Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students

Li Zhanfeng[1], Suwana Juithong[2] and Wassaporn Jirojphan[3]

[1]Ph.D. student, Curriculum and Instruction Program, Valaya Alongkron Rajabhat University under the Royal Patronage, Pathum Thani Province, Thailand

[2,3]Curriculum and Instruction Program, Valaya Alongkron Rajabhat University under the Royal Patronage, Pathum Thani Province, Thailand

[1] E-mail: 2739057191@qq.com, ORCID ID: https://orcid.org/0009-0000-5622-2161

[2] E-mail: suwana@vru.ac.th, ORCID ID: https://orcid.org/0009-0002-1391-5819

[3] E-mail: wassaporn@vru.ac.th, ORCID ID: https://orcid.org/0009-0007-6934-5372

Received 14/03/2026 Revised 31/03/2026 Accepted 02/05/2026

Abstract

Background and Aims: Mathematics is the foundation of major technological innovations and development, so cultivating mathematical problem-solving abilities is particularly important. However, traditional teacher-centered methods often emphasize rote memorization over problem-solving abilities, leading to limited student engagement and limited mathematics problem-solving abilities. This study aims to: 1) compare students' mathematics problem-solving abilities before and after implementing a junior middle school mathematics course based on cooperative learning combined with inquiry-based learning; 2) compare students' mathematics problem-solving abilities after implementing the course with a criterion set at 70%; and 3) compare students' satisfaction after implementing the course with a criterion set at 70%.

Methodology: This study involved 450 students in the 9th grade from Zhoukou No. 19 Junior Middle School, selecting 30 students (1 class) as the sample through cluster random sampling. Research tools included lesson plans, a mathematics problem-solving ability test, and a students' satisfaction questionnaire. The experimental design was a one-group pretest and post-test design. Data collection and analysis employed the mean, standard deviation, one-sample t-test, and paired-samples t-test.

Results: Cooperative learning combined with inquiry-based learning strategies stimulated students' learning enthusiasm, and students' post-test scores were significantly improved compared to pre-test scores; mathematics problem-solving abilities were significantly higher than the determined standard of 70% at the .05 statistical significance level; students' satisfaction was at a high level and was significantly higher than the determined standard of 70%.

Conclusion: Cooperative learning combined with inquiry-based learning strategies has a significant effect on enhancing students' mathematics problem-solving ability. Furthermore, students were satisfied with these methods.

Keywords: Junior Middle School Mathematics Course; Cooperative Learning; Inquiry-based Learning; Mathematics Problem-solving Ability; Students' Satisfaction

Citation: Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

Introduction

Mathematics plays a crucial role in cultivating students' logical thinking, spatial reasoning, calculation abilities, and problem-solving abilities. The Compulsory Education Mathematics Curriculum Standards (2022 Edition) emphasizes cultivating students' basic knowledge, skills, concepts, and practical experience, as well as their ability to use mathematical knowledge to discover, analyze, and solve problems. The focus in the future will be on cultivating students' ability to effectively integrate resources, collaborate with others, and solve problems (Zhong, 2016).

Despite curriculum reforms emphasizing problem-solving abilities, classroom reality often contradicts these policy intentions. Observations at junior middle schools in Zhoukou City reveal that under the pressure of standardized test requirements and limited lesson preparation time, teachers often adopt traditional teaching methods. The main problems include: 1) Monotonous classroom formats and low student participation. Classroom teaching is teacher-centered, with students passively receiving knowledge, lacking learning interest, and unwilling to participate in teaching activities. 2) Poor student problem-solving abilities. Because students mechanically apply formulas without understanding their underlying meaning, they struggle to establish effective connections with other knowledge, let alone flexibly apply knowledge to solve practical problems. 3) The evaluation method is singular. Over-reliance on exam scores neglects the evaluation of the learning process, innovative thinking, and practical abilities. Teachers cannot promptly understand students' learning progress and cannot flexibly adjust teaching strategies. This seriously hinders students' personalized development and the cultivation of problem-solving abilities. (Ni, 2020)

