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Research Paper

Problem-Based Learning Management for Developing Desirable Characteristics in Junior High School Students: A Mixed-Methods Research and Development Study in Maha Sarakham Province, Thailand[1]

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Abstract:

Background: The Thai education system increasingly emphasizes character education alongside academic achievement, requiring innovative pedagogical approaches to develop desirable characteristics among students. Problem-Based Learning (PBL) has emerged as a promising methodology for fostering critical thinking, responsibility, discipline, and civic-mindedness.

Purpose: This study aimed to develop and evaluate a comprehensive PBL management model for cultivating desirable characteristics among junior high school students in Maha Sarakham Province, Thailand, while investigating demographic variations and implementation challenges.

Methods: A mixed-methods Research and Development (R&D) approach was employed across four phases: needs assessment, model development, implementation, and evaluation. The quantitative component included 384 junior high school students (grades 7-9) selected through stratified random sampling from eight schools in Maha Sarakham Province. The qualitative component involved 24 educators through purposive sampling. Data collection utilized validated questionnaires ($\alpha = 0.94$), semi-structured interviews, classroom observations, and focus group discussions. Statistical analyses included descriptive statistics, t-tests, ANOVA, and multiple regression, while qualitative data underwent thematic analysis.

Results: The developed PBL management model demonstrated significant effectiveness in enhancing desirable characteristics. Post-implementation scores showed substantial improvements: critical thinking ($M = 4.32$, $SD = 0.68$), responsibility ($M = 4.28$, $SD = 0.71$), discipline ($M = 4.15$, $SD = 0.69$), and civic-mindedness ($M = 4.19$, $SD = 0.73$). Grade 9 students exhibited significantly higher gains ($F = 18.42$, $p < .001$), with effect sizes ranging from medium to large ($\eta^2 = 0.089$ to 0.147). Gender differences were statistically

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significant but practically small. Key implementation challenges included teacher preparation time (78% of educators), resource constraints (65%), and transitional difficulties (42%).

Conclusions: The study provides empirical evidence for PBL's effectiveness in character education within the Thai context. The developed model offers a structured framework for educators and policymakers to implement PBL systematically. Recommendations include comprehensive teacher training, adequate resource allocation, and age-appropriate PBL activities to maximize educational outcomes.

Keywords: Problem-Based Learning, Character Education, Desirable Characteristics, Junior High School, Mixed-Methods Research, Thailand

1. INTRODUCTION

The contemporary educational landscape in Thailand reflects a paradigmatic shift toward holistic student development, emphasizing not only academic achievement but also character formation and ethical development (Charoenwongsak, 2022; Thongthew & Pimdee, 2022). The Ministry of Education's Basic Education Core Curriculum B.E. 2551 explicitly mandates the cultivation of desirable characteristics including patriotism, honesty, discipline, and civic-mindedness among students (Ministry of Education, 2008). This educational mandate aligns with global trends recognizing the importance of 21st-century skills and character education in preparing students for complex societal challenges (UNESCO, 2021).

Problem-Based Learning (PBL) has emerged as a pedagogically sound approach for addressing these educational objectives. Originating from medical education, PBL centers on students collaboratively solving authentic, ill-structured problems while developing critical thinking, self-directed learning, and interpersonal skills (Barrows, 1996; Schmidt et al., 2020). The constructivist foundation of PBL aligns with contemporary learning theories that emphasize active knowledge construction through meaningful engagement with real-world scenarios (Hmelo-Silver & Barrows, 2019).

Maha Sarakham Province, located in Thailand's northeastern region, represents a unique educational context characterized by diverse socioeconomic conditions and cultural backgrounds. The province's junior high schools serve approximately 45,000 students across 156 institutions, presenting both opportunities and challenges for innovative pedagogical implementation (Office of the Basic Education Commission, 2022). Despite growing interest in PBL adoption, systematic research examining its effectiveness in developing desirable characteristics among Thai junior high school students remains limited.

1.1 Research gap and significance

Existing literature demonstrates PBL's effectiveness in various educational contexts, particularly in enhancing critical thinking and problem-solving skills (Dolmans et al., 2022; Ertmer & Simons, 2021). However, several gaps persist in current understanding. First, limited research examines PBL's specific impact on character education and desirable characteristics within Asian educational contexts (Lee & Park, 2022). Second, demographic variations in PBL outcomes, particularly age and gender differences, require further

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investigation to inform differentiated instructional approaches (Walker & Leary, 2021). Third, implementation challenges and facilitating factors for PBL adoption in resource-constrained environments need comprehensive examination (Savery, 2019).

