Pak. j. life soc. Sci. (2024), 22(2): 20475-20485 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2024-22.2.00155

RESEARCH ARTICLE

Fostering Critical and Creative Thinking through Mathematics Instruction in High Schools in the Lao People's Democratic Republic

Thongdeng Pathoumma[1], Do Thi Trinh[2*]

[1] Nguadeng High School, Sanasomboun District, Champasak Province, Lao People's Democratic Republic
[1,2] Thai Nguyen University of Education, 20 Luong Ngoc Quyen Street, Thai Nguyen City, Thai Nguyen Province, Vietnam

ARTICLE INFO

Received: Oct 29, 2024

Accepted: Dec 18, 2024

Keywords

Critical Thinking

Creative Thinking

Mathematics Instruction

Educational Reform

Lao People's Democratic Republic

***Corresponding Author:**

trinhdt@tnue.edu.vn

ABSTRACT

This study aims to explore the effectiveness of innovative mathematics instructional strategies in enhancing critical and creative thinking skills among high school students in the Lao People's Democratic Republic (Lao PDR). Utilizing a mixed-methods approach, the research combined quasi-experimental and descriptive techniques, involving 200 students and 56 teachers from four secondary schools in Champasak Province. Quantitative data were gathered through pre- and post-intervention assessments, while qualitative insights were collected via classroom observations and interviews. The quantitative analysis demonstrated significant improvements in critical and creative thinking skills among students who participated in the new instructional strategies compared to a control group. Qualitative data corroborated these findings, highlighting increased student engagement and enhanced problem-solving abilities. However, the study also identified challenges related to the adaptation and preparation time required for implementing these methods. The research highlights the positive impact of innovative mathematics instruction on fostering essential cognitive skills among high school students in Lao PDR. The findings suggest that adopting innovative teaching methods could significantly benefit mathematics education in Laos, informing future educational practices and policy developments aimed at enhancing student cognitive skills.

INTRODUCTION

In the contemporary educational landscape, the imperative to cultivate critical and creative thinking skills in students has never been more pronounced. These cognitive abilities are increasingly recognized as essential for success in a rapidly changing world, characterized by complex problems and the need for innovative solutions [1]. Mathematics education, with its inherent focus on problem-solving and analytical reasoning, plays a pivotal role in developing these skills [2]. However, traditional approaches to teaching mathematics, particularly in developing countries, often emphasize rote learning and procedural knowledge at the expense of fostering deeper cognitive engagement [3], [4]. This introductory section explores the significance of enhancing mathematics instruction to promote critical and creative thinking, specifically within the context of high schools in the Lao People's Democratic Republic (Lao PDR).

Mathematics education is traditionally viewed as a domain that requires students to master specific algorithms and techniques. While this approach ensures that students acquire foundational skills, it may not sufficiently engage students in higher-order thinking or creative

problem-solving [5]. The ability to think critically and creatively extends beyond the application of mathematical formulas; it involves analyzing problems from multiple perspectives, generating novel solutions, and applying mathematical concepts in various real-world contexts [6]. As such, integrating these cognitive skills into mathematics instruction is crucial for preparing students to navigate the complexities of the modern world.

In Laos, the education system has historically focused on a more traditional pedagogical approach, emphasizing memorization and repetitive practice [7]. This method, while effective in ensuring basic competency, may not adequately support the development of critical and creative thinking skills. Recent educational reforms in Laos have aimed to address these limitations by introducing new teaching strategies that emphasize deeper cognitive engagement. However, the implementation of these reforms has been inconsistent, and there remains a significant gap between policy intentions and classroom practices [8].

The need to bridge this gap has become increasingly apparent as educators and policymakers recognize the importance of equipping students with skills that extend beyond rote memorization. Developing critical and creative thinking through mathematics instruction can enhance students' problem-solving abilities and prepare them for future challenges [9]. Effective instructional strategies, therefore, must be identified and integrated into the curriculum to achieve these goals. This necessitates a thorough examination of current teaching practices and the identification of methods that can effectively promote these cognitive skills.

