational Contexts

Research on critical thinking within Asian educational contexts has revealed complex relationships between cultural values, pedagogical traditions, and critical thinking development. Early scholarship suggested fundamental incompatibilities between Asian cultural values emphasizing respect for authority and critical thinking requirements for questioning and analysis (Ku & Ho, 2020). However, more recent research has challenged these simplistic characterizations, demonstrating that critical thinking can be successfully developed within diverse cultural frameworks when approaches are culturally responsive and appropriately adapted.

Studies from Singapore, South Korea, and Hong Kong demonstrate successful integration of critical thinking into educational systems with strong traditional foundations (Lau & Chan, 2019). These cases suggest that success requires careful attention to cultural values while creating structured opportunities for analytical thinking within respectful learning environments. Key strategies include framing critical thinking as collaborative inquiry rather than individual criticism, emphasizing evidence-based reasoning that honors different perspectives, and connecting analytical thinking to cultural values such as seeking truth and understanding.

Research specifically examining critical thinking in Thai educational contexts has revealed both challenges and opportunities. Changwong et al. (2018) found that Thai university students demonstrated limited critical thinking abilities, with particular weaknesses in analysis and evaluation skills. However, their research also indicated that targeted interventions focusing on explicit critical thinking instruction could produce significant improvements in student performance. Similarly, studies by Chantarasombat (2020) demonstrated that culturally adapted critical thinking instruction that incorporated Buddhist principles of mindful inquiry could enhance student engagement and learning outcomes.

The role of language in critical thinking development presents particular considerations in multilingual Asian contexts. Research suggests that critical thinking instruction in students' native language may be more effective than instruction in second languages, particularly during initial development phases (Lau & Chan, 2019). However, the global nature of knowledge and communication also requires developing critical thinking capabilities in international languages, creating pedagogical challenges for balancing local and global language requirements.

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2.3 Teacher Development and Pedagogical Transformation

Teacher preparation and professional development emerge as critical factors determining the success of critical thinking integration efforts. Research consistently demonstrates that teachers' pedagogical content knowledge, confidence in facilitating critical thinking activities, and experience with innovative instructional methods significantly influence their classroom implementation of critical thinking instruction (Changwong et al., 2018).

Studies examining teacher development for critical thinking instruction reveal several key principles for effective professional learning. First, teachers need explicit instruction in critical thinking concepts and processes, as many educators lack clear understanding of what critical thinking entails and how it differs from other cognitive activities (Abrami et al., 2015). Second, professional development must provide opportunities for teachers to experience critical thinking as learners, allowing them to understand the cognitive and emotional dimensions of analytical thinking from student perspectives.

Third, effective teacher development includes extensive practice with critical thinking instructional strategies, feedback on implementation attempts, and ongoing support for refinement of pedagogical approaches (Ku & Ho, 2020). Research demonstrates that one-time workshops or brief training sessions are insufficient for developing the complex pedagogical skills required for effective critical thinking instruction. Instead, sustained professional learning opportunities that extend over multiple months or years are necessary for meaningful change in teacher practice.

The cultural dimensions of teacher development present particular considerations in Thai contexts. Research by Suwannoi and Pasiphol (2021) found that Thai teachers often experience tension between traditional pedagogical roles emphasizing knowledge transmission and innovative roles requiring facilitation and questioning. Professional development programs that acknowledge these cultural tensions while providing practical strategies for gradual pedagogical transformation appear more successful than approaches that demand immediate wholesale changes in teaching practice.

2.4 Assessment and Critical Thinking

The assessment of critical thinking presents significant challenges for educational systems accustomed to traditional testing methods that emphasize content recall and procedural knowledge. Critical thinking assessment requires approaches that can capture complex cognitive processes, evaluate reasoning quality, and assess dispositions and metacognitive awareness in addition to technical skills (Abrami et al., 2015).

Performance-based assessment approaches, including portfolio assessments, extended written responses, and collaborative problem-solving tasks, offer more authentic measures of critical thinking capabilities than traditional multiple-choice examinations (Facione, 2020). However, these assessment methods require substantial changes in teacher preparation, scoring procedures, and institutional policies, making their implementation particularly challenging in highly standardized educational systems.

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Research on critical thinking assessment in Asian contexts reveals additional complexities related to cultural factors and language considerations. Studies suggest that assessment approaches emphasizing individual performance and competitive evaluation may conflict with cultural values emphasizing collective achievement and face-saving behaviors (Lau & Chan, 2019). Alternative assessment strategies that incorporate peer evaluation, group reflection, and collaborative analysis appear more culturally appropriate while still providing meaningful information about critical thinking development.

2.5 Technology and Critical Thinking Integration

The role of technology in supporting critical thinking development has gained increasing attention as digital tools become more prevalent in educational settings. Research suggests that technology can enhance critical thinking instruction by providing access to diverse information sources, enabling sophisticated analysis and visualization, and facilitating collaboration across geographic boundaries (Changwong et al., 2018).

However, technology integration for critical thinking development requires careful pedagogical planning to ensure that digital tools enhance rather than replace deep thinking processes. Studies indicate that technology use focused primarily on information consumption or entertainment may actually inhibit critical thinking development, while technology applications that require analysis, evaluation, and creation can support higher-order thinking skills (Abrami et al., 2015).

The COVID-19 pandemic provided natural experiments in technology-enhanced critical thinking instruction as educators worldwide rapidly adapted to online learning environments. Research from Thai contexts suggests that while initial adaptations were challenging, many teachers recognized opportunities for innovative pedagogical approaches that supported critical thinking development through digital collaboration and inquiry-based learning (Thongsin et al., 2021).

