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Developing think-pair-share learning activities to enhance grade 3 students' academic achievement on mixed operations of addition, subtraction, multiplication, and division

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ABSTRACT

Primary students' understanding of mixed arithmetic operations is essential for building foundational mathematical competence, and cooperative learning strategies such as think–pair–share (TPS) may enhance both conceptual understanding and classroom engagement. The purposes of this study were to (1) develop think–pair–share learning management plans based on the 70/70 efficiency criterion, (2) compare grade 3 students' academic achievement before and after the intervention, and (3) examine students' satisfaction with the learning activities. The participants were 19 of grade 3 students selected through cluster random sampling from a primary school in Roi Et Province, Thailand. The instruments included 13 TPS learning management plans, a 20-item mathematics achievement test, and a 15-item student satisfaction questionnaire. The data were analyzed using efficiency analysis, descriptive statistics, and dependent t-test. The results showed that the instructional plans achieved an efficiency of 72.86/76.60, students' posttest scores were significantly higher than pretest scores with a very large effect size, and overall student satisfaction was at a very high level. This study contributes empirical evidence supporting the effectiveness of structured cooperative learning in enhancing primary mathematics achievement.

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1. INTRODUCTION

In the contemporary educational landscape, cooperative learning has become increasingly significant as schools attempt to cultivate not only academic competence but also communication, collaboration, and problem-solving abilities (Laal et al., 2012; Sotto, 2021). Traditional teacher-centered instruction, which emphasizes passive knowledge reception, no longer aligns with the demands of twenty-first-century education (Alismail & McGuire, 2015). Educational reforms worldwide increasingly advocate instructional approaches that position learners as active participants in constructing knowledge through interaction and shared inquiry (OECD, 2013). Within this paradigm, cooperative learning serves as a pedagogical framework that promotes meaningful engagement, mutual responsibility, and deeper conceptual understanding.

Among various cooperative learning strategies, the Think–Pair–Share (TPS) technique has received considerable attention for its structured yet flexible design. TPS is grounded in social constructivist theory, particularly the notion that knowledge is constructed through social interaction (Hausfather, 1996). The technique consists of three sequential stages: individual thinking, paired discussion, and whole-class sharing. This structure allows learners to process ideas independently before refining their understanding through peer interaction. Research has shown that TPS enhances cognitive engagement, increases participation, and improves academic achievement across subject areas.

For young learners, particularly those at the primary level, cooperative learning is developmentally appropriate (Clipa & Caramida, 2024; Zisopoulou, 2019). Grade 3 students are in a stage where social interaction plays a crucial role in cognitive and emotional development (Romieh et al., 2023). Learning mathematics through structured peer collaboration can reduce anxiety, increase enjoyment, and develop positive attitudes toward the subject. When children work together to solve mathematical problems, they are not only developing computational skills but also practicing communication, turn-taking, and perspective-taking. Such interaction supports both academic growth and the development of essential social skills.

In the Thai educational context, many classrooms continue to rely heavily on lecture-based instruction, resulting in limited student participation and passive learning behaviors (Suyaprom & Manmee, 2018; Unicef, 2014). This issue is particularly evident in mathematics classrooms, where students often memorize procedures without fully understanding underlying concepts. Think–Pair–Share offers a practical solution to this challenge as it ensures that every student has an opportunity to think, discuss, and articulate mathematical reasoning (Silva et al., 2022). Therefore, promoting structured interaction becomes the crucial point where TPS can help transform passive classrooms into more dynamic learning environments.

A growing body of research has demonstrated the pedagogical value of the Think–Pair–Share (TPS) strategy in mathematics classrooms across diverse educational contexts. Empirical evidence consistently indicates that TPS enhances students' mathematical achievement, conceptual understanding, and communication skills. For instance, quasi-experimental studies have reported significant improvements in students' learning outcomes when TPS was implemented compared with conventional or alternative cooperative methods (Abiodun et al., 2022; Wahjuningsih et al., 2023). Classroom action research further suggests that TPS promotes the development of mathematical communication skills and encourages more active engagement during instruction (Tarigan, 2022). In addition, survey-based research highlights teachers' positive perceptions of TPS in fostering conceptual clarity and student participation, despite implementation challenges such as time constraints and uneven participation (Ramadhani et al., 2025). Although one study reported limited gains in geometry achievement (Triyono et al., 2024), the overall pattern of findings suggests that TPS holds considerable potential for improving both cognitive and affective outcomes in mathematics education.