Furthermore, understanding how to adapt instructional strategies to the specific context of Lao high schools is crucial for the successful implementation of educational reforms. The unique challenges faced by educators in Laos, including resource constraints and varying levels of teacher training, must be considered when developing and applying new teaching approaches [10]. By addressing these challenges, it is possible to create a more effective and contextually relevant framework for teaching mathematics that fosters critical and creative thinking.

In conclusion, the integration of critical and creative thinking into mathematics education represents a significant opportunity to enhance the educational experience and outcomes for students in Laos. As the country continues to reform its education system, it is essential to focus on instructional strategies that not only improve mathematical skills but also promote higher-order cognitive abilities. This study aims to contribute to this effort by exploring effective methods for fostering critical and creative thinking through mathematics instruction and providing insights into how these methods can be implemented within the context of Lao high schools.

LITERATURE REVIEW

Theoretical Framework

Theories of Critical and Creative Thinking

Critical and creative thinking are two distinct yet complementary cognitive processes crucial for educational development and lifelong learning. These cognitive skills enable individuals to analyze, evaluate, and generate new ideas, thus playing a pivotal role in academic and professional success.

Critical Thinking

Critical thinking is defined as the ability to engage in reflective and independent thinking, making reasoned judgments about what to believe or do [1]. This process involves several key cognitive skills: analysis, interpretation, inference, evaluation, and explanation. According to Paul and Elder [11], critical thinking requires individuals to scrutinize arguments and information rigorously, identify biases and assumptions, and draw well-supported conclusions.

The theoretical underpinnings of critical thinking are deeply rooted in the work of philosophers such as John Dewey and Richard Paul. Dewey (1933) emphasized the role of reflective thinking in education, arguing that critical thinking involves a systematic approach to problem-solving that includes questioning, investigation, and reasoning. Dewey's model underscores the importance of engaging students in active, reflective inquiry to develop their critical thinking skills.

Paul and Elder's [11] framework further elaborates on this by proposing that critical thinking encompasses both cognitive skills and intellectual virtues, such as open-mindedness, intellectual humility, and intellectual courage. This approach highlights that effective critical thinking requires not only the application of specific skills but also the cultivation of a mindset oriented toward continuous questioning and improvement.

Creative Thinking

Creative thinking, in contrast, is characterized by the ability to generate novel and useful ideas [9]. This process involves divergent thinking, which is the capacity to explore multiple possible solutions to a problem and think "outside the box." Guilford [12] introduced the concept of divergent thinking as a fundamental aspect of creativity, distinguishing it from convergent thinking, which focuses on deriving a single, correct solution.

Torrance [13], a pioneer in creativity research, expanded on Guilford's work by identifying key components of creative thinking, including fluency (the ability to produce a large number of ideas), flexibility (the ability to generate ideas from different categories), and originality (the ability to produce unique ideas). Torrance's tests, known as the Torrance Tests of Creative Thinking, are widely used to assess these dimensions of creativity in educational and psychological research.

Creativity is also influenced by environmental factors and individual traits. Csikszentmihalyi [14] introduced the concept of "flow," a psychological state where individuals are fully immersed in an activity, leading to enhanced creativity and productivity. This concept emphasizes the importance of creating environments that facilitate deep engagement and intrinsic motivation, which are crucial for fostering creative thinking.

Theoretical Framework for Mathematics Instruction and Cognitive Development

The integration of critical and creative thinking into mathematics instruction requires a theoretical framework that connects cognitive development theories with effective teaching practices. Two prominent theories in this context are Piaget's theory of cognitive development and Vygotsky's sociocultural theory.

Piaget's Theory of Cognitive Development

Jean Piaget (1973) [12] proposed that cognitive development occurs in distinct stages, each characterized by different ways of thinking and understanding the world. According to Piaget, children progress from concrete operational stages, where they handle tangible information and problems, to formal operational stages, where they develop the ability to think abstractly and systematically.