3. RESEARCH QUESTIONS

Based on the literature review and identified research gaps, this study addresses the following research questions:

Primary Research Question: How do secondary school teachers in northeast Thailand currently integrate critical thinking into their instructional practices, and what factors influence successful implementation?

Secondary Research Questions:

1. What is the current level of critical thinking integration in secondary schools across four northeastern provinces?
2. What are teachers' perceptions of their preparedness and confidence in facilitating critical thinking instruction?

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3. What barriers do teachers identify as most significant in implementing critical thinking approaches?

4. How do cultural factors influence critical thinking integration in Thai classroom contexts?

5. What strategies do successful teachers employ to overcome implementation challenges?

6. How do student experiences and perceptions relate to teachers' critical thinking integration efforts?

4. RESEARCH OBJECTIVES

4.1 Primary Objective

To examine the current state of critical thinking integration in secondary education across four northeastern Thai provinces, identifying implementation patterns, barriers, and success factors through mixed-methods analysis.

4.2 Secondary Objectives

1. To assess the extent of critical thinking integration in classroom practices among secondary school teachers

2. To evaluate teacher confidence and self-efficacy in implementing critical thinking instruction

3. To identify and analyze barriers to critical thinking integration from teacher and student perspectives

4. To explore cultural factors that influence critical thinking implementation in Thai educational contexts

5. To document successful strategies and practices employed by teachers effectively integrating critical thinking

6. To examine relationships between teacher characteristics, training experiences, and critical thinking implementation levels

7. To provide evidence-based recommendations for improving critical thinking integration in Thai secondary education

5. METHODOLOGY

5.1 Research Design

This study employed a convergent parallel mixed-methods design, collecting and analyzing quantitative and qualitative data simultaneously to provide comprehensive

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understanding of critical thinking integration in northeast Thailand's secondary schools (Creswell & Plano Clark, 2018). The mixed-methods approach was selected to capture both the breadth of implementation patterns across the region and the depth of lived experiences that influence pedagogical transformation.

The quantitative component utilized a cross-sectional survey design to assess critical thinking integration practices, teacher self-efficacy, and implementation barriers across a representative sample of secondary school teachers. The qualitative component employed phenomenological inquiry through semi-structured interviews and focus group discussions to explore deeper meanings, cultural influences, and contextual factors affecting critical thinking implementation.

5.2 Research Setting and Participants

The study was conducted across four northeastern provinces of Thailand: Khon Kaen, Nakhon Ratchasima, Udon Thani, and Roi Et. These provinces were selected to represent diverse geographic, economic, and demographic characteristics within the northeastern region. Khon Kaen and Nakhon Ratchasima represent larger urban centers with universities and industrial development, while Udon Thani and Roi Et represent smaller cities with predominantly agricultural economies.

5.2.1 Quantitative Sample

The quantitative sample comprised 487 secondary school teachers from 64 schools across the four provinces. Sample size was calculated using G*Power 3.1.9 software with effect size of 0.3, alpha level of 0.05, and statistical power of 0.80, yielding a minimum required sample of 469 participants. Stratified random sampling ensured proportional representation across provinces, school types (public/private), and teaching subjects.

Participant demographics revealed 68.4% female teachers, mean age of 36.7 years (SD = 8.2), and mean teaching experience of 11.3 years (SD = 7.8). Subject area distribution included 23.6% mathematics teachers, 21.8% science teachers, 19.2% Thai language teachers, 16.4% social studies teachers, 11.7% English teachers, and 7.3% other subjects.

5.2.2 Qualitative Sample

The qualitative sample included 45 teachers selected through purposive sampling to represent diverse implementation levels, teaching subjects, and school contexts. Additionally, 36 students from six focus groups provided perspectives on critical thinking integration experiences. Qualitative participants were selected based on survey responses, teaching experience, and willingness to participate in extended interviews.

5.3 Data Collection Instruments

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5.3.1 Critical Thinking Teaching Practices Survey (CTTPS)

A validated instrument adapted from Abrami et al. (2015) and culturally adapted for Thai contexts measured teachers' critical thinking integration practices. The survey comprised four subscales: (1) instructional practices (12 items), (2) self-efficacy beliefs (10 items), (3) perceived barriers (8 items), and (4) cultural factors (6 items). Items used 5-point Likert scales ranging from "never" (1) to "always" (5).

Pilot testing with 64 teachers established internal consistency reliability with Cronbach's alpha coefficients of 0.89 for instructional practices, 0.87 for self-efficacy, 0.83 for barriers, and 0.81 for cultural factors. Confirmatory factor analysis supported the four-factor structure with good model fit indices ($\chi^2/df = 2.14$, CFI = 0.94, RMSEA = 0.067).

5.3.2 Semi-Structured Interview Protocol

Interview protocols explored teachers' experiences with critical thinking integration, implementation challenges, successful strategies, and cultural considerations. Questions included: "Describe how you incorporate critical thinking into your teaching," "What challenges do you face in implementing critical thinking approaches?" and "How do Thai cultural values influence your teaching of critical thinking?"

5.3.3 Student Focus Group Protocol

Student focus groups examined perceptions of critical thinking activities, learning experiences, and cultural factors affecting classroom participation. Questions explored students' understanding of critical thinking, preferences for different instructional approaches, and comfort levels with questioning and analytical activities.