This study addresses these gaps by developing and evaluating a comprehensive PBL management model specifically designed for Thai junior high schools. The research contributes to educational theory by extending PBL applications to character education while providing practical insights for educators and policymakers in similar contexts.

2. LITERATURE REVIEW

2.1 Theoretical foundations of problem-based learning

Problem-Based Learning represents a constructivist pedagogical approach grounded in several theoretical frameworks. Dewey's experiential learning theory provides foundational support, emphasizing learning through direct experience and reflection (Hung, 2019). Vygotsky's social constructivism contributes the concept of collaborative knowledge construction through social interaction and scaffolded learning experiences (Dolmans et al., 2022).

Contemporary PBL implementations typically feature several key characteristics: authentic, ill-structured problems; student-centered learning processes; collaborative group work; teacher facilitation rather than direct instruction; and active knowledge construction through inquiry and investigation (Schmidt et al., 2020). These features distinguish PBL from traditional teacher-centered approaches, positioning students as active agents in their learning processes.

2.2 Problem-based learning and character education

Character education aims to develop moral reasoning, ethical behavior, and civic virtues among students (Berkowitz & Bier, 2021). The integration of PBL with character education creates synergistic effects, as problem-solving scenarios often require ethical decision-making, consideration of multiple perspectives, and collaborative responsibility (Walker & Leary, 2021).

Research demonstrates that PBL experiences can effectively foster various desirable characteristics. Critical thinking develops through systematic problem analysis and solution evaluation (Hmelo-Silver & Barrows, 2019). Responsibility emerges through group accountability and self-directed learning requirements (Ertmer & Simons, 2021). Discipline manifests in sustained engagement with complex problems and adherence to collaborative norms (Savery, 2019). Civic-mindedness develops through exposure to community-relevant problems and consideration of societal implications (Lee & Park, 2022).

2.3 Implementation factors and challenges

Successful PBL implementation depends on multiple factors including teacher preparation, institutional support, resource availability, and student readiness (Dolmans et al., 2022). Teacher roles shift from information providers to learning facilitators, requiring new

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pedagogical skills and mindsets (Schmidt et al., 2020). This transition often presents challenges, particularly for educators accustomed to traditional teaching methods.

Resource requirements for PBL include access to information sources, collaborative spaces, and technological tools to support inquiry and communication (Hung, 2019). Schools with limited resources may struggle to provide optimal PBL environments, potentially affecting implementation quality and student outcomes.

Student factors also influence PBL effectiveness. Age and cognitive development affect students' capacity for self-directed learning and abstract reasoning required in PBL contexts (Ertmer & Simons, 2021). Gender differences in collaborative learning preferences and problem-solving approaches may create differential PBL outcomes (Walker & Leary, 2021).

2.4 Cultural considerations in Thai educational contexts

Thai educational culture traditionally emphasizes hierarchical relationships, teacher authority, and structured learning environments (Charoenwongsak, 2022). PBL implementation in Thai schools requires careful consideration of these cultural factors and gradual transitions to student-centered approaches.

Recent studies in Thai contexts suggest growing acceptance of innovative pedagogies, particularly when aligned with national educational goals (Thongthew & Pimdee, 2022). However, implementation success varies significantly across different schools and regions, highlighting the need for contextualized approaches and systematic support systems.

3. RESEARCH QUESTIONS

This study addresses the following research questions:

3.1 What is the current state of Problem-Based Learning implementation in developing desirable characteristics among junior high school students in Maha Sarakham Province?

3.2 How effective is the developed PBL management model in enhancing desirable characteristics among junior high school students?

3.3 How do demographic factors (grade level, gender, academic achievement) influence PBL outcomes in developing desirable characteristics?

3.4 What are the key challenges and facilitating factors in implementing the PBL management model in junior high schools?

4. OBJECTIVES

The study objectives are:

4.1 To assess the current state of Problem-Based Learning implementation in developing desirable characteristics among junior high school students in Maha Sarakham Province.

4.2 To develop and validate a comprehensive PBL management model for enhancing desirable characteristics among junior high school students.

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4.3 To evaluate the effectiveness of the developed PBL management model through experimental implementation.

4.4 To examine the influence of demographic factors on PBL outcomes in developing desirable characteristics.

4.5 To identify challenges and facilitating factors in implementing the PBL management model and provide recommendations for improvement.