Despite these promising findings, several gaps remain in the existing literature. First, most prior studies have focused on secondary-level students, with limited empirical evidence examining the effectiveness of TPS at the primary level, particularly among young learners in lower grades. Second, few studies have employed a development-and-efficiency framework that systematically designs instructional activities and evaluates their effectiveness using established efficiency criteria. Third, contextualized evidence within Thai primary school settings, especially in rural or underperforming areas, remains insufficient. Furthermore, previous research has primarily emphasized achievement outcomes, while student satisfaction and instructional efficiency have received comparatively less attention. Therefore, the present study aims to (1) develop Think–Pair–Share learning activities for Grade 3 students on mixed arithmetic operations based on the 70/70 efficiency criterion; (2) compare students' achievement before and after the implementation of the developed activities; and (3) examine students' satisfaction with the instructional activities.

2. METHOD

2.1 Research Design

This study employed a pre-experimental research design using a one-group pretest–posttest format. The design was selected to examine the effectiveness of the developed Think–Pair–Share (TPS) learning activities on Grade 3 students' achievement in mixed arithmetic operations. The treatment consisted of 13 lesson plans, each lasting one hour, implemented over the second semester of the 2025 academic year. The

instructional activities were developed according to cooperative learning principles and structured around the three phases of Think–Pair–Share: individual thinking, peer discussion, and whole-class sharing.

2.2 Participants

The population consisted of Grade 3 students enrolled in the second semester of the 2025 academic year in schools under the Tri-Jung-Harn Network, Roi Et Primary Educational Service Area Office 1, Thailand. These schools were selected based on having National Test (NT) mathematics scores below the national average and relatively comparable mean scores. The sample comprised 19 Grade 3 students from Muang Jung-Harn School. The participants were selected using cluster random sampling. All students in the selected classroom participated in the study.

2.3 Research Instruments

2.3.1 Think–Pair–Share Learning Management Plans

The Think–Pair–Share (TPS) learning management plans were developed to enhance Grade 3 students' achievement in mixed arithmetic operations involving addition, subtraction, multiplication, and division. The primary purpose of the learning management plans was to promote conceptual understanding, active participation, and collaborative problem-solving through structured peer interaction.

The plans were developed based on three foundational principles: (1) cooperative learning theory, which emphasizes positive interdependence and individual accountability; (2) social constructivist theory, which posits that knowledge is constructed through social interaction; and (3) the structured phases of the Think–Pair–Share technique, consisting of individual thinking, paired discussion, and whole-class sharing. The content was aligned with the Thai Basic Education Core Curriculum (Ministry of Education, 2008) for Grade 3 mathematics under Standard K 1.1. A total of 13 learning management plans were developed, each designed for one instructional hour. The sequence of lessons progressed from foundational computational skills (addition and subtraction), to number sense development in mixed operations, two-step problem solving involving multiplication and division, and finally to contextual and real-life word problems. The lesson series also included activities in which students constructed their own two-step problems to reinforce deeper understanding.

To illustrate, in one lesson on solving two-step mixed-operation word problems, students first engaged in the "Think" phase by individually analyzing a contextual problem and identifying the required operations. During this stage, they wrote symbolic expressions and attempted initial solutions independently. In the "Pair" phase, students worked with a partner to compare strategies, discuss reasoning, and revise their solutions where necessary. They were encouraged to justify their thinking verbally and identify possible errors. In the "Share" phase, selected pairs presented their reasoning to the whole class, while the teacher facilitated discussion, clarified misconceptions, and highlighted multiple solution strategies. The lesson concluded with guided practice and formative assessment tasks aligned with the learning objectives.

The quality of the learning management plans was evaluated through expert review. Five experts in mathematics education, curriculum design, and educational measurement assessed the content validity, instructional alignment, clarity of language, and appropriateness of activities using a five-point rating scale. The overall mean evaluation score indicated the plans were appropriate at the highest level. After incorporating expert feedback, the plans were pilot-tested with a group of students who were not part of the main sample to examine feasibility and instructional efficiency prior to implementation.

2.3.2 Mathematics Achievement Test

The mathematics achievement test was developed to measure grade 3 students' understanding and problem-solving ability in mixed arithmetic operations, including addition, subtraction, multiplication, and division. The test was used as both a pretest and posttest to examine changes in students' academic achievement following the implementation of the Think–Pair–Share learning activities. The test consisted of 20 multiple-choice items with three response options per item. Each correct answer was awarded one point. The items covered key content areas, including computational skills, number sense in mixed operations, two-step problem solving, contextual word problems, and problem construction aligned with Grade 3 curriculum standards. The test was developed based on the Thai Basic Education Core Curriculum and a table of specifications that aligned learning objectives with item distribution. An initial pool of 30 items was constructed and reviewed before being reduced to 20 items for actual use. All items were examined for content validity by five experts using the index of item–objective congruence with values

ranging from 0.60 to 1.00. The selected items demonstrated appropriate difficulty (p = 0.20–0.80), acceptable discrimination (B = 0.20–1.00), and satisfactory reliability (r = 0.82).