The State Council's "Decision on the Reform and Development of Basic Education" clearly states: "Encourage students to explore independently and learn collaboratively, promote mutual exchange and common development among students, and promote two-way learning between teachers and students." Mathematics teaching activities should be a process of active participation, interactive exchange, and common growth for both teachers and students. Effective teaching activities are an organic combination of students' active learning and teachers' scientific guidance; students are the main body of learning, while teachers play the role of organizers, guides, and coordinators. Current teaching development is moving towards "cooperative learning" and "joint exploration" (Peng, 2023)

The combination of cooperative learning and inquiry-based learning has completely overturned the traditional teaching model. This student-centered teaching model promotes deep interaction between students and the teaching content, peers, and teachers through creating scenarios, problem-driven learning, and organizing activities, thereby improving classroom learning efficiency. Adopting this model in teaching activities not only effectively enlivens the classroom

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

atmosphere and stimulates students' enthusiasm for learning, but also cultivates students' spirit of inquiry, cooperative awareness, and problem-solving abilities. With the continuous deepening of educational reform, collaborative inquiry-based learning has become a new teaching model for students' knowledge construction and ability development, and also an important strategy for improving students' problem-solving abilities.

Objectives

The objectives of this research were to determine the effectiveness of implementing a junior middle school mathematics course based on cooperative learning combined with inquiry-based learning.

1) Compare students' mathematics problem-solving ability before and after implementing the course.

2) Compare students' mathematics problem-solving ability after implementing the course with a criterion set at 70%.

3) Compare students' satisfaction after implementing the course with a criterion set at 70%.

Literature Review

Mathematics course based on cooperative learning combined with inquiry-based learning

According to Okoronka and Wada (2014), learners need to be made to construct their own knowledge and ideas in learning because they are the architects of their own learning; otherwise, continued use of teacher-centered strategies would yield consistently poor results in external examinations. Aina (2013) opined that science (physics) education must focus attention on innovative teaching methods such as cooperative learning strategies and inquiry-based learning that can promote creative thinking and develop problem-solving skills in students.

Cooperative learning, according to Igboekwu (2012), is the deliberate intellectual use of homogeneous or heterogeneous small groups of students who work together to maximize each other's learning. Ifamuyiwa and Onakoya (2013) viewed cooperative learning as an instructional method in which learners work together in small groups in such a manner that each member of the group can participate in a clearly defined collective task and engage in discussion with one another while participating in authentic learning activities. Most of these focus on the construction of cooperative learning forms and do not pay enough attention to the collision of students' ideas, the improvement of problem-solving abilities, and the cultivation of creative thinking during the cooperation process. Rather than having the teacher as the only dispenser of facts and lower-level cognitive information, constructivists believe that the teacher should serve as a facilitator who

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

attempts to structure an environment in which the learner organizes meaning on a personal level (Patall, Cooper & Robinson, 2008).

Inquiry-based learning is a teaching method in which teachers ask questions and students collect data, analyze information, and solve problems (Perry & Richardson, 2001). Inquiry-based learning, which emphasizes students asking questions, exploring situations, and developing solutions, is linked to a learning culture that attempts to mimic the way scientists work (Artigue & Blomhøj, 2013). Inquiry-based learning advocates that teachers guide students to explore experiences and enhance their interest and ability to learn through hands-on practice. Studies have shown that inquiry-based learning has a positive impact on students' behavior and motivation (Camenzuli & Buhagiar, 2014; Caswell & LaBrie, 2017). Most of these studies stay at "formal exploration". Students' exploration process lacks autonomy and openness, making it difficult to truly cultivate students' problem-solving abilities.

In mathematics and science education, the combination of cooperative learning and self-directed exploration of inquiry-based learning is particularly critical (Artigue & Blomhøj, 2013). It can achieve the complementarity of "group collaboration" and "individual exploration" to better cope with the challenges of mathematical problem solving. Cooperative learning and structured group activities provide a platform for teamwork and interaction in inquiry-based learning, while the self-directed exploration and problem-solving mode of inquiry-based learning enhances the depth and breadth of cooperative learning. This combination not only transforms students from traditional passive recipients of knowledge to active knowledge builders but also significantly improves student engagement and learning outcomes in the learning process (Johnson & Johnson, 2009).