In the context of mathematics education, Piaget's theory suggests that instruction should be tailored to the cognitive developmental stage of students. For instance, young children might benefit from hands-on, concrete experiences with mathematical concepts, while older students can engage in abstract reasoning and complex problem-solving tasks. This alignment with developmental stages supports the effective integration of critical and creative thinking into mathematics instruction.

Vygotsky's Sociocultural Theory

Lev Vygotsky [25] emphasized the role of social interaction and cultural tools in cognitive development. According to Vygotsky, learning is a collaborative process where students develop higher-order thinking skills through interaction with more knowledgeable others, such as teachers and peers. His concept of the "zone of proximal development" (ZPD) highlights the importance of providing support and guidance that enables students to perform tasks they cannot yet accomplish independently but can achieve with assistance.

In mathematics education, Vygotsky's theory implies that instructional strategies should incorporate collaborative learning and guided problem-solving activities. These strategies help students develop critical and creative thinking skills by engaging them in discussions, exploratory activities, and reflective practices. The use of scaffolding, or temporary support provided by teachers or peers, is crucial in helping students progress through their ZPD and develop more advanced cognitive abilities.

Schoenfeld's Framework of Mathematical Thinking

Schoenfeld [6] proposed a comprehensive framework for understanding mathematical thinking, which integrates both procedural and conceptual understanding. According to Schoenfeld, effective mathematics instruction involves more than just teaching procedures; it requires fostering students' ability to reason, reflect, and engage in problem-solving activities.

Schoenfeld's framework emphasizes the importance of metacognition—the ability to think about one's own thinking processes—in developing critical and creative thinking skills. By encouraging students to reflect on their problem-solving approaches, evaluate their strategies, and consider alternative solutions, teachers can help students build deeper mathematical understanding and enhance their cognitive skills.

Previous Research

Overview of Previous Research on Mathematics Instruction and Thinking Skills

The field of mathematics education has seen a growing body of research dedicated to understanding how various instructional methods influence the development of critical and creative thinking skills. This research explores the efficacy of different teaching strategies and their impact on students' cognitive development, particularly in fostering higher-order thinking skills.

A significant body of work has focused on problem-based learning (PBL) and inquiry-based learning (IBL) as methods that enhance critical and creative thinking in mathematics. Problem-based learning, which involves presenting students with complex, real-world problems that do not have a single solution, has been shown to improve students' critical thinking by requiring them to analyze, reason, and devise multiple solutions [15]. Research by Hmelo-Silver [16] supports this by demonstrating that PBL promotes deep learning and the application of critical thinking skills through collaborative problem-solving.

Similarly, inquiry-based learning emphasizes student-driven exploration and investigation, which encourages students to question, hypothesize, and engage in scientific reasoning. According to a meta-analysis by Tamim [17], IBL approaches positively impact students' conceptual understanding and problem-solving skills. This research suggests that inquiry-based methods not only enhance students' mathematical knowledge but also foster critical and creative thinking by allowing them to explore and construct their own understanding of mathematical concepts.

Additionally, research on the use of open-ended problems in mathematics instruction has highlighted their effectiveness in promoting both critical and creative thinking. Open-ended

problems require students to explore multiple strategies and solutions, thereby engaging them in higher-order cognitive processes. Studies by Stein and Smith [18] and other scholars have shown that open-ended problems encourage students to think creatively and critically by challenging them to justify their reasoning and explore alternative approaches.

The role of collaborative learning in mathematics education is another area of significant research. Collaborative learning, which involves students working together to solve problems and discuss mathematical concepts, has been shown to enhance critical and creative thinking by providing opportunities for peer interaction and shared problem-solving [19]. Research by Webb [20] indicates that collaborative learning environments promote deeper cognitive engagement and higher-order thinking skills, as students are exposed to diverse perspectives and problem-solving approaches.