5.4 Data Collection Procedures

Data collection occurred between March and July 2022, following approval from Khon Kaen University's Human Research Ethics Committee. School principals provided site permissions, and all participants provided informed consent. Survey data were collected through online platforms with paper alternatives for teachers with limited internet access. Interviews and focus groups were conducted face-to-face in Thai language, audio-recorded with participant permission, and professionally transcribed.

5.5 Data Analysis

5.5.1 Quantitative Analysis

Quantitative data were analyzed using SPSS 28.0 with descriptive statistics, correlation analysis, and multiple regression analysis. Missing data (< 3% for all variables) were handled through pairwise deletion. Assumptions for parametric tests were verified through normality tests, homoscedasticity assessment, and multicollinearity diagnostics.

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Multiple regression analysis examined relationships between teacher characteristics (age, experience, subject area, training exposure) and critical thinking integration levels. Hierarchical regression models controlled for demographic variables before adding training and cultural factors.

5.5.2 Qualitative Analysis

Qualitative data were analyzed using thematic analysis following Braun and Clarke's (2019) six-phase approach. Interview transcripts were coded inductively to identify patterns and themes related to critical thinking integration experiences. Cross-case analysis identified common themes across participants and contexts.

NVivo 12 software supported data organization and theme development. Two researchers independently coded 20% of transcripts to establish inter-rater reliability, achieving Cohen's kappa of 0.82. Themes were refined through iterative analysis and member checking with selected participants.

5.5.3 Mixed-Methods Integration

Quantitative and qualitative findings were integrated through comparison and contrast of results, identification of convergent and divergent patterns, and development of meta-inferences combining both data types. Joint displays visualized relationships between quantitative results and qualitative themes.

5.6 Ethical Considerations

The study received ethical approval from Khon Kaen University's Human Research Ethics Committee (HE651275). All participants provided written informed consent, with particular attention to voluntary participation and withdrawal rights. Student participants provided assent with parental consent. Data confidentiality was maintained through anonymization and secure storage protocols.

5.7 Validity and Reliability

Quantitative validity was established through instrument pilot testing, confirmatory factor analysis, and construct validation. Qualitative trustworthiness was ensured through triangulation of data sources, member checking, peer debriefing, and thick description of contexts and experiences.

Mixed-methods validity was addressed through timing considerations, sample relatedness, and equal emphasis on both quantitative and qualitative components. Integration validity was supported through careful comparison of findings and transparent reporting of convergent and divergent results.

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6. RESULTS

6.1 Quantitative Results

6.1.1 Critical Thinking Integration Levels

Analysis of the Critical Thinking Teaching Practices Survey revealed significant variations in implementation levels across the northeastern region. The overall mean score for critical thinking instructional practices was 2.84 (SD = 0.73) on a 5-point scale, indicating moderate levels of integration. However, only 23.4% of teachers (n = 114) scored above 3.5, suggesting high implementation levels, while 41.7% (n = 203) scored below 2.5, indicating limited integration.

Provincial analysis revealed significant differences in implementation levels ($F(3,483) = 12.47$, $p < 0.001$). Post-hoc Tukey tests indicated that Khon Kaen teachers demonstrated significantly higher integration levels ($M = 3.12$, $SD = 0.68$) compared to Roi Et ($M = 2.67$, $SD = 0.71$, $p < 0.001$) and Udon Thani ($M = 2.73$, $SD = 0.69$, $p < 0.01$). Nakhon Ratchasima teachers showed intermediate levels ($M = 2.91$, $SD = 0.78$).

Subject area analysis revealed significant differences ($F(5,481) = 8.23$, $p < 0.001$), with English teachers reporting highest integration levels ($M = 3.21$, $SD = 0.64$), followed by social studies ($M = 3.08$, $SD = 0.71$) and science teachers ($M = 2.94$, $SD = 0.73$). Mathematics teachers reported lower levels ($M = 2.68$, $SD = 0.76$), while Thai language teachers showed moderate integration ($M = 2.79$, $SD = 0.75$).

6.1.2 Teacher Self-Efficacy in Critical Thinking Instruction

Self-efficacy scores revealed concerning patterns in teacher confidence levels. The mean self-efficacy score was 2.97 (SD = 0.81), with only 31.2% of teachers (n = 152) reporting high confidence levels (scores > 3.5). Analysis of individual items revealed that teachers felt least confident in "facilitating student debates and discussions" ($M = 2.41$, $SD = 1.02$) and "designing authentic assessment for critical thinking" ($M = 2.38$, $SD = 0.97$).

Correlation analysis revealed significant positive relationships between self-efficacy and implementation levels ($r = 0.672$, $p < 0.001$), suggesting that confident teachers were more likely to integrate critical thinking approaches. Professional development exposure showed moderate correlations with both self-efficacy ($r = 0.487$, $p < 0.001$) and implementation ($r = 0.521$, $p < 0.001$).

6.1.3 Implementation Barriers

Analysis of perceived barriers revealed that 76.8% of teachers identified cultural factors as significant implementation challenges. The highest-rated barriers included "students' reluctance to question or challenge ideas" ($M = 3.92$, $SD = 0.88$), "pressure to cover extensive curriculum content" ($M = 3.84$, $SD = 0.94$), and "lack of appropriate instructional materials" ($M = 3.76$, $SD = 1.01$).

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Factor analysis of barrier items revealed three underlying dimensions: cultural/social barriers (explaining 34.2% of variance), systemic/structural barriers (22.8% of variance), and resource/capacity barriers (18.6% of variance). These factors demonstrated significant negative correlations with implementation levels ($r = -0.543$, -0.467, and -0.392 respectively, all $p < 0.001$).