Based on research on cooperative learning and inquiry-based learning, and combined with the characteristics of the junior middle school mathematics course, this paper organically combines the advantages of each approach to construct a teaching process for the junior middle school mathematics course based on a combination of cooperative learning and inquiry-based learning.

Step 1: Create situations and introduce new lessons.

Based on the learning objectives, content, and students' situation, the teacher creates an effective teaching situation to introduce the topic.

Step 2: Self-directed inquiry, cooperation, and communication.

In the teaching process, students should be problem-oriented, engage in independent inquiry and cooperative learning, and realize personalized knowledge construction.

Step 3: Achievements are displayed, Induction, and summarized.

Students need to present their learning outcomes. The teacher should promptly correct any problems and guide students in summarizing.

Step 4: Strengthening practice, enhancing understanding.

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

Teachers should design extension exercises related to the learned knowledge to enhance students' memory and understanding.

Step 5: Class summary, evaluation, and reflection

Teachers and students jointly summarize the key content, problem-solving strategies, methods, and skills learned in this lesson, and promptly evaluate students' performance during the learning process, reflecting on the learning outcomes.

Mathematics problem-solving ability

Problem-solving ability is closely related to people's knowledge and experience, and various psychological processes, and is the ability to mobilize individual cognitive resources to solve related problems. Yu Qiushi (1997) believes that from the perspective of mathematics education, the significance of problem solving is to actively and optimistically use the basic knowledge, basic skills, and abilities that you already have, and creatively solve new problems from mathematics classes or practical learning activities. According to the NCTM (2000), indicators of problem solving are: 1) building new mathematical knowledge through problem solving, 2) applying and adapting a variety of appropriate strategies to solve problems, 3) solving problems that arise in mathematics and in other contexts, and 4) monitoring and reflecting on the process of mathematics problem solving.

In short, mathematical problem-solving ability refers to a student's ability to understand and analyze mathematical problems, construct mathematical models, flexibly apply mathematical knowledge to solve real-life problems, and reflect on and evaluate their own work after solving the problems.

Conceptual Framework

In this study, the independent variable is the implementation of the Junior Middle School Mathematics Course based on Cooperative Learning (Ifamuyiwa & Onakoya, 2013) combined with Inquiry-Based Learning (Artigue & Blomhøj, 2013), and the dependent variables are mathematics problem-solving ability (Yu, 1997) and students' satisfaction.

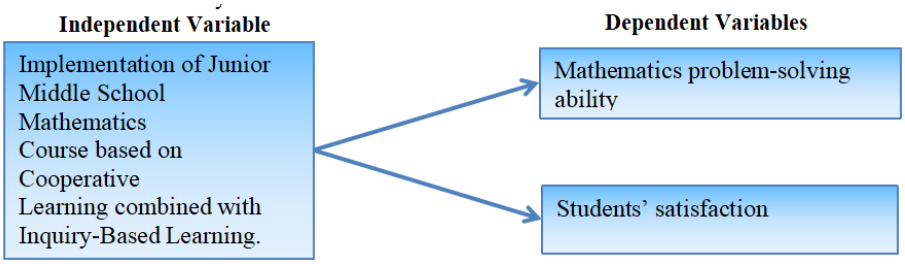


Figure 1 Conceptual Framework of the Research

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

Mothodology

Population and Samples: The population was 450 students of 9th grade students of Zhoukou No.19 Junior Middle School. The sample was 30 students (1 class) of 9th grade, which was derived using the cluster random sampling method.

1. Experimental instruments

1.1 Junior middle school mathematics course based on cooperative learning combined with inquiry-based learning: Five experts evaluated the draft course using a 25-item course evaluation form; the lowest mean score was 4.20 (*SD*=0.45), and the highest mean score was 4.80 (*SD*=0.45). It was revealed that the course was of a very high level (*M*=4.58, *SD*=0.52).