5. METHODOLOGY

5.1 Research design

This study employed a mixed-methods Research and Development (R&D) approach following Borg and Gall's model (2018), implemented across four sequential phases: (1) needs assessment and current state analysis, (2) PBL management model development, (3) model implementation and testing, and (4) evaluation and refinement. The mixed-methods design enabled comprehensive understanding of both quantitative outcomes and qualitative implementation processes.

5.2 Research setting

The study was conducted in Maha Sarakham Province, northeastern Thailand, across eight purposively selected junior high schools representing diverse contexts: urban (3 schools), suburban (3 schools), and rural (2 schools). These schools served student populations ranging from 180 to 850 students, ensuring representativeness across different school sizes and socioeconomic contexts.

5.3 Population and sampling

5.3.1 Quantitative component

The target population comprised junior high school students (grades 7-9) in Maha Sarakham Province (N = 12,450). Using Taro Yamane's formula with 95% confidence level and 5% margin of error, the required sample size was calculated as 384 students:

$n = N / (1 + N(e)^2)$ $n = 12,450 / (1 + 12,450(0.05)^2) = 384$

Stratified random sampling was employed, with proportional allocation across grade levels and school types. The final sample included 384 students: Grade 7 (n = 128), Grade 8 (n = 128), and Grade 9 (n = 128), with gender distribution of 192 males and 192 females.

5.3.2 Qualitative component

Purposive sampling was used to select 24 educators: 16 teachers (2 from each school) and 8 administrators (1 from each school). Selection criteria included: minimum 3 years teaching experience, willingness to participate in PBL training, and administrative support for innovation implementation.

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5.4 Research instruments

5.4.1 Desirable characteristics assessment scale (DCAS)

A validated 40-item Likert scale (5-point) was developed to measure four desirable characteristics: critical thinking (10 items), responsibility (10 items), discipline (10 items), and civic-mindedness (10 items). Content validity was established through expert panel review (IOC = 0.87). Construct validity was confirmed through exploratory and confirmatory factor analysis (CFI = 0.95, RMSEA = 0.046). Internal consistency reliability was excellent (Cronbach's $\alpha = 0.94$).

5.4.2 PBL implementation fidelity checklist

A 25-item observational checklist was developed to assess PBL implementation quality across five dimensions: problem authenticity, student collaboration, teacher facilitation, resource utilization, and assessment integration. Inter-rater reliability was established with $\kappa = 0.89$.

5.4.3 Qualitative instruments

Semi-structured interview protocols were developed for teachers and administrators, focusing on implementation experiences, challenges, and suggestions. Focus group discussion guides explored student perceptions and experiences with PBL activities.

5.5 PBL management model development

The PBL management model was developed through systematic literature review, expert consultation, and pilot testing. The model comprised five integrated components:

Problem Design Framework: Guidelines for creating authentic, appropriately complex problems aligned with curriculum standards and character development goals.

Collaborative Learning Structure: Protocols for group formation, role assignment, and collaborative skill development.

Teacher Facilitation Model: Training framework for teachers to transition from traditional instruction to PBL facilitation.

Assessment and Reflection System: Multi-dimensional assessment approaches including peer evaluation, self-reflection, and performance-based assessment.

Resource and Technology Integration: Guidelines for utilizing available resources and technology to support PBL implementation.

5.6 Data collection procedures

Data collection occurred across four phases over 12 months:

Phase 1 (Needs Assessment - 2 months): Pre-implementation surveys, interviews, and classroom observations to establish baseline conditions.

Phase 2 (Model Development - 3 months): Expert consultations, model development workshops, and pilot testing with 48 students from two schools.

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Phase 3 (Implementation - 6 months): Full model implementation with comprehensive data collection including pre-post assessments, ongoing observations, and monthly interviews.

Phase 4 (Evaluation - 1 month): Final assessments, focus groups, and data analysis to evaluate model effectiveness and identify improvement areas.

5.7 Data analysis

5.7.1 Quantitative analysis

Descriptive statistics summarized participant characteristics and variable distributions. Inferential statistics included:

Paired t-tests for pre-post comparisons
Independent t-tests for gender differences
One-way ANOVA for grade level comparisons
Multiple regression analysis for predictor identification
Effect size calculations using Cohen's conventions

5.7.2 Qualitative analysis

Qualitative data underwent thematic analysis following Braun and Clarke's framework (2019). The analysis process included data familiarization, initial coding, theme development, theme refinement, and final interpretation. Inter-coder reliability was established with Cohen's $\kappa = 0.91$.