6.1.4 Professional Development Impact

Teachers who participated in critical thinking-related professional development ($n = 178$, 36.6%) demonstrated significantly higher implementation scores compared to those without such training ($M = 3.24$ vs. 2.61, $t(485) = 8.47$, $p < 0.001$, Cohen's $d = 0.89$). However, only 23.2% of teachers reported receiving comprehensive training (> 20 hours), while 41.7% had minimal exposure (< 5 hours).

Multiple regression analysis examining predictors of critical thinking integration revealed that professional development exposure ($\beta = 0.387$, $p < 0.001$), self-efficacy beliefs ($\beta = 0.312$, $p < 0.001$), and teaching experience ($\beta = 0.184$, $p < 0.01$) were significant positive predictors, while perceived cultural barriers were significant negative predictors ($\beta = -0.267$, $p < 0.001$). The model explained 58.3% of variance in implementation levels ($R^2 = 0.583$, $F(7,479) = 95.42$, $p < 0.001$).

6.2 Qualitative Results

6.2.1 Implementation Challenges and Cultural Dynamics

Thematic analysis of interview data revealed five primary themes related to critical thinking implementation: (1) hierarchical resistance, (2) resource constraints, (3) assessment misalignment, (4) professional development needs, and (5) cultural adaptation strategies.

Hierarchical Resistance: Teachers consistently described challenges related to traditional authority structures that discourage student questioning and analysis. A mathematics teacher from Roi Et explained: "Students are taught from young age to respect teacher's knowledge without questioning. When I ask them to analyze different problem-solving approaches, they look confused and ask 'Which way is correct?' They want the single right answer, not to think about multiple possibilities."

Students themselves acknowledged these dynamics. A focus group participant from Udon Thani noted: "We are uncomfortable when teacher asks us to disagree with textbook or give different opinion. It feels disrespectful, even when teacher says it's okay."

Resource Constraints: Rural schools faced particular challenges in accessing materials and technology supporting critical thinking instruction. A science teacher from a small district in Nakhon Ratchasima described: "I want to have students research environmental issues online and create presentations, but our internet is unreliable and we have only few computers. I must use traditional methods because resources are not available."

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Assessment Misalignment: Teachers expressed frustration with assessment systems that prioritized content recall over critical thinking skills. An English teacher from Khon Kaen explained: "I teach students to analyze literature and think critically about themes, but O-NET exam asks for factual recall and grammar rules. Students and parents worry that critical thinking activities take time away from test preparation."

6.2.2 Successful Implementation Strategies

Despite challenges, some teachers had developed effective strategies for integrating critical thinking within Thai cultural contexts. Analysis revealed several key approaches:

Cultural Bridging: Successful teachers framed critical thinking as collaborative inquiry rather than individual criticism. A social studies teacher described: "Instead of asking students to criticize government policies, I ask them to work in groups to research different perspectives and present findings respectfully. This way they develop analytical skills while maintaining harmony."

Gradual Introduction: Effective implementers introduced critical thinking elements gradually, building student comfort with questioning and analysis over time. A science teacher explained: "First semester, I ask simple questions like 'What do you observe?' Later, I ask 'Why might this happen?' and 'What evidence supports this explanation?' Students become more comfortable with thinking deeply."

Local Contextualization: Teachers who successfully integrated critical thinking often connected analytical activities to local issues and cultural contexts. An English teacher described using local environmental issues as subjects for critical analysis: "Students analyze water pollution in our province, interview community members, and propose solutions. They engage more because it affects their families directly."

6.2.3 Student Perspectives and Experiences

Student focus groups revealed complex relationships with critical thinking activities. While students initially expressed discomfort with questioning and analysis, many recognized the value of these skills for their future success.

A student from Khon Kaen explained: "At first, I was scared to give my opinion because I might be wrong and lose face. But after practice, I understand that thinking carefully about problems helps me learn better and prepare for university."

However, students also identified barriers to engagement, including concerns about peer judgment and uncertainty about teacher expectations. A student from Roi Et noted: "Sometimes we don't understand what teacher wants when asking for our thinking. Are there right answers? Can we disagree with classmates? Clear guidance helps us participate more."

6.3 Integrated Mixed-Methods Findings

Integration of quantitative and qualitative results revealed several key patterns and insights:

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6.3.1 Professional Development Imperative

Both quantitative correlation analysis ($r = 0.521$, $p < 0.001$) and qualitative themes consistently identified professional development as crucial for successful implementation. Teachers with training demonstrated higher confidence and more frequent use of critical thinking approaches, while interviews revealed that untrained teachers often misunderstood critical thinking concepts or lacked practical implementation strategies.

6.3.2 Cultural Adaptation Necessity

Quantitative results showing cultural barriers as the most frequently cited implementation challenge (76.8% of teachers) aligned with qualitative themes emphasizing the need for culturally responsive approaches. Successful teachers described strategies that honored Thai values while developing analytical skills, suggesting that cultural adaptation rather than cultural abandonment is essential.

6.3.3 Systemic Reform Requirements

Both data types revealed that individual teacher efforts alone were insufficient for comprehensive critical thinking integration. Quantitative results showing assessment pressures as major barriers aligned with qualitative descriptions of system-level conflicts between critical thinking goals and traditional evaluation methods.