1.2 Lesson plans: Five experts evaluated the eight lesson plans. Among the lesson plan evaluation forms, the lowest mean score was 4.28 (*SD*=0.59), and the highest mean score was 4.63 (*SD*=0.51). It was revealed that lesson plans were of a very high level (*M*=4.51, *SD*=0.53).

2. Instruments for collecting data

2.1 Mathematics Problem-Solving Ability Test Paper: The test paper consisted of 2 sections. In section A, students are supposed to do 20 multiple-choice questions with 1 point for each question. In section B, students are supposed to do 4 solution questions, and each question is worth 5 points. Five experts evaluated the mathematics problem-solving ability test paper; each question's IOC on the test paper was between 0.60 and 1.00, higher than 0.5. The results of analyzing the IOC index showed that the mathematics problem-solving ability test paper can be used as a test. In section A, the difficulty (p) of each item in the range of 0.37-0.80, the discriminant (r) of each item in the range of 0.2-0.73, and the reliability value was 0.73 (Kuder & Richardson,1939), more than 0.70. In Section B, the difficulty (p) of each item in the range of 0.32-0.68, the discriminant (r) of each item in the range of 0.7-0.93, and the reliability value was 0.88 (Lee Cronbach, 1951), more than 0.70.

2.2 Students' satisfaction questionnaire: The questionnaire was provided to 5 experts for content validity checking and suggestions. The results of analyzing the IOC index showed that all test items were appropriate and could be used in the test. The Cronbach’s Alpha coefficient of the reliability of the student satisfaction questionnaire is 0.81, which is greater than 0.70. Therefore, the reliability of the student satisfaction questionnaire meets the requirements.

2.3 Data Collection: The procedures of data collection were as follows:

1) The sample was given a pretest to measure students' mathematics problem-solving ability.

2) After receiving instruction, the students in the experimental group underwent a post-test using the same tools as the pre-test.

3) The sample was given the students' satisfaction questionnaire to express their

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

opinion on the course.

2.4 Data Analysis: In this study, data were analyzed using statistical methods according to the research objectives.

1) Compare students' mathematics problem-solving ability before and after implementing the junior middle school mathematics course based on cooperative learning combined with inquiry-based learning by using the t-test for dependent samples.

2) Compare students' mathematics problem-solving ability after implementing the course with a criterion set at 70% by using a t-test for one sample.

3) Compare students' satisfaction after implementing the course with the criterion of 3.51 by using the arithmetic mean, standard deviation, and t-test for one sample.

Results

According to the research objectives, the results were as follows:

Table 1 The results of comparing the different scores of Mathematics Problem-Solving Ability before and after learning through the Junior Middle School Mathematics Course, based on cooperative learning combined with inquiry-based learning

Group	n	Pre-test scores		Post-test scores		*t*	*p*
		M	*SD*	*M*	*SD*		
Experimental group	30	20.40	5.72	33.10	4.35	36.68**	.001

**$p<.05$

As presented in Table 1, the mean scores of the pre-test of students' mathematics problem-solving ability were (M=20.4, SD=5.72), and the post-test was (M=33.10, SD=4.35). After learning through the course, students' mathematics problem-solving ability was higher than before at the .05 level of statistical significance (t_{29}=36.68, p=0.001<.05).

Table 2 The results of comparing students' mathematics problem-solving ability scores in the course after the course implementation, with the criterion of 70%

Group	n	Full score	The criteria score of 70%	*M*	*SD*	*t*	*p*
Experimental group	30	40	28	33.10	4.29	6.51**	.001

**$p<.05$

As presented in Table 2, the mean scores of students' mathematics problem-solving ability test after learning through the course were 33.10 out of a possible full marks of 40, and the standard deviation was 4.29, which was statistically higher than the determined criterion of 70% at the .05 level of statistical significance (t_{29}=6.51, p=.001 < .05). This indicates that students'

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

mathematics problem-solving abilities have significantly improved after implementing the course.