Research in Similar Educational Contexts

Internationally, various studies have investigated the impact of different instructional strategies on the development of critical and creative thinking skills in mathematics education, providing valuable insights that can inform practices in diverse educational contexts.

In the United States, extensive research has been conducted on the effectiveness of inquiry-based and problem-based learning approaches. For instance, the work of Brusilovsky and Millán [21] highlights that inquiry-based methods significantly improve students' problem-solving abilities and critical thinking skills by engaging them in active learning processes. Similarly, research by Hattie [22] indicates that problem-based learning and inquiry-based approaches lead to substantial gains in student achievement and cognitive development.

In Singapore, which is known for its high-performing education system, research by Leong and Lee [23] has shown that integrating problem-solving and critical thinking into the mathematics curriculum leads to improved student outcomes. The study emphasizes the importance of designing instructional activities that challenge students to apply mathematical concepts in novel and meaningful ways, thereby fostering both critical and creative thinking.

In Finland, the emphasis on student-centered learning and innovative teaching practices has been linked to high levels of critical and creative thinking among students. Research by Aho [24] highlights that Finnish education practices, such as project-based learning and interdisciplinary approaches, effectively promote higher-order thinking skills and a deep understanding of mathematical concepts.

In the context of developing countries, including Laos, research has identified several challenges and opportunities for improving mathematics instruction. For example, a study by [10] highlights the need for professional development and capacity-building for teachers to implement effective instructional strategies that support critical and creative thinking. Similarly, research by the [8] underscores the importance of contextualizing instructional reforms to address specific educational challenges and resource constraints.

Overall, the existing research provides a robust foundation for understanding how various instructional strategies can enhance critical and creative thinking in mathematics education. By examining successful practices from different educational contexts, educators and policymakers can gain valuable insights into designing and implementing effective teaching methods that support the development of these essential cognitive skills.

METHODOLOGY

Research Design

This study utilized a mixed-methods research design to evaluate the effectiveness of instructional strategies in enhancing critical and creative thinking among high school students in the Lao People's Democratic Republic. The design combined elements of quasi-experimental and descriptive research methods to provide a comprehensive assessment of the impact of innovative teaching methods.

A quasi-experimental approach was employed to test the efficacy of targeted instructional interventions. Schools were assigned to either an experimental group, which implemented the new teaching strategies, or a control group, which continued with traditional methods. This approach allowed for a comparative analysis of the instructional methods' effects on students' cognitive development. Additionally, descriptive research methods were used to gather qualitative data through observations and interviews, providing insights into the practical application of the instructional strategies and their effects on both students and teachers.

Participants

The study involved high school students and mathematics teachers from four secondary schools in the Champasak Province of Laos.

Teachers: Data collection for teachers was conducted in two phases, from April 2022 to June 2022. The schools included in the study were: Pakse High School, Pakse District; Nguadeng High School, Sanasomboun District; PakSong High School, Paksong District; PhonThong High School, Phonthong District.

In addition, a number of teachers from BaChieng District and PaThoumPhon District participated. A total of 56 questionnaires were distributed to these teachers, and all 56 questionnaires were successfully collected, ensuring a full response rate.

Students: For the student component, data collection was carried out at the beginning of the 2022-2023 academic year. The schools involved were: Pakse High School, Pakse District; Nguadeng High School, Sanasomboun District; PakSong High School, Paksong District; PhonThong High School, Phonthong District.

A total of 200 questionnaires were distributed to students in grades 10 and 11 across these schools, and all 200 questionnaires were returned, resulting in a complete response rate.

Data Collection

Data were collected using a combination of quantitative and qualitative methods to ensure a comprehensive evaluation of the instructional strategies.

Quantitative Data Collection:

Pre- and Post-Intervention Assessments: To measure the impact of the instructional interventions on students' critical and creative thinking skills, pre- and post-intervention assessments were administered. These assessments included standardized tests designed to evaluate critical thinking and creativity, such as the Critical Thinking Skills Test [1] and the Torrance Tests of Creative Thinking [13]. These tests provided quantitative data on students' cognitive abilities before and after the interventions.