7. DISCUSSION

7.1 Current State of Critical Thinking Integration

The findings reveal a significant gap between educational policy aspirations and classroom realities in northeast Thailand's secondary schools. While national curricula and policy documents emphasize critical thinking development, the mean implementation score of 2.84 indicates that most teachers are implementing critical thinking approaches only occasionally or at surface levels. This finding aligns with previous research by Changwong et al. (2018) suggesting that systemic barriers and limited teacher preparation constrain meaningful pedagogical transformation.

The provincial variations in implementation levels provide important insights into factors that support or inhibit critical thinking integration. Khon Kaen's significantly higher implementation levels likely reflect the province's university presence, greater access to professional development opportunities, and more diverse economic base that creates demand for analytical thinking skills. These patterns suggest that successful critical thinking integration requires supportive educational ecosystems that extend beyond individual schools to encompass community resources, economic opportunities, and institutional support structures.

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Subject area differences reveal important disciplinary considerations for critical thinking integration. English teachers' higher implementation levels may reflect the communicative nature of language learning that naturally incorporates discussion, analysis, and multiple perspective consideration. Mathematics teachers' lower scores align with traditional approaches emphasizing procedural knowledge and standardized solution methods, suggesting particular challenges for integrating critical thinking into highly structured content areas.

7.2 Professional Development and Teacher Preparedness

The strong correlation between professional development exposure and critical thinking implementation ($r = 0.521$, $p < 0.001$) underscores the critical importance of comprehensive teacher preparation for successful pedagogical transformation. However, the finding that only 36.6% of teachers had received any critical thinking-related training, with merely 23.2% experiencing comprehensive preparation, reveals substantial gaps in professional development provision.

The relationship between teacher self-efficacy and implementation levels ($r = 0.672$, $p < 0.001$) aligns with social cognitive theory's emphasis on efficacy beliefs as determinants of effort and persistence in challenging situations (Bandura, 2006). Teachers who lack confidence in facilitating critical thinking activities are unlikely to attempt these approaches consistently, even when they understand their theoretical importance. This finding suggests that effective professional development must address both knowledge and confidence dimensions through experiential learning and ongoing support.

Qualitative insights reveal that many teachers lack clear understanding of what critical thinking instruction entails, often conflating it with simply asking more questions or assigning open-ended tasks. This conceptual confusion reflects inadequate teacher preparation programs that may mention critical thinking without providing concrete strategies for classroom implementation. Successful professional development initiatives must begin with clear conceptual foundations before progressing to practical implementation strategies.

7.3 Cultural Factors and Adaptation Strategies

The identification of cultural barriers by 76.8% of teachers as significant implementation challenges confirms previous research highlighting tensions between traditional Thai educational culture and critical thinking requirements (Suwannoi & Pasiphol, 2021). However, the qualitative findings provide more nuanced understanding of these cultural dynamics, revealing both challenges and opportunities for culturally responsive critical thinking integration.

The hierarchical resistance theme reflects deep-seated cultural patterns that extend beyond educational settings to encompass broader social relationships and communication norms. Students' reluctance to question authority or express disagreement stems from cultural values emphasizing harmony, respect, and face-saving that are fundamental to Thai social

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identity. However, the successful strategies documented in this study demonstrate that critical thinking can be developed within these cultural parameters when approached thoughtfully.

The "cultural bridging" strategies employed by successful teachers illustrate how critical thinking can be reframed as collaborative inquiry that honors cultural values while developing analytical capabilities. By emphasizing group investigation, respectful exploration of multiple perspectives, and evidence-based reasoning rather than confrontational debate, teachers can create learning environments that feel culturally appropriate while fostering critical thinking development.

The Buddhist philosophical foundations that influence Thai culture actually provide potential support for critical thinking development when properly understood and applied. Buddhist emphasis on mindful observation, questioning the nature of reality, and seeking understanding through investigation aligns well with critical thinking principles (Chantarasombat, 2020). Teachers who understand these connections can frame critical thinking activities as consistent with rather than opposed to Thai cultural values.

7.4 Systemic Barriers and Reform Implications

The assessment misalignment theme emerging from qualitative analysis reflects broader systemic challenges that extend beyond individual teacher practices to encompass institutional structures, policy frameworks, and societal expectations. The continued emphasis on standardized testing that prioritizes content recall creates powerful incentives for traditional teaching approaches, even when teachers understand the importance of critical thinking development.

The resource constraints documented in this study, particularly affecting rural schools, highlight equity issues that compound the challenges of educational transformation. Schools lacking reliable internet connectivity, adequate library resources, and modern instructional materials face additional barriers to implementing inquiry-based learning approaches that support critical thinking development. These disparities risk creating or exacerbating educational inequalities between urban and rural areas.

The bureaucratic and administrative barriers identified by teachers reflect structural impediments within Thailand's highly centralized educational system. While centralization has historically ensured consistency and quality control, it may also limit the flexibility necessary for pedagogical innovation. Successful critical thinking integration may require greater autonomy for schools and teachers to adapt curricula and instructional approaches to local contexts and student needs.

7.5 Student Perspectives and Engagement

Student focus group findings provide crucial insights into the learner experience of critical thinking integration efforts. The initial discomfort expressed by students when asked to engage in questioning and analysis reflects deeply internalized cultural patterns learned

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from early childhood. However, students' recognition of the value of these skills for future success suggests potential for transformation when approached gradually and supportively.

The student request for clearer guidance about expectations and acceptable forms of participation highlights the importance of explicit instruction in critical thinking processes and norms. Students accustomed to clearly defined right and wrong answers may struggle in learning environments that emphasize process over product and multiple valid perspectives over single correct solutions. Teachers implementing critical thinking approaches must provide scaffolding that helps students develop comfort with ambiguity and intellectual risk-taking.