Table 3 The students' satisfaction with Junior Middle School Mathematics Course Based on Cooperative Learning combined with Inquiry-Based Learning

Contents	Questions	M	SD	Satisfaction level
Part 1: Learning aspect	1. The teaching objectives clearly guide students to develop their mathematical problem-solving abilities.	4.00	0.83	High level
	2. The teacher can effectively combine abstract mathematical knowledge with practical problem-solving.	4.10	0.48	High level
	3. The teaching objectives are set in accordance with the students' cognitive level.	4.17	0.53	High level
	4. The teaching objectives provide clear guidance for group cooperation tasks.	4.20	0.61	High level
Part 2: Teaching aspect	5. The teaching design encourages students to actively explore and communicate, which can effectively stimulate mathematical thinking.	4.33	0.48	High level
	6. The course design that integrates cooperative learning and inquiry-based learning helps to improve problem-solving skills.	4.30	0.65	High level
	7. The teaching content of this course is clearly expressed; the knowledge points are clear, and it is easy to understand and master.	4.33	0.48	High level
	8. This course can encourage students to actively complete the learning tasks assigned by the teacher.	4.10	0.48	High level
	9. Multimedia courseware (e.g., geometry animation) has a significant auxiliary teaching effect.	4.00	0.83	High level
	10. Online learning platforms (e.g., homework feedback system) are easy to operate	4.17	0.53	High level
	11. Tools required for group cooperation (e.g., mind map templates) are fully equipped.	4.10	0.48	High level
Part 3: Learning effectiveness	12. The situation setting can enhance learning interest and improve learning efficiency.	4.33	0.48	High level
	13. Independent exploration and group discussion are	4.17	0.53	High level

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

Contents	Questions	M	SD	Satisfaction level
	arranged appropriately and effectively.			
	14. The teacher can promptly guide students to overcome difficulties in the exploration process.	4.33	0.48	High level
	15. The classroom question design helps to promote in-depth thinking.	4.20	0.61	High level
	16. Students of different abilities can effectively participate in classroom activities.	4.33	0.48	High level
Part 4: Evaluations aspect	17. Teachers' feedback on the inquiry process is timely and instructive.	4.00	0.83	High level
	18. Test results can objectively reflect the improvement of problem-solving ability.	4.10	0.48	High level
	19. The evaluation criteria for classroom performance are clear and transparent, and the evaluation mechanism is implemented objectively and fairly.	4.33	0.48	High level
	Total	4.19	0.27	High level

As presented in Table 3, the students' satisfaction with the Junior Middle School Mathematics Course Based on Cooperative Learning combined with Inquiry-Based Learning was at a high level (*M*= 4.19, *SD*=0.27). In the 19 items of the satisfaction questionnaire, the lowest mean score was 4.00 (*SD*=0.83), and the highest mean score was 4.33 (*SD*=0.48).

Table 4 The results of comparing the scores of students' satisfaction after learning through Junior Middle School Mathematics Course Based on Cooperative Learning, combined with Inquiry-Based Learning, with the criteria set at 70%

Group	n	Criteria	*M*	*SD*	*t*	*p*
Experimental group	30	3.51	4.19	0.27	13.79**	.001

**$p<.01$

As presented in Table 4, the students' satisfaction after learning through the course was higher than the criterion of 3.51 at the .05 level of statistical significance (t_{29}=13.79, $p < .05$). It can be seen that the students' satisfaction after learning through the course is higher than 70%.