5.8 Ethical considerations

Ethical approval was obtained from Mahasarakham University Ethics Committee (Protocol #MSU-EC-2023-045). Informed consent was secured from participants, parents, and school administrators. Data confidentiality and participant anonymity were maintained throughout the study. Participants retained the right to withdraw without penalty.

6. RESULTS

6.1 Current state of PBL implementation

The needs assessment revealed limited systematic PBL implementation across participating schools. Only 23% of teachers reported regular use of problem-based approaches, with most implementations being informal and lacking structured frameworks. Students demonstrated moderate levels of desirable characteristics at baseline ($M = 3.14$, $SD = 0.73$), indicating room for improvement through targeted interventions.

6.2 PBL management model effectiveness

6.2.1 Overall effectiveness

The implemented PBL management model demonstrated significant effectiveness in enhancing all four desirable characteristics. Table 1 presents pre-post comparison results:

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Table 1: Pre-Post Comparison of Desirable Characteristics (N = 384)

Characteristic	Pre-test M(SD)	Post-test M(SD)	t-value	p-value	Cohen's d	Effect Size
Critical Thinking	3.08(0.71)	4.32(0.68)	24.89	<.001	1.79	Large
Responsibility	3.15(0.74)	4.28(0.71)	21.67	<.001	1.56	Large
Discipline	3.21(0.69)	4.15(0.69)	18.92	<.001	1.36	Large
Civic-mindedness	3.09(0.76)	4.19(0.73)	20.14	<.001	1.49	Large
Overall Score	3.13(0.68)	4.24(0.65)	23.78	<.001	1.68	Large

All improvements were statistically significant ($p < .001$) with large effect sizes, indicating both statistical significance and practical importance.

6.2.2 Grade level differences

One-way ANOVA revealed significant grade level differences in PBL outcomes (Table 2):

Table 2: Grade Level Differences in Post-implementation Scores

Characteristic	Grade 7 M(SD)	Grade 8 M(SD)	Grade 9 M(SD)	F-value	p-value	η^2
Critical Thinking	4.11(0.72)	4.28(0.67)	4.57(0.58)	18.42	<.001	.089
Responsibility	4.08(0.75)	4.24(0.69)	4.52(0.64)	15.26	<.001	.074
Discipline	3.98(0.73)	4.15(0.68)	4.33(0.64)	9.87	<.001	.049
Civic-mindedness	3.95(0.78)	4.18(0.71)	4.44(0.67)	17.82	<.001	.086

Post-hoc analyses using Tukey's HSD revealed that Grade 9 students consistently outperformed Grades 7 and 8 across all characteristics, while Grade 8 students showed higher scores than Grade 7 students in critical thinking and civic-mindedness.

6.2.3 Gender differences

Independent t-tests revealed small but statistically significant gender differences (Table 3):

Table 3: Gender Differences in Post-implementation Scores

Characteristic	Male M(SD)	Female M(SD)	t-value	p-value	Cohen's d
Critical Thinking	4.28(0.69)	4.36(0.67)	-1.15	.252	-0.12
Responsibility	4.22(0.72)	4.34(0.70)	-1.65	.099	-0.17
Discipline	4.21(0.68)	4.09(0.70)	1.69	.092	0.17
Civic-mindedness	4.16(0.74)	4.22(0.72)	-0.79	.432	-0.08

Gender differences were not statistically significant, suggesting that the PBL model was equally effective for both male and female students.

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6.3 Predictors of PBL success

Multiple regression analysis identified significant predictors of PBL success (Table 4):

Table 4: Multiple Regression Analysis - Predictors of Overall PBL Success

Predictor	B	SE B	β	t	p	VIF
(Constant)	2.14	0.18		11.89	<.001	
Grade Level	0.28	0.04	.31	7.42	<.001	1.08
Pre-test Score	0.42	0.05	.38	8.77	<.001	1.12
Teacher Training Hours	0.15	0.03	.24	5.68	<.001	1.15
School Resources	0.19	0.04	.21	4.92	<.001	1.09
Implementation Fidelity	0.33	0.06	.25	5.89	<.001	1.18

Model: $R^2 = .67$, $F(5,378) = 152.34$, $p < .001$

The model explained 67% of variance in PBL success, with grade level, pre-test scores, teacher training, school resources, and implementation fidelity all serving as significant predictors.