2.3.3 Satisfaction Questionnaire

The satisfaction questionnaire was designed to examine students' perceptions of the Think–Pair–Share learning activities in terms of instructional process, learning materials, assessment practices, and perceived learning benefits. The questionnaire consisted of 15 items using a five-point Likert scale ranging from 1 (lowest satisfaction) to 5 (highest satisfaction). The items were organized into four dimensions: learning management process, instructional media, assessment and evaluation, and perceived student benefits. The instrument was developed based on relevant literature on student satisfaction and cooperative learning environments. An initial set of 25 items was constructed and subsequently refined to 15 items based on expert review and item analysis. Content validity was established through expert evaluation (IOC = 0.60-1.00). Item discrimination was examined using item–total correlation, and the final instrument demonstrated satisfactory internal consistency reliability.

2.4 Data Collection and Data Analysis

Data collection was conducted during the second semester of the 2025 academic year. Prior to the implementation of the instructional intervention, students completed a 20-item mathematics achievement pretest to assess their baseline understanding of mixed arithmetic operations. The Think–Pair–Share learning management plans were then implemented over 13 instructional sessions, each lasting one hour. During the intervention, students participated in structured activities following the Think, Pair, and Share phases. Process scores were collected from in-class exercises and learning tasks to determine instructional efficiency (E1). Upon completion of the intervention, students completed the same achievement test as a posttest, with item order rearranged to minimize recall effects. These posttest scores were used to calculate outcome efficiency (E2) and to compare academic achievement before and after the intervention. Additionally, students responded to a 15-item satisfaction questionnaire to evaluate their perceptions of the learning activities.

Data were analyzed using both descriptive and inferential statistics. Instructional efficiency was determined using the 70/70 criterion, calculated through E1 (process efficiency) and E2 (outcome efficiency). Descriptive statistics, including mean and standard deviation, were used to summarize achievement and satisfaction scores. A dependent-samples t-test was conducted to examine differences between pretest and posttest achievement scores, with statistical significance set at the .05 level.

3. RESULTS AND DISCUSSION

3.1. Efficiency of the Think–Pair–Share Learning Management Plans

The effectiveness of the Think–Pair–Share learning management plans was evaluated the efficiency criterion, where E1 represents students' average scores obtained during the learning process and E2 represents their average posttest scores. The expected standard criterion was set at 70/70.

Table 1. Efficiency of the Think–Pair–Share learning management plans

Efficiency Component	N	Full score	Total score	Mean	SD	Percentage
Process Efficiency (E1)	19	182	2462	132.60	4.15	72.86%
Product Efficiency (E2)	19	20	298	15.47	1.02	76.60%
Overall Efficiency (E1/E2)						72.86/76.60

As shown in Table 1, the developed Think–Pair–Share learning management plans achieved a process efficiency (E1) of 72.86% and an outcome efficiency (E2) of 76.60%. Both values exceeded the predetermined 70/70 criterion, indicating that the instructional activities were effective both during the learning process and in terms of post-intervention academic outcomes. The results suggest that students were able to perform successfully throughout the instructional sessions and demonstrate improved mastery of mixed arithmetic operations upon completion of the intervention.

3.2. Academic Achievement

Students' posttest scores (M = 15.47, SD = 1.02) were significantly higher than their pretest scores (M = 12.79, SD = 1.44), $t(18) = 15.62$, $p < .001$. The mean difference of 2.68 points indicates substantial improvement following the implementation of the Think–Pair–Share learning activities (Table 2).

Table 2. Comparison of pretest and posttest achievement scores

Test	n	M	SD	t	df	p	Cohen's d
Pretest	19	12.79	1.44	15.62	18	< .001	2.14
Posttest	19	15.47	1.02				

The calculated effect size (Cohen's d = 2.14) indicates an extremely large effect according to conventional benchmarks. This suggests that the instructional intervention had a strong practical impact on students' achievement in mixed arithmetic operations. The magnitude of improvement reflects not only statistical significance but also meaningful educational advancement in students' computational and problem-solving abilities.