Surveys: Surveys were distributed to both students and teachers to gather data on their perceptions of the instructional strategies. The student survey included questions about their experiences with the new teaching methods and their perceived impact on their thinking skills.

The teacher survey focused on their experiences with implementing the new strategies and their observations of students' engagement and cognitive development.

Qualitative Data Collection:

Classroom Observations: Researchers conducted structured classroom observations to assess how the instructional strategies were implemented and to gather insights into classroom interactions. The observations focused on the use of specific teaching methods, student participation, and the dynamics of student-teacher interactions.

Interviews: Semi-structured interviews were conducted with a subset of students and teachers to gain deeper insights into their experiences and perspectives. The interviews aimed to explore the influence of the instructional strategies on students' critical and creative thinking, as well as to identify any challenges or successes in the implementation process.

Data Analysis

The analysis of data involved both quantitative and qualitative methods to provide a thorough evaluation of the instructional interventions.

Quantitative Analysis:

Statistical Analysis: Quantitative data from the pre- and post-intervention assessments were analyzed using statistical methods, including paired t-tests and analysis of covariance (ANCOVA). These analyses assessed the effectiveness of the instructional strategies in improving students' critical and creative thinking skills and compared the performance of the experimental and control groups.

Survey Analysis: Responses from the surveys were analyzed using descriptive statistics to summarize the perceptions of students and teachers regarding the instructional strategies. This analysis provided insights into the effectiveness and reception of the new teaching methods.

Qualitative Analysis:

Thematic Analysis: Qualitative data from classroom observations and interviews were analyzed using thematic analysis. This involved identifying and coding recurring themes and patterns related to the implementation and impact of the instructional strategies. Thematic analysis provided a nuanced understanding of how the teaching methods influenced students' cognitive development and the practical challenges encountered.

Triangulation: To enhance the reliability and validity of the findings, triangulation was employed by comparing results from different data sources, including assessments, surveys, observations, and interviews. This approach ensured a comprehensive and robust evaluation of the instructional strategies' impact.

RESULTS

Findings

The results from this study provide a comprehensive evaluation of the effectiveness of innovative instructional strategies on enhancing critical and creative thinking among high school students in the Lao People's Democratic Republic. The analysis is based on both quantitative and qualitative data collected from various sources.

Quantitative Findings

Impact on Critical Thinking Skills

To assess changes in students' critical thinking skills, the Critical Thinking Skills Test ([1], 2015) was administered before and after the intervention. The data were analyzed and the results are summarized in Table 1.

Table 1: Pre- and Post-Test Mean Scores for Critical Thinking

Group	Pre-Test Mean Score	Post-Test Mean Score	Mean Difference	Statistical Significance (p-value)
Experimental	72.5	83.2	10.7	$p < 0.01$
Control	71.8	75	3.2	Not Significant

The experimental group, which engaged with the new instructional strategies, demonstrated a significant improvement in critical thinking skills, with a mean score increase of 10.7 points from pre-test to post-test. In contrast, the control group showed only a modest increase of 3.2 points. The p-value of less than 0.01 indicates that the improvement in the experimental group is statistically significant, suggesting that the new instructional methods were effective in enhancing students' critical thinking skills.

Impact on Creative Thinking Skills

The Torrance Tests of Creative Thinking [13] were used to measure changes in creative thinking skills. The results are detailed in Table 2.

Table 2: Pre- and Post-Test Mean Scores for Creative Thinking

Group	Pre-Test Mean Score	Post-Test Mean Score	Mean Difference	Statistical Significance (p-value)
Experimental	65.4	73	7.6	$p < 0.05$
Control	64.9	67.3	2.4	Not Significant

Similar to critical thinking, the experimental group exhibited a significant improvement in creative thinking skills, with a mean score increase of 7.6 points. The control group's mean score increased by only 2.4 points. The p-value of less than 0.05 indicates a significant improvement in the experimental group, supporting the effectiveness of the new instructional strategies in fostering creative thinking.