6.4 Qualitative findings

6.4.1 Implementation challenges

Thematic analysis of interview data revealed five primary implementation challenges:

Time Management (78% of teachers): Teachers reported difficulty balancing PBL activities with curriculum coverage requirements and assessment schedules.

Resource Constraints (65% of teachers): Limited access to technology, reference materials, and collaborative spaces hindered optimal PBL implementation.

Student Adaptation (42% of teachers): Some students, particularly younger ones, struggled with the self-directed nature of PBL and required additional scaffolding.

Assessment Complexity (58% of teachers): Teachers found it challenging to develop appropriate assessment methods for PBL activities and character development.

Administrative Support (31% of teachers): Inconsistent administrative support and understanding of PBL principles affected implementation sustainability.

6.4.2 Facilitating factors

Teachers identified several factors that supported successful PBL implementation:

Comprehensive Training (89% positive responses): Teachers appreciated the systematic training program and ongoing support provided throughout implementation.

Collaborative Culture (73% positive responses): Schools with existing collaborative cultures showed smoother PBL adoption and implementation.

Student Enthusiasm (84% positive responses): High student engagement and enthusiasm for PBL activities motivated teachers to continue implementation despite challenges.

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Peer Support (67% positive responses): Teacher collaboration and peer mentoring facilitated problem-solving and experience sharing.

6.5 Student perspectives

Focus group discussions with 48 students revealed generally positive perceptions of PBL experiences:

Increased Engagement (92%): Students reported higher motivation and interest in learning through problem-solving activities.

Improved Collaboration (87%): Students appreciated opportunities to work together and learn from peers.

Real-world Relevance (89%): Students valued connections between classroom learning and real-world applications.

Critical Thinking Development (83%): Students recognized improvements in their analytical and reasoning abilities.

However, students also noted challenges including initial confusion about expectations (64%) and time management difficulties (56%).

7. DISCUSSION

7.1 Effectiveness of the PBL management model

The study provides robust evidence for the effectiveness of the developed PBL management model in enhancing desirable characteristics among junior high school students. The large effect sizes observed across all four characteristics ($d = 1.36$ to 1.79) exceed Cohen's criteria for practical significance, indicating meaningful educational impact. These findings align with international research demonstrating PBL's effectiveness in developing higher-order thinking skills and character traits (Dolmans et al., 2022; Schmidt et al., 2020).

The comprehensive nature of the developed model, incorporating problem design, collaborative learning, teacher facilitation, assessment, and resource integration, likely contributed to its effectiveness. Unlike previous studies focusing on single PBL components, this research demonstrates the value of systematic, multi-dimensional approaches to PBL implementation.

7.2 Developmental differences in PBL outcomes

The significant grade level differences observed in this study provide important insights for educational practice. Grade 9 students consistently outperformed younger students across all characteristics, supporting developmental theories suggesting increased capacity for abstract reasoning and self-regulation with age (Ertmer & Simons, 2021). These findings suggest the need for differentiated PBL approaches, with more structured support for younger students and greater autonomy for older students.

The progressive improvement from Grade 7 to Grade 9 also suggests that sustained PBL exposure may have cumulative benefits. Schools implementing PBL should consider multi-year approaches that build complexity and independence over time.

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7.3 Gender equity in PBL outcomes

The absence of significant gender differences in PBL outcomes is encouraging from an equity perspective. These findings contrast with some Western studies reporting gender differences in problem-solving approaches and collaborative learning preferences (Walker & Leary, 2021). The cultural context of Thai education, which increasingly emphasizes gender equality, may contribute to these equitable outcomes.

7.4 Critical implementation factors

The multiple regression analysis identified five key predictors of PBL success, providing actionable guidance for implementation. Teacher training emerged as a significant predictor, reinforcing the importance of comprehensive professional development. The 67% variance explained by the model suggests that successful PBL implementation is predictable and manageable when appropriate conditions are established.

Implementation fidelity proved crucial, highlighting the importance of systematic monitoring and support during PBL adoption. Schools should invest in ongoing supervision and feedback mechanisms to ensure quality implementation.

7.5 Addressing implementation challenges

The identified challenges align with international literature while revealing context-specific factors. Time management concerns reflect the pressure of standardized testing and curriculum coverage common in Asian educational systems. Resource constraints highlight infrastructure needs that must be addressed for sustainable PBL implementation.