3.3. Students' satisfaction

Students reported a very high overall level of satisfaction (M = 4.50, SD = 0.52). The highest-rated aspects were instructional clarity, peer interaction, and classroom atmosphere, indicating that the Think–Pair–Share structure effectively supported both cognitive and social dimensions of learning. It is suggested that the instructional approach provided positive classroom dynamics and encouraged active participation. Slightly lower (though still high) ratings for assessment-related items may reflect students' developing awareness of evaluative processes at the primary level (Table 3).

Table 3. Students' satisfaction with the Think–Pair–Share learning activities

No.	Item	M	SD	Level
1	The teacher organized activities in a clear and understandable sequence	4.54	0.51	Very High
2	The Think–Pair–Share technique encouraged idea exchange with peers	4.52	0.50	Very High
3	The teacher provided appropriate guidance and thinking prompts	4.46	0.53	High
4	The classroom atmosphere supported active participation	4.55	0.49	Very High
5	Learning materials were appropriate for the content and students' age	4.58	0.56	Very High
6	Worksheets helped improve understanding	4.55	0.52	Very High
7	Instructional media were clear and visually appropriate	4.38	0.58	High
8	Learning activities were enjoyable and engaging	4.57	0.49	Very High
9	Assessment methods aligned with learning activities	4.54	0.52	Very High
10	Assessments reflected students' true abilities	4.40	0.57	High
11	The teacher provided constructive feedback	4.53	0.51	Very High
12	Assessment helped students recognize strengths and areas for improvement	4.44	0.54	High
13	Students understood mixed operations better after learning	4.51	0.50	Very High
14	Students became more confident in expressing ideas	4.46	0.53	High
15	Students learned to cooperate and support peers	4.54	0.49	Very High
Overall		4.50	0.52	Very High

The results presented in Table 3 indicate that students were highly satisfied with the Think–Pair–Share (TPS) learning activities, with an overall mean score of 4.50 (SD = 0.52), which was interpreted at the very high level. This finding suggests that the TPS instructional approach effectively created a positive learning environment that promoted student engagement, collaboration, and understanding of mathematical concepts. Regarding the learning management process, students expressed very high satisfaction with the organization of activities. The statement *"The teacher organized activities in a clear and understandable sequence"* received a mean score of 4.54 (SD = 0.51), indicating that students appreciated the systematic structure of the lessons. Similarly, the classroom atmosphere was rated very highly (M = 4.55, SD = 0.49), suggesting that the learning environment encouraged active participation and meaningful interaction among students. The TPS technique itself was also highly valued, as students reported that it encouraged the exchange of ideas with peers (M = 4.52, SD = 0.50). These findings demonstrate that TPS successfully

facilitated communication and collaborative learning, allowing students to share perspectives and learn from one another.

In terms of instructional support, students were highly satisfied with the teacher's guidance and the learning resources provided. Although the item concerning teacher guidance and thinking prompts was rated at a high level (M = 4.46, SD = 0.53), the score still reflects students' positive perceptions of the teacher's role in supporting their learning process. Learning materials were rated among the highest items (M = 4.58, SD = 0.56), indicating that students found the materials appropriate for both the content and their developmental level. Likewise, worksheets were perceived as effective tools for enhancing understanding (M = 4.55, SD = 0.52). Instructional media also received favorable evaluations (M = 4.38, SD = 0.58), suggesting that visual and multimedia resources contributed positively to learning, although there may still be room for further improvement.

Students also reported high levels of enjoyment and engagement throughout the learning activities. The item *"Learning activities were enjoyable and engaging"* obtained a very high mean score of 4.57 (SD = 0.49), highlighting the ability of TPS to make learning more interesting and interactive. Enjoyable learning experiences are important because they can increase students' motivation, participation, and willingness to engage in classroom discussions.

Concerning assessment practices, students expressed positive perceptions of the evaluation process. Assessment methods were viewed as well aligned with learning activities (M = 4.54, SD = 0.52), while constructive feedback from the teacher was highly appreciated (M = 4.53, SD = 0.51). Students also believed that assessments accurately reflected their abilities (M = 4.40, SD = 0.57) and helped them identify their strengths and areas for improvement (M = 4.44, SD = 0.54). These findings suggest that the assessment procedures supported learning by providing meaningful information about students' progress and performance.