Qualitative Findings

Classroom Observations

Structured classroom observations were conducted to understand the implementation of instructional strategies. Observations revealed that the experimental group classrooms were more dynamic, with increased student engagement and interaction. Teachers noted that students were more involved in problem-solving activities and collaborative tasks, reflecting a higher level of cognitive engagement and application of new strategies.

Interviews

Interviews with students and teachers provided additional insights into their experiences with the new instructional methods. The key themes identified are summarized in Table 3.

Table 3: Key Themes from Interviews

Theme	Students	Teachers
Engagement	Increased motivation and interest	More active participation in classes

Problem-Solving Skills	Enhanced application of concepts	Improved student problem-solving abilities
Challenges	Initial difficulty with new methods	Time-consuming preparation and adaptation

Students reported a notable increase in motivation and interest due to the new instructional methods, which were perceived as more engaging. Teachers observed improved problem-solving skills among students and highlighted the positive impact of collaborative learning. However, challenges included the time required to adapt to new methods and the initial difficulty in implementation. These insights underscore both the benefits and the practical challenges of implementing innovative instructional strategies.

DISCUSSION

The study's findings demonstrate that the innovative instructional strategies significantly enhanced both critical and creative thinking skills among high school students. The substantial improvements in the experimental group, as evidenced by the statistical analyses, validate the effectiveness of these new teaching methods.

The improvements observed align with theoretical frameworks that advocate for problem-based and inquiry-based learning. Research by Barrows [15] and [16] supports the notion that such approaches foster higher-order thinking by promoting active engagement. The results of this study are consistent with these theories and with previous research in other contexts. For example, studies conducted in Singapore [23] and Finland [24] have similarly found that innovative teaching practices enhance cognitive skills.

The findings also highlight specific contextual factors affecting the implementation of instructional strategies in Laos. Resource limitations and variations in teacher preparedness were noted as challenges. Teachers reported that the new methods, while effective, required significant preparation time and adaptation. Additionally, cultural and educational differences in Laos may influence the application and success of these strategies. Understanding these contextual factors is crucial for adapting and scaling effective educational practices in diverse settings.

CONCLUSION

This study demonstrates that innovative instructional strategies can significantly enhance critical and creative thinking skills among high school students in Laos. The implementation of new teaching methods led to notable improvements in both critical and creative thinking abilities, as evidenced by significant increases in assessment scores for the experimental group compared to the control group. The study's findings align with theoretical frameworks supporting problem-based and inquiry-based learning approaches, which emphasize active engagement and higher-order thinking. Qualitative data further highlighted the effectiveness of these strategies in increasing student motivation and problem-solving skills, though practical challenges related to implementation were identified. Addressing these challenges, such as providing adequate preparation time and support for teachers, is crucial for successful integration of innovative methods into existing curricula. This research contributes valuable insights into enhancing mathematics education in Laos and offers recommendations for educators and policymakers to better support cognitive development through effective instructional practices. Future studies should explore the long-term impacts of these strategies and their applicability in diverse educational contexts to further refine and expand effective teaching methods.

REFERENCES

[1] Facione, P. A. *Critical Thinking: What It Is and Why It Counts*. Insight Assessment, 2015.

[2] Do, T.-T., Hoang, K. C., Do, T., Trinh, T. P. T., Nguyen, D. N., Tran, T., Le, T. T. B. T., Nguyen, T. C., and Nguyen, T.-T. "Factors Influencing Teachers' Intentions to Use Realistic Mathematics Education in Vietnam: An Extension of the Theory of Planned Behavior." *Journal on Mathematics Education* 12, no. 2 (2021): 331-348. https://doi.org/10.22342/jme.12.2.14094.331-348.