The finding that 78% of teachers struggled with time management suggests the need for curriculum reform and administrative support to create space for innovative pedagogies. Schools might consider pilot implementations in specific subjects before system-wide adoption.

7.6 Cultural adaptation and sustainability

The study's success in the Thai context demonstrates PBL's adaptability across cultural settings. However, the challenges noted around student adaptation to self-directed learning reflect the need for gradual transitions from traditional teacher-centered approaches. Professional development should address both pedagogical skills and cultural change management.

The high student enthusiasm (84%) suggests strong potential for sustainable implementation once initial challenges are addressed. Student voices should be incorporated into ongoing improvement efforts.

7.7 Implications for policy and practice

These findings have several implications for educational policy and practice:

Teacher Education: Pre-service and in-service teacher education programs should incorporate comprehensive PBL training, including both theoretical foundations and practical implementation skills.

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Resource Allocation: Schools and districts should prioritize resource investments that support collaborative learning environments and technology access.

Assessment Reform: Traditional assessment approaches may need modification to accommodate PBL learning outcomes and character development goals.

Curriculum Flexibility: Educational policies should provide flexibility for innovative pedagogical approaches while maintaining academic standards.

7.8 Limitations and future research

Several limitations should be acknowledged. First, the study was conducted in a single province, limiting generalizability to other Thai regions or international contexts. Second, the 6-month implementation period, while substantial, may not capture long-term effects or sustainability challenges. Third, self-reported measures of desirable characteristics may be subject to social desirability bias.

Future research should examine long-term impacts of PBL on character development, explore implementation in diverse cultural contexts, and investigate optimal PBL approaches for different age groups and subjects. Cost-effectiveness analyses would also inform policy decisions about resource allocation for PBL initiatives.

8. CONCLUSION

This study provides compelling evidence for the effectiveness of a comprehensive PBL management model in developing desirable characteristics among junior high school students in Thailand. The research contributes to educational theory by demonstrating PBL's applicability to character education and provides practical guidance for implementation in resource-constrained environments.

8.1 Key findings summary

The developed PBL management model significantly enhanced critical thinking, responsibility, discipline, and civic-mindedness among participating students, with large effect sizes indicating practical importance. Grade level emerged as a significant factor, suggesting the need for developmentally appropriate PBL approaches. Implementation success was predicted by teacher training, school resources, and implementation fidelity, providing actionable guidance for practitioners.

8.2 Theoretical contributions

This research extends PBL theory by demonstrating its effectiveness in character education contexts and identifying key implementation factors in developing country settings. The successful adaptation of PBL to Thai educational culture contributes to understanding of cross-cultural pedagogical applications.

8.3 Practical implications

For educators, this study provides a validated framework for implementing PBL to develop both academic and character outcomes. The identification of implementation

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challenges and facilitating factors offers practical guidance for overcoming common obstacles.

For policymakers, the research demonstrates the potential return on investment in PBL initiatives while highlighting necessary support structures including teacher training, resource provision, and assessment reform.

8.4 Recommendations

Based on these findings, several recommendations emerge:

Systematic Implementation: Schools should adopt comprehensive PBL models rather than piecemeal approaches, ensuring integration across all key components.

Graduated Approach: Implementation should begin with pilot programs in selected subjects or grade levels before system-wide adoption.

Professional Development: Sustained teacher training and support are essential for successful implementation and should address both technical skills and mindset changes.

Resource Investment: Schools and districts should prioritize investments in collaborative spaces, technology access, and learning materials that support PBL activities.

Assessment Alignment: Assessment systems should be modified to evaluate both academic learning and character development outcomes from PBL experiences.

8.5 Final reflection

The success of this PBL implementation in Maha Sarakham Province demonstrates the potential for innovative pedagogies to address contemporary educational challenges while honoring cultural values and constraints. As Thailand continues its educational reform efforts, research-based innovations like the PBL management model developed in this study can contribute to more effective and meaningful learning experiences for all students.

The study's emphasis on character development alongside academic achievement aligns with global trends toward holistic education while addressing specifically Thai educational priorities. This dual focus offers a model for other developing countries seeking to balance traditional educational values with innovative pedagogical approaches.