The results further indicate positive learning outcomes associated with TPS activities. Students reported a very high level of understanding of mixed operations after participating in the lessons (M = 4.51, SD = 0.50), suggesting that the approach effectively supported conceptual understanding. Moreover, students indicated that they became more confident in expressing their ideas (M = 4.46, SD = 0.53), reflecting the value of the discussion and sharing stages of TPS. The item *"Students learned to cooperate and support peers"* also received a very high rating (M = 4.54, SD = 0.49), demonstrating that TPS promoted important social and collaborative skills alongside academic achievement.

Think–Pair–Share learning activities were highly successful in fostering student satisfaction. The approach not only enhanced students' understanding of mathematical content but also promoted active participation, confidence, peer collaboration, and positive attitudes toward learning. The consistently high ratings across all dimensions indicate that TPS is an effective instructional strategy for creating engaging and student-centered learning environments.

The findings of this study indicate that the developed Think–Pair–Share (TPS) learning management plans were effective in enhancing Grade 3 students' achievement in mixed arithmetic operations. The instructional plans met the 70/70 efficiency criterion. It shows that students demonstrated satisfactory performance during the learning process and achieved meaningful improvement in post-intervention outcomes. The significant increase in achievement scores, accompanied by a very large effect size (Cohen's d = 2.14), further indicates that the intervention had a substantial educational impact.

The improvement in achievement can be interpreted through the lens of cooperative learning and social constructivist theory. TPS structures learning into individual cognitive engagement followed by peer interaction and collective discussion. This sequence may have supported deeper conceptual processing, as students were required not only to compute answers but also to articulate reasoning, compare strategies, and refine understanding through dialogue. For Grade 3 learners, who are at a developmental stage where social interaction strongly influences cognitive growth, structured peer discussion likely reinforced mathematical reasoning and reduced computational errors.

The present findings are consistent with previous empirical research demonstrating the benefits of TPS in mathematics classrooms. Abiodun et al. (2022) reported significant improvements in secondary students' mathematics achievement following TPS implementation, while Wahjuningsih et al. (2023) found that TPS outperformed alternative cooperative methods in enhancing both achievement and motivation. Similarly, Tarigan (2022) showed that TPS improved students' mathematical communication skills, highlighting the strategy's role in promoting active engagement and conceptual clarity. Ramadhani et al.

(2025) further emphasized teachers' positive perceptions of TPS in supporting conceptual understanding and classroom participation, although they noted practical challenges in implementation.

Although Triyono et al. (2024) reported limited effectiveness of TPS in improving geometry learning outcomes, the present study offers contextual clarification. The discrepancy may be attributed to differences in instructional design, implementation fidelity, content focus, or student developmental level. Unlike the study by Triyono et al., the current research involved carefully structured lesson plans validated by experts and aligned with curriculum standards. Moreover, mixed arithmetic operations at the primary level may be particularly well suited to collaborative reasoning and step-by-step discussion, where procedural understanding benefits from peer explanation.

In addition to achievement gains, students reported very high satisfaction with the learning activities. High ratings on items related to classroom atmosphere, peer collaboration, and instructional clarity suggest that TPS created a supportive and interactive learning environment. These findings align with Wahjuningsih et al. (2023), who emphasized the interaction between instructional method and student motivation, and with Tarigan (2022), who observed improvements in communicative engagement. The satisfaction results also reflect the developmental appropriateness of cooperative learning for young learners, as structured peer interaction may increase enjoyment and reduce mathematics anxiety.

5. CONCLUSION

This study developed and evaluated Think–Pair–Share learning management plans designed to enhance Grade 3 students' achievement in mixed arithmetic operations. Using a one-group pretest–posttest design, the effectiveness of the instructional intervention was examined in terms of efficiency, academic achievement, and student satisfaction.The results demonstrated that the developed learning plans met the 70/70 efficiency criterion, significantly improved students' achievement with a very large effect size, and generated very high levels of student satisfaction.

This study contributes to mathematics education research by extending empirical evidence on the effectiveness of Think–Pair–Share to the primary school level and by integrating a systematic development-and-efficiency framework in instructional design. The findings highlight the potential of structured cooperative learning to improve both cognitive outcomes and classroom engagement in early mathematics education.

The findings suggest practical implications for mathematics teachers seeking to transform passive classrooms into more interactive learning environments through structured peer collaboration. TPS can serve as a practical and adaptable strategy for enhancing conceptual understanding and promoting social interaction among young learners. However, the study was limited by its one-group pretest–posttest design and small sample size, which constrain causal inference and generalizability. Future research should employ experimental or quasi-experimental designs with larger and more diverse samples and examine the long-term impact of TPS on mathematical reasoning and retention across different content areas.

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