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Interdisciplinary Academic and Research Journal, 6 (6), November-December 2026
Old ISSN 2774-0374: New ISSN 2985-2749
Website: https://so03.tci-thaijo.org/index.php/IARJ/index
Article ID: e299446

Discussion

The following points, based on the research results, were discussed:

1. The results of the study revealed that after completing the junior middle school mathematics course based on cooperative learning combined with inquiry-based learning, students' mathematics problem-solving abilities have significantly improved after participating in the new course. The post-test mean score of problem-solving ability was 12.7 points higher than the pre-test, with statistical significance at the 0.05 level(t_{29}=6.51, p=*0.001*< .05). This demonstrates that the intervention had a positive impact on students' mathematics problem-solving ability, which is consistent with the findings of Sukontawaree et al. (2022). This may be due to the course based on a combination of cooperative and inquiry-based learning, is student-centered, emphasizing students' active role in the learning process. This student-centered learning approach helps to stimulate students' learning interest and initiative (Johnson, Johnson & Hollubek, 2013). Inquiry-based learning encourages students to ask questions boldly, explore solutions to problems, and analyze different results, thereby cultivating innovation and creativity. This aligns with the findings of Kurniashih et al. (2019). Cooperative learning, on the other hand, enhances problem-solving abilities by integrating collective wisdom and strength to solve problems together. These preliminary findings suggest that cooperative and inquiry-based strategies may support problem-solving development, though replication with larger samples and stronger designs is needed.

2. The results of the study revealed that students' satisfaction with the new mathematics course was significantly higher than the 70% criterion at the .05 statistical significance level. The mean satisfaction score (M = 4.19, SD = 0.27) exceeded the benchmark, with t_{29}=13.79, p=0.001 <.01. This suggests that students not only improved in problem-solving ability but also experienced the learning process as more engaging and rewarding. This may be due to the following reasons: First, the course created a supportive and interactive learning environment, where students felt valued and were encouraged to contribute their perspectives. This is consistent with the findings of Igboekwu (2012), whose study found that a diverse and interactive learning environment enhances student satisfaction. Second, the course encourages students to actively complete tasks and participate in group discussions. This is consistent with the findings of Johnson, Johnson & Hollubek, 2013), whose research found that collaborative learning not only enhances students' learning interest, teamwork ability, and communication skills, but also allows them to gain a sense of accomplishment and satisfaction, thereby improving overall satisfaction. Third, personalized guidance provided by teachers effectively meets the diverse needs of students, ensuring that each student receives targeted support, thus improving learning satisfaction.

This preliminary study suggests that integrating cooperative and inquiry-based approaches may support ninth-grade students' mathematics problem-solving development. However, the

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

single-group design and brief intervention period limit causal inferences. Future research should employ randomized controlled designs with longer implementation periods to establish effectiveness more definitively.

Recommendation

1. Recommendations for Implication

1) Encourage teachers to adopt a teaching model that combines cooperative learning and inquiry-based learning. Strengthen pre-service training to help teachers transform from "one-way knowledge instillers" to "teaching facilitators".

2) Emphasize formative assessment and focus on students' learning process. This includes evaluating not only students' mastery of mathematical knowledge but also their performance throughout the teaching process.

3) Value the innovation and development of educational technology. Integrating advanced educational technology into classroom teaching can improve students' classroom learning efficiency and enhance teaching effectiveness.

2. Recommendation for further research

1) Further research on the application of cooperative and inquiry-based learning in teaching. Conduct a longitudinal follow-up study to examine whether the improvement in problem-solving ability is sustainable.

2) Emphasize research on problem-solving abilities. Social development increasingly requires talent capable of flexibly applying knowledge to solve practical problems; this is not only a requirement of educational development but also an urgent need in today's big data era.

3) Develop new and more effective teaching strategies. Diverse teaching strategies ensure flexibility in teaching, enabling teachers to adjust their teaching methods according to students' needs, content requirements, and other factors.