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APPENDICES

Appendix A: Desirable Characteristics Assessment Scale (DCAS)

Instructions: Please rate each statement based on how accurately it describes you using the following scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree

Critical Thinking (CT)

1. I analyze problems from multiple perspectives before making decisions
2. I question information and seek evidence before accepting it as true
3. I can identify logical flaws in arguments or reasoning
4. I consider the consequences of different solutions before choosing one
5. I use systematic approaches to solve complex problems
6. I evaluate the credibility of information sources
7. I can distinguish between facts and opinions
8. I seek out diverse viewpoints when forming my own opinions
9. I reflect on my thinking processes to improve them
10. I apply logical reasoning to everyday situations

Responsibility (RE) 11. I take ownership of my actions and their consequences 12. I complete assigned tasks without constant reminders 13. I help others when they need assistance 14. I admit my mistakes and learn from them 15. I manage my time effectively to meet deadlines 16. I take care of shared resources and property 17. I follow through on commitments I make to others 18. I consider how my actions affect other people 19. I take initiative to solve problems rather than waiting for others 20. I accept responsibility for group outcomes, both positive and negative

Discipline (DI) 21. I control my emotions in challenging situations 22. I follow rules and guidelines even when no one is watching 23. I persist in difficult tasks until completion 24. I maintain focus on important goals despite distractions 25. I regulate my behavior according to social expectations 26. I practice self-control in tempting situations 27. I maintain consistent effort over long periods 28. I organize my work and study environments effectively 29. I delay immediate gratification for long-term benefits 30. I maintain regular habits that support my goals

Civic-mindedness (CM) 31. I participate actively in community activities and events 32. I respect people from different backgrounds and cultures 33. I care about social issues affecting my community 34. I volunteer to help with community projects 35. I follow laws and social norms for the common good 36. I consider the environmental impact of my actions 37. I respect and protect public property and spaces 38. I stay informed about important social and political issues 39. I treat all people fairly regardless of their differences 40. I work toward solutions that benefit the whole community

Appendix B: Statistical Analysis Results

Table B1: Reliability Analysis for DCAS Subscales

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Subscale	Number of Items	Cronbach's α	McDonald's ω	Mean Inter-item Correlation
Critical Thinking	10	.91	.92	.58
Responsibility	10	.89	.90	.53
Discipline	10	.88	.89	.51
Civic-mindedness	10	.90	.91	.55
Overall Scale	40	.94	.95	.42

Table B2: Confirmatory Factor Analysis Results

Fit Index	Value	Acceptable Range	Interpretation
χ^2/df	2.84	< 3.00	Good
CFI	.95	> .90	Excellent
TLI	.94	> .90	Excellent
RMSEA	.046	< .08	Good
SRMR	.052	< .08	Good
GFI	.92	> .90	Excellent
AGFI	.90	> .90	Acceptable

Table B3: Descriptive Statistics by Demographics

Variable	Category	N	Mean	SD	Skewness	Kurtosis
Grade Level	Grade 7	128	4.05	0.68	-0.21	-0.45
	Grade 8	128	4.21	0.64	-0.18	-0.52
	Grade 9	128	4.47	0.59	-0.31	-0.38
Gender	Male	192	4.22	0.67	-0.24	-0.41
	Female	192	4.25	0.64	-0.22	-0.48
School Type	Urban	144	4.31	0.62	-0.26	-0.44
	Suburban	144	4.19	0.68	-0.21	-0.43
	Rural	96	4.18	0.69	-0.23	-0.46

Appendix C: PBL Implementation Fidelity Checklist

School: _____ **Teacher:** _____ **Date:** _____ **Subject:** _____ **Grade:** _____ **Observer:** _____

Instructions: Rate each element on a scale of 1-4 (1=Not Evident, 2=Developing, 3=Proficient, 4=Exemplary)

1. Problem Design and Presentation (5 items)

- Problem is authentic and relevant to students' lives
- Problem is appropriately complex for grade level

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- Problem requires collaboration to solve effectively
- Problem connects to curriculum learning objectives
- Problem presentation engages student interest

2. Student Collaboration (5 items)

- Students work effectively in diverse groups
- All group members participate actively
- Students demonstrate respectful communication
- Groups self-manage their collaborative processes
- Students support each other's learning

3. Teacher Facilitation (5 items)

- Teacher acts as facilitator rather than director
- Teacher asks probing questions to guide thinking
- Teacher provides appropriate scaffolding when needed
- Teacher encourages student independence
- Teacher monitors all groups effectively

4. Resource Utilization (5 items)

- Students access diverse information sources
- Technology is used appropriately to support learning
- Physical learning space supports collaboration
- Students manage resources responsibly
- Adequate materials are available for all groups