[3] Hiebert, J., and Grouws, D. A. "The Effects of Classroom Mathematics Teaching on Students' Learning." In *Second Handbook of Research on Mathematics Teaching and Learning*, edited by F. K. Lester Jr., 371-404. Information Age Publishing, 2007.

[4] Nguyen Van Luong, Mai Quoc Khanh, Tran Viet Cuong, and Tran Trung Tinh. "Evaluating the Pedagogical Professionalism of Students in Pedagogical Universities in Vietnam in the Context of Open Knowledge." *Research Journal in Advanced Humanities* 4, no. 2 (2023). https://doi.org/10.58256/rjah.v4i2.1073.

[5] Kilpatrick, J., Swafford, J., and Findell, B. *Adding It Up: Helping Children Learn Mathematics*. National Research Council, 2001.

[6] Schoenfeld, A. H. *Mathematical Thinking and Problem Solving*. Routledge, 2016.

[7] Lao Ministry of Education and Sports. *Education Statistics and Reports*. Government of Lao PDR, 2021.

[8] World Bank. *Lao PDR: Education Sector Review*. World Bank Group, 2019.

[9] Robinson, K. *Out of Our Minds: Learning to Be Creative*. Capstone Publishing, 2011.

[10] UNESCO. *Education for Sustainable Development: A Roadmap*. United Nations Educational, Scientific and Cultural Organization, 2020.

[11] Paul, R., and Elder, L. *Critical Thinking: Tools for Taking Charge of Your Learning and Your Life*. Pearson, 2014.

[12] Piaget, J. *To Understand Is to Invent: The Future of Education*. Grossman Publishers, 1973.

[13] Torrance, E. P. *Torrance Tests of Creative Thinking*. Personnel Press, 1974.

[16] Hmelo-Silver, C. E. "Problem-Based Learning: What and How Do Students Learn?" *Educational Psychology Review* 16, no. 3 (2004): 235-266.

[17] Tamim, S. F., Bernard, R. M., Borokhovski, E., Abrami, P. C., and Schmid, R. F. "What Forty Years of Research Says About the Impact of Technology on Learning: A Meta-Analysis." *Review of Educational Research* 81, no. 1 (2011): 4-28.

[18] Stein, M. K., and Smith, M. S. "Mathematics Reform in the United States: The Case of the NCTM Standards." In *Providing a Foundation for Teaching and Learning Mathematics*, edited by J. T. Sowder and B. P. Schappelle, 1-22. National Council of Teachers of Mathematics, 1998.

[19] Johnson, D. W., and Johnson, R. T. *Learning Together and Alone: Cooperative, Competitive, and Individualistic Learning*. Allyn & Bacon, 1994.

[13] Guilford, J. P. "Creativity." *American Psychologist* 5, no. 9 (1950): 444-454.

[14] Csikszentmihalyi, M. *Creativity: Flow and the Psychology of Discovery and Invention*. HarperCollins, 1996.

[15] Barrows, H. S. "A Taxonomy of Problem-Based Learning Methods." *Medical Education* 20, no. 6 (1986): 481-486.

[20] Webb, N. M. "The Role of Collaborative Learning in Mathematics Education." In *Mathematics Education: A Critical Review*, edited by P. L. Galbraith, N. N. Bednarz, and J. A. V., 237-252. Routledge, 2009.

[21] Brusilovsky, P., and Millán, E. *User Models for Adaptive Hypermedia and Adaptive Educational Systems*. Springer, 2007.

[22] Hattie, J. *Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement*. Routledge, 2009.

[23] Leong, Y. K., and Lee, H. L. "Problem-Solving and Critical Thinking: Practices and Results." *Journal of Mathematics Education* 10, no. 2 (2017): 69-80.

[24] Aho, E., Bybee, R. W., and Lang, J. *The Future of Education in Finland*. Springer, 2013.

[25] Vygotsky, L. S. *Mind in Society: The Development of Higher Psychological Processes*. Harvard University Press, 1978.