References

Aina, J. K. (2013). Importance of science education to national development and problems militating against its development. *American Journal of Educational Research, 1*(7), 225–229. https://doi.org/10.12691/education-1-7-2

Artigue, M., & Blomhøj, M. (2013). Conceptualising inquiry-based education in mathematics. *ZDM Mathematics Education, 45*(6), 797–810. https://doi.org/10.1007/s11858-013-0506-6

Camenzuli, J., & Buhagiar, M. A. (2014). Using inquiry-based learning to support the mathematical learning of students with SEBD. *International Journal of Emotional Education, 6*(2), 69–85. https://eric.ed.gov/?id=EJ1085727

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Caswell, C. J., & LaBrie, D. J. (2017). Inquiry-based learning from the learner's point of view: A teacher candidate's success story. *Journal of Humanistic Mathematics, 7*(2), 161–186. https://doi.org/10.5642/jhummath.201702.08

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297–334. https://doi.org/10.1007/BF02310555

Ifamuyiwa, A. S., & Onakoya, S. K. (2013). Impact of think-pair-share instructional strategy on students' achievement in secondary school mathematics. *Journal of Science Teachers Association of Nigeria, 48*(1), 26–34.

Igboegwu, E. N. (2012). Effect of guided discovery and demonstration teaching methods on achievement of chemistry students at different levels of scientific literacy. *Journal of Research in Curriculum and Teaching, 6*(1), 445–458.

Johnson, D. W., & Johnson, R. T. (2009). An educational psychology success story: Social interdependence theory and cooperative learning. *Educational Researcher, 38*(5), 365–379. https://doi.org/10.3102/0013189X09339057

Johnson, D. W., Johnson, R. T., & Holubec, E. J. (2013). *Cooperation in the classroom* (9th ed.). Interaction Book Company.

Kuder, G. F., & Richardson, M. W. (1939). The theory of the estimation of test reliability. *Psychometrika, 4*(2), 151–160. https://doi.org/10.1007/BF02288391

Kurniashih, R., Syarifuddin, H., & Darmansyah. (2019). The influence of the guided inquiry learning model on students' mathematical problem-solving ability. In *Proceedings of the 1st International Conference on Innovation in Education (ICoIE 2018)* (pp. 358–362). Atlantis Press. https://doi.org/10.2991/icoie-18.2019.78

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. https://www.nctm.org/Standards-and-Positions/Principles-and-Standards/

Ni, C. (2021). *Action research on the cultivation of mathematics problem-solving ability in rural junior middle schools based on the flipped classroom* [Unpublished master's thesis]. Northwest Normal University.

Okoronka, U. A., & Wada, B. Z. (2014). Effects of analogy instructional strategy, cognitive style, and gender on senior secondary school students' achievement in some physics concepts in Mubi metropolis, Nigeria. *American Journal of Educational Research, 2*(9), 788–792.

Patall, E. A., Cooper, H., & Robinson, J. C. (2008). The effects of choice on intrinsic motivation and related outcomes: A meta-analysis of research findings. *Psychological Bulletin, 134*(2), 270–300. https://doi.org/10.1037/0033-2909.134.2.270

Peng, Z. (2023). *Study on teaching strategies for junior high school mathematics problem-solving based on the concept of cooperative learning* [Unpublished master's thesis]. Shanghai

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446

Normal University.

Perry, V. R., & Richardson, C. P. (2001). The New Mexico Tech master of science teaching program: An exemplary model of inquiry-based learning. In *31st Annual Frontiers in Education Conference: Impact on Engineering and Science Education* (Vol. 1, pp. T3E-1–T3E-4). IEEE. https://doi.org/10.1109/FIE.2001.963917

Sukontawaree, N., Poonputta, A., & Prasitnok, O. (2022). Development of problem-solving abilities in science by inquiry-based learning with cooperative learning for grade 4 students. *Journal of Educational Issues, 8*(2), 771–782. https://doi.org/10.5296/jei.v8i2.20418

Yu, Q. (1997). "Problem-solving" and the middle school mathematics curriculum. *Curriculum, Teaching Material and Method, 8*, 31–34.

Zhong, Q. (2016). Problem-based learning: A learning approach for the new century. *China Educational Journal, 9*, 31–35.

Citation:
Li, Z., Juithong, S., & Jirojphan, W. (2026). Effects of Cooperative Learning Combined with Inquiry-Based Learning Strategies on Mathematics Problem-Solving Abilities Among Ninth-Grade Students. Interdisciplinary Academic and Research Journal, 6(6), e299446; DOI: https://doi.org/10.60027/iarj.2026.e299446