The finding that students engaged more readily with critical thinking activities connected to local contexts and personal experiences aligns with constructivist learning principles emphasizing the importance of meaningful, relevant learning opportunities (Vygotsky, 1978). This suggests that successful critical thinking integration should connect analytical activities to students' lived experiences and community contexts rather than relying solely on abstract or distant examples.

7.6 Technology Integration and Digital Literacy

While not a primary focus of this study, the technology-related themes emerging from qualitative analysis deserve attention given their relevance for 21st-century skill development. The resource constraints affecting rural schools' technology access highlight digital divide issues that may exacerbate educational inequalities. However, the COVID-19 pandemic experience suggests potential for creative technology integration when teachers receive appropriate support and training.

The successful integration of technology for critical thinking development requires moving beyond simple tool adoption to consider how digital resources can enhance analytical thinking processes. Online research capabilities, collaborative platforms, and multimedia creation tools can support critical thinking when integrated within pedagogically sound instructional frameworks. However, teachers need professional development in both technical skills and pedagogical applications to use technology effectively for critical thinking development.

7.7 Implications for Educational Policy and Practice

The findings have significant implications for educational policy development and implementation in Thailand. First, comprehensive teacher professional development programs must be established that provide sustained, job-embedded learning opportunities focused on critical thinking instruction. These programs should combine conceptual understanding with practical implementation strategies and ongoing classroom support.

Second, assessment and accountability systems require fundamental reform to align with critical thinking development goals. This may include developing alternative assessment approaches that capture analytical thinking processes, revising standardized testing to include

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higher-order thinking items, and establishing accountability measures that value process and growth alongside achievement outcomes.

Third, resource allocation policies must address equity concerns by ensuring that all schools have basic infrastructure and materials necessary for implementing innovative pedagogical approaches. This includes reliable internet connectivity, adequate library resources, and modern instructional materials that support inquiry-based learning.

Fourth, curriculum policies should provide greater flexibility for local adaptation while maintaining quality standards. This might include reducing excessive content requirements that prevent depth of learning, allowing schools to customize instructional approaches based on local contexts, and encouraging interdisciplinary connections that support critical thinking development.

7.8 Limitations and Future Research Directions

Several limitations should be acknowledged in interpreting these findings. First, the cross-sectional design captures implementation patterns at a single point in time, limiting understanding of change processes and development trajectories. Longitudinal research following teachers and students over multiple years would provide valuable insights into implementation evolution and sustainability.

Second, while the study included four northeastern provinces, findings may not generalize to other regions with different economic, cultural, or educational characteristics. Comparative research across different Thai regions would enhance understanding of contextual factors affecting critical thinking integration.

Third, the reliance on self-reported implementation levels from teachers may overestimate actual classroom practices due to social desirability bias. Future research should include classroom observation data to triangulate teacher reports with observed practices.

Fourth, the focus on teacher and student perspectives provides valuable insights but does not capture administrator, parent, or community viewpoints that may influence implementation success. Broader stakeholder studies would provide more comprehensive understanding of implementation contexts.

Future research should investigate specific professional development models that effectively prepare teachers for critical thinking instruction in Thai contexts. Experimental or quasi-experimental designs comparing different preparation approaches would provide evidence for scaling successful programs. Additionally, research examining the long-term impacts of critical thinking integration on student outcomes, including academic achievement, problem-solving capabilities, and post-secondary success, would strengthen the case for educational transformation.

Investigation of successful school models that have effectively integrated critical thinking within Thai cultural contexts would provide practical examples for broader implementation. Case study research examining whole-school transformation efforts would illuminate organizational factors supporting sustained change.

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Finally, research examining the economic and social impacts of critical thinking education on communities and regions would provide evidence for the broader benefits of educational transformation beyond individual student outcomes.

8. CONCLUSION

This mixed-methods investigation of critical thinking integration in northeast Thailand's secondary schools reveals significant gaps between educational policy aspirations and classroom realities. While teachers recognize the importance of developing students' analytical thinking capabilities, systemic barriers, cultural challenges, and inadequate professional preparation limit meaningful implementation of critical thinking approaches.

The finding that only 23.4% of teachers demonstrate high levels of critical thinking integration, combined with concerning patterns in teacher confidence and professional development exposure, underscores the urgent need for comprehensive educational reform. However, the documented success strategies and student receptiveness to appropriately implemented critical thinking activities demonstrate that transformation is achievable when approached thoughtfully and systematically.

The study's key contributions include empirical documentation of implementation patterns across a representative regional sample, identification of specific barriers and success factors through teacher and student voices, and demonstration of relationships between professional development, cultural factors, and implementation outcomes. These findings provide evidence-based foundations for policy development and professional practice improvement.

The cultural adaptation strategies documented in this research offer particular value for educational contexts seeking to balance traditional values with innovative pedagogical approaches. The demonstration that critical thinking can be developed within respectful, collaborative learning environments suggests pathways for transformation that honor cultural identity while preparing students for global citizenship.

The professional development imperative emerging from both quantitative and qualitative findings indicates that successful educational transformation requires substantial investment in teacher preparation and ongoing support. The strong relationships between training exposure, self-efficacy beliefs, and implementation levels suggest that comprehensive professional development programs could significantly improve critical thinking integration across the region.

However, individual teacher development alone is insufficient for systematic transformation. The systemic barriers documented in this study, including assessment misalignment, resource constraints, and administrative impediments, require policy-level interventions that address structural factors limiting pedagogical innovation. Successful critical thinking integration demands coherent reform efforts that align multiple system components toward common goals.