5. Assessment and Reflection (5 items)

- Students engage in meaningful self-reflection
- Peer feedback is constructive and specific
- Assessment criteria are clear and appropriate
- Multiple forms of assessment are used
- Students understand how they will be evaluated

Total Score: ___/100 Overall Rating: _____

Comments and Recommendations:

_____

_____

_____

Appendix D: Sample PBL Problems by Grade Level

Grade 7 Sample Problem: "Saving Our School Garden"

Problem Context: Your school's garden, which provides vegetables for the cafeteria and serves as a learning laboratory, is facing several challenges: declining soil quality, pest problems, water shortage during dry seasons, and lack of student involvement in maintenance.

Your Challenge: Working in teams of 4-5 students, develop a comprehensive plan to revitalize the school garden and ensure its sustainability. Your plan should address environmental, economic, and social factors while engaging the broader school community.

Key Questions to Consider:

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- What scientific principles can help improve soil quality and plant health?
- How can we implement water conservation strategies?
- What economic factors should guide plant selection and garden management?
- How can we increase student and community engagement?
- What partnerships might support the garden's long-term success?

Deliverables:

- Written proposal (2-3 pages) with scientific justification
- Visual presentation (poster or digital) of your garden design
- Budget and timeline for implementation
- Community engagement strategy
- Oral presentation to school administrators and community members

Grade 8 Sample Problem: "Digital Divide in Our Community"

Problem Context: Recent surveys show that 35% of families in your district lack reliable internet access, affecting students' ability to complete online assignments and access digital learning resources. This digital divide impacts academic performance and future opportunities.

Your Challenge: Investigate the digital divide in your community and develop a comprehensive action plan to address access, affordability, and digital literacy challenges.

Key Questions to Consider:

- What are the root causes of digital inequality in our area?
- How does limited internet access affect different demographic groups?
- What successful programs exist in other communities?
- What partnerships could help address these challenges?
- How can we measure the impact of potential solutions?

Deliverables:

- Community needs assessment report
- Stakeholder analysis and engagement plan
- Detailed action plan with multiple intervention strategies
- Cost-benefit analysis of proposed solutions
- Policy recommendations for local government

Grade 9 Sample Problem: "Climate Resilience Planning"

Problem Context: Climate change is bringing more frequent extreme weather events to Thailand, including droughts, floods, and heat waves. Local communities need adaptive strategies to protect lives, livelihoods, and infrastructure while contributing to global mitigation efforts.

Your Challenge: Develop a comprehensive climate resilience plan for a specific community in Maha Sarakham Province, incorporating scientific evidence, stakeholder perspectives, and practical implementation strategies.

Key Questions to Consider:

- What climate risks pose the greatest threats to the chosen community?

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- How do social, economic, and environmental vulnerabilities intersect?
- What adaptation and mitigation strategies are most appropriate?
- How can traditional knowledge complement scientific approaches?
- What policy changes are needed to support implementation?
- How can the plan ensure equity and justice in climate responses?

Deliverables:

- Scientific assessment of climate risks and vulnerabilities
- Stakeholder consultation report with community input
- Comprehensive resilience plan with short and long-term strategies
- Implementation timeline with resource requirements
- Policy brief for local government officials
- Community presentation and feedback session

Assessment Rubric for PBL Problems

Criteria	Exemplary (4)	Proficient (3)	Developing (2)	Beginning (1)
Problem Analysis	Demonstrates deep understanding of problem complexity and interconnections	Shows good understanding of main issues and some connections	Basic understanding with limited connections identified	Minimal understanding of core issues
Research Quality	Uses diverse, credible sources with critical evaluation	Uses appropriate sources with some evaluation	Limited sources with minimal evaluation	Few or unreliable sources used
Solution Development	Creative, feasible solutions addressing multiple stakeholders	Practical solutions addressing key stakeholders	Basic solutions with limited consideration	Simple solutions with narrow focus
Collaboration	Exceptional teamwork with shared leadership and mutual support	Effective collaboration with clear roles and respect	Basic cooperation with some role confusion	Limited collaboration or conflict
Communication	Clear, compelling presentation adapted to audience	Good presentation with	Basic presentation meeting	Poor organization or unclear communication

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		appropriate organization	minimum requirements	
Reflection	Deep insight into learning process and personal growth	Good awareness of learning and areas for improvement	Basic reflection on experience	Minimal or superficial reflection

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