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The equity implications revealed through provincial and resource availability differences highlight the importance of ensuring that educational transformation benefits all students regardless of geographic location or economic circumstances. Rural schools and economically disadvantaged communities require particular attention to prevent critical thinking education from becoming another source of educational inequality.

Looking forward, Thailand's educational system has the opportunity to become a regional model for culturally responsive critical thinking integration that prepares students for 21st-century challenges while preserving cultural values and social cohesion. Realizing this potential requires sustained commitment from educators, policymakers, and communities working together toward shared visions of educational excellence.

The transformation from traditional to critical thinking-centered education represents more than pedagogical change; it embodies Thailand's commitment to developing citizens capable of thoughtful analysis, creative problem-solving, and constructive engagement with complex challenges. The evidence from northeast Thailand suggests that this transformation is both necessary and achievable when approached with strategic planning, cultural sensitivity, and sustained commitment to improvement.

The implications extend beyond Thailand's borders to inform broader discussions about educational transformation in contexts balancing traditional cultural values with global competency requirements. The strategies and insights documented in this research may prove valuable for other educational systems navigating similar transformation challenges.

Ultimately, the success of critical thinking integration efforts will be measured not only by improved test scores or enhanced pedagogical practices but by the development of thoughtful, capable citizens prepared to contribute meaningfully to their communities and the broader world. The foundations for this success exist within Thailand's educational system and cultural values; what remains is the collective will and sustained effort necessary to build upon these foundations toward comprehensive transformation.

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APPENDICES

Appendix A: Ethical Approval

This study received ethical approval from Khon Kaen University's Human Research Ethics Committee (Protocol Number: HE651275, approved March 15, 2022). All procedures followed institutional guidelines for human subject's research, including informed consent protocols, voluntary participation assurance, and data confidentiality protection.

Participant Rights and Protections:

- Voluntary participation with right to withdraw without penalty
- Informed consent with clear explanation of research purposes and procedures
- Confidentiality protection through data anonymization and secure storage
- Minimal risk assessment with appropriate safeguards for emotional wellbeing
- Student participant protections including parental consent and age-appropriate procedures

Data Management and Security:

- Secure digital storage with password protection and encryption
- Limited access to research team members only
- Data retention period of five years following publication
- Anonymization procedures removing all identifying information
- Destruction protocols for sensitive materials following retention period

Appendix B: Funding Declaration

This research was conducted as an independent scholarly investigation without external funding from governmental, institutional, or commercial sources. All research expenses, including data collection costs, transcription services, and analysis software, were supported through the principal investigator's personal resources and standard university research allocations.

Funding Status: No external funding received Institutional Support: Standard university research resources (library access, statistical software licenses, ethics review) Conflict of Interest: No financial or professional conflicts of interest to declare Independence: Research design, data collection, analysis, and reporting conducted independently without external influence or constraints

Appendix C: Data Collection Instruments

C.1 Critical Thinking Teaching Practices Survey (Sample Items)

Instructional Practices Subscale (12 items)

1. I ask students to analyze different perspectives on controversial topics
2. I encourage students to question information presented in textbooks

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3. I design activities that require students to evaluate evidence quality
4. I use collaborative problem-solving activities in my classes
5. I ask students to explain their reasoning processes

Self-Efficacy Subscale (10 items)

1. I am confident in my ability to facilitate critical thinking discussions
2. I can effectively guide students through analytical thinking processes
3. I am skilled at designing authentic assessments for critical thinking
4. I can adapt critical thinking activities for different ability levels
5. I feel prepared to address student questions about complex issues

Barriers Subscale (8 items)

1. Students are reluctant to question or challenge ideas presented in class
2. Pressure to cover extensive curriculum content limits time for critical thinking
3. Lack of appropriate instructional materials hampers critical thinking integration
4. Parent expectations focus on test scores rather than thinking skills
5. School administrators do not support innovative teaching methods

Cultural Factors Subscale (6 items)

1. Thai cultural values make it difficult to implement critical thinking approaches
2. Students' respect for authority inhibits questioning and analysis behaviors
3. Traditional teaching methods are more appropriate for Thai students
4. Critical thinking can be developed while maintaining cultural values
5. Thai Buddhist principles support reflective and analytical thinking

C.2 Interview Protocol for Teachers

Opening Questions:

1. How long have you been teaching, and what subjects do you currently teach?
2. How would you define critical thinking in your own words?
3. Can you describe how you typically incorporate critical thinking into your lessons?

Implementation Experience: 4. What specific strategies or activities do you use to develop students' critical thinking skills? 5. Can you give me an example of a successful critical thinking lesson you've taught recently? 6. What challenges do you face when trying to implement critical thinking approaches? 7. How do your students typically respond to critical thinking activities?

Cultural Considerations: 8. How do Thai cultural values influence your approach to teaching critical thinking? 9. Do you think critical thinking is compatible with traditional Thai educational approaches? Why or why not? 10. How do you balance respect for authority with encouraging student questioning and analysis? 11. What strategies do you use to make students comfortable with expressing different opinions?

Professional Development and Support: 12. What training or professional development have you received related to critical thinking instruction? 13. What additional

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support or resources would help you implement critical thinking more effectively? 14. How does your school administration support or hinder your critical thinking teaching efforts?

Future Perspectives: 15. What changes would you like to see in Thai education to better support critical thinking development? 16. How important do you think critical thinking skills are for your students' future success? 17. Is there anything else you'd like to share about your experiences with critical thinking instruction?

C.3 Student Focus Group Protocol

Ice Breaker and Introduction:

1. Can you tell us about your favorite subject in school and why you enjoy it?
2. What does "thinking carefully" mean to you?

Learning Experiences: 3. Can you describe a time when a teacher asked you to analyze or evaluate something in class? 4. How do you feel when teachers ask you to give your own opinion about topics? 5. What kinds of classroom activities help you think most deeply about subject matter? 6. Do you prefer activities where there is one right answer or multiple possible answers? Why?

Cultural and Social Factors: 7. Are you comfortable disagreeing with your teacher or classmates during discussions? Why or why not? 8. How important is it to avoid making mistakes or giving wrong answers in class? 9. Do you think it's respectful for students to question what they read in textbooks? Explain your thinking. 10. How do your parents and family feel about you expressing your own opinions in school?

Critical Thinking Perceptions: 11. What does it mean to think critically about something? 12. Do you think critical thinking skills will be important for your future? How so? 13. What would help you feel more comfortable participating in discussions and sharing your ideas? 14. What suggestions do you have for teachers who want to help students think more deeply?

Closing: 15. Is there anything else you'd like to tell us about your learning experiences?

Appendix D: Statistical Analysis Details

D.1 Descriptive Statistics Summary

Participant Demographics (N = 487)

- Gender: Female 333 (68.4%), Male 154 (31.6%)
- Age: M = 36.7 years, SD = 8.2, Range = 24-58 years
- Teaching Experience: M = 11.3 years, SD = 7.8, Range = 1-34 years
- Education Level: Bachelor's 298 (61.2%), Master's 189 (38.8%)
- School Type: Public 421 (86.5%), Private 66 (13.5%)

Provincial Distribution:

- Khon Kaen: n = 142 (29.2%)

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- Nakhon Ratchasima: n = 135 (27.7%)
- Udon Thani: n = 118 (24.2%)
- Roi Et: n = 92 (18.9%)

Subject Area Distribution:

- Mathematics: n = 115 (23.6%)
- Science: n = 106 (21.8%)
- Thai Language: n = 93 (19.1%)
- Social Studies: n = 80 (16.4%)
- English: n = 57 (11.7%)
- Other: n = 36 (7.4%)

D.2 Reliability Analysis Results

Cronbach's Alpha Coefficients:

- Critical Thinking Instructional Practices: α = 0.89
- Self-Efficacy Beliefs: α = 0.87
- Perceived Barriers: α = 0.83
- Cultural Factors: α = 0.81
- Overall Survey: α = 0.91

Item-Total Correlations: All items demonstrated adequate item-total correlations ($r > 0.30$), with no items requiring deletion for reliability improvement.

D.3 Confirmatory Factor Analysis Results

Model Fit Indices:

- Chi-square/df = 2.14 (< 3.0 indicates good fit)
- Comparative Fit Index (CFI) = 0.94 (> 0.90 indicates good fit)
- Tucker-Lewis Index (TLI) = 0.93 (> 0.90 indicates good fit)
- Root Mean Square Error of Approximation (RMSEA) = 0.067 (< 0.08 indicates acceptable fit)
- Standardized Root Mean Square Residual (SRMR) = 0.063 (< 0.08 indicates good fit)

Factor Loadings: All items demonstrated significant factor loadings ($\lambda > 0.50$, $p < 0.001$), supporting the four-factor structure of the instrument.

D.4 Correlation Matrix

Variable	1	2	3	4	5	6	7
1. CT Implementation	1.00						
2. Self-Efficacy	0.672**	1.00					
3. Professional Development	0.521**	0.487**	1.00				

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4. Cultural Barriers	-0.543**	-0.412**	-0.298**	1.00			
5. Systemic Barriers	-0.467**	-0.378**	-0.256**	0.623**	1.00		
6. Resource Barriers	-0.392**	-0.334**	-0.445**	0.456**	0.512**	1.00	
7. Teaching Experience	0.184**	0.156**	0.298**	-0.123**	-0.089	-0.267**	1.00

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

D.5 Multiple Regression Analysis Results

Dependent Variable: Critical Thinking Implementation Level

Model Summary:

- $R^2 = 0.583$
- Adjusted $R^2 = 0.577$
- $F(7, 479) = 95.42$, $p < 0.001$
- Standard Error of Estimate = 0.487

Regression Coefficients:

Predictor	B	SE B	β	t	p	95% CI
Constant	1.247	0.198		6.29	< 0.001	[0.858, 1.636]
Professional Development	0.298	0.041	0.387	7.24	< 0.001	[0.217, 0.379]
Self-Efficacy	0.284	0.048	0.312	5.92	< 0.001	[0.190, 0.378]
Teaching Experience	0.017	0.006	0.184	2.83	0.005	[0.005, 0.029]
Cultural Barriers	-0.263	0.052	-0.267	-5.06	< 0.001	[-0.365, -0.161]
Systemic Barriers	-0.187	0.049	-0.196	-3.82	< 0.001	[-0.283, -0.091]
Resource Barriers	-0.098	0.043	-0.118	-2.28	0.023	[-0.182, -0.014]
Age	0.003	0.005	0.032	0.62	0.536	[-0.007, 0.013]

Assumptions Testing:

- Normality: Kolmogorov-Smirnov test $p > 0.05$
- Linearity: Scatterplot inspection confirmed linear relationships
- Homoscedasticity: Levene's test $p > 0.05$
- Multicollinearity: All VIF values < 3.0, Tolerance values > 0.30

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Conflicts of Interest

The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.