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The Effect of Think Pair and Share Learning Model Assisted by Pop Up Book Media on Fifth Grade Students' Mathematics Learning Outcomes

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A B S T R A C T

This study was motivated by the low mathematics learning outcomes in fractions among fifth-grade students at SDN 1 Dawuan due to conventional teaching methods and limited learning media. The study aimed to examine the effect of the Think Pair and Share (TPS) learning model assisted by Pop Up Book media on students' cognitive learning outcomes. This study differs from previous research by integrating TPS and Pop Up Book media in fraction learning. A quantitative quasi-experimental design with a Two-Group Pretest Posttest Non-Equivalent Control Group was employed. The sample consisted of 42 students, including 21 students in the experimental group and 21 students in the control group. Data were collected using a validated multiple-choice test. The results showed that the experimental group's mean score increased from 31.11% to 58.41%, while the control group's score increased from 32.38% to 38.41%. The N-Gain score of 0.3315 indicated moderate effectiveness, and the Independent Samples T-Test yielded a significance value of 0.000 (< 0.05). The findings indicate that TPS assisted by Pop Up Book media effectively improves students' mathematics learning outcomes on fraction material through collaborative and visual learning experiences.

1. Introduction

Primary education is a crucial foundation of the formal national education system, shaping students' cognitive, emotional, and motor skills to prepare them for the evolving challenges of the modern era (Yayuk et al. 2020). Among primary school subjects, mathematics holds a vital and strategic role Recent studies in elementary mathematics education have demonstrated that student centered learning models can significantly improve learning participation and conceptual understanding. For

example, Mustika and Sastrawati (2024) reported that innovative learning approaches supported by appropriate pedagogical strategies enhanced students' engagement and achievement in mathematics learning. The national curriculum emphasizes that mathematics learning should focus on problem solving in everyday life within meaningful contexts (Fauziah Nur et al., 2022). Ginanjar (2023) highlights that primary mathematics teaching must align with children's natural characteristics by offering direct experiences and promoting intellectual engagement through manipulable objects. Similarly, Isma et al. (2025) describes mathematics as a universal thinking tool that helps students progress from concrete understanding to abstract and applicable reasoning. Despite curriculum expectations, there is a significant gap in students' academic achievements in mathematics (Tsuwaibatul Aslamiyah Lubis, 2025). In Indonesia, many children demonstrate low proficiency, particularly in numerical literacy, logical reasoning, and solving non procedural math problems (Rahmania et al., 2024). This issue is evident at SDN 1 Dawuan, where preliminary studies show that 65% of fifth graders did not meet the Minimum Mastery Standard (KKTP) of 70, with only 35% achieving it. This finding is consistent with Rizqi (2025) who found that cooperative learning models positively affected elementary students' numeracy skills and learning motivation.

Low achievement is closely linked to students' negative perceptions of mathematics as a difficult and boring subject. This perception reduces motivation, resulting in passive participation, reluctance to ask questions, and copying peers' answers. The problem is worsened by traditional, teacher centered methods characterized by one-way lectures, mechanical problem examples, and textbook worksheets. According to Safitri et al. (2023) such practices reduce mathematics learning to rote memorization without deep conceptual understanding, creating a dull and unengaging learning environment. Another significant issue is the limited use of appropriate learning media in classrooms. The importance of instructional media has also been highlighted by Utami and Rahmah (2025) who reported that integrating learning models with visual media significantly improved elementary students' learning outcomes. Teachers often depend on printed textbooks that present material in static, abstract two dimensional (2D) visuals. Safitri and Wijayanti (2022) observed that this lack of visual and tactile stimulation causes primary students struggle to visualize complex mathematical concepts to visualize complex mathematical concepts. These challenges are especially pronounced when teaching fractions. Fractions, a critical fifth grade topic, require deep conceptual understanding. Sukma Kurnia Syukra, et al. (2025) emphasize that fractions form the foundation for more advanced math topics such as decimals, percentages, scale comparisons, ratios, and algebra in secondary education. Misconceptions frequently arise in the topic of fractions. Students often incorrectly apply whole number rules, such as adding numerators and denominators directly when adding fractions with different denominators. This contradicts Fauziah and Safari (2025) theory, which states that children aged 7-12 are in the concrete operational stage and need real objects or interactions to build their cognitive understanding, rather than abstract or deductive thinking.

To address this complex instructional challenge, a renewed learning strategy is needed that combines a cooperative model with interactive three-dimensional visual media. learning is more effective when students actively construct knowledge through social interaction and guided collaboration in a supportive environment. According to Rudi, et al. (2019) mathematics education in Indonesia is a crucial part of the formal education system because it plays a crucial role in developing logical thinking skills, problem solving skills, and higher order thinking skills in students. Mathematics can enrich students' understanding of logical, rational, critical, thorough, effective, and efficient thinking. According to Sari Diana, et al. (2021) elementary school children's thinking development can be improved by employing learning strategies that prioritize moral principles. This includes the use of active learning methods like Think Pair and Share and creative media like Pop Up Books, making learning experiences, particularly in mathematics, more meaningful and aligned with religious teachings, thereby continuously improving the quality of knowledge. The Think Pair and Share (TPS) model, developed by Endang et al. (2023) is a flexible and effective cooperative learning approach. It involves three continuous phases: individual thinking (Think), paired discussion with a seatmate (Pair), and collective sharing of ideas with the class (Share). Faqih (2019) found that the TPS model significantly increases active participation, sharpens mathematical communication skills, and reduces misconceptions in challenging math topics.

To make the TPS model more contextual, engaging, and suited to primary school children's psychological needs, supporting it with concrete instructional media like a Pop Up Book is essential. According to Andreansyah and Sari (2024) a Pop Up Book is a book based learning medium featuring three-dimensional (3D) elements that pop up, move, or stand out when pages are opened. This feature helps students visualize abstract fraction concepts. Integrating Pop Up Books with TPS creates a more engaging learning environment. Empirical evidence supports combining the TPS model with Pop Up Books. Nadzri et al. (2023) found that collaborative strategies using 3D media significantly improve primary students' cognitive mathematics outcomes. Likewise, Darmawan (2026) noted that interactive media boosts the effectiveness of cooperative discussions by providing consistent observational objects. Based on this analysis, the present quasi-experimental study aims to comprehensively examine the effect of the Think Pair and Share model supported by Pop Up Book media on fifth graders' mathematics learning outcomes in fractions at SDN 1 Dawuan.

2. Methodology

Data Collection

This study employed a quantitative approach with a quasi-experimental method. This method was chosen because true randomization of individual students to form new experimental and control groups is not feasible in primary school classrooms due to the disruption it would cause to ongoing teaching activities. Instead, naturally formed intact classes within the school were used as samples. The experimental

design was a Two Group Pretest Posttest Non Equivalent Control Group Design. It involved two groups: the experimental group, which received the Think Pair and Share learning model supported by Pop Up Book media, and the control group, which was taught using conventional methods such as lectures, Q&A, and textbook assignments. Both groups took the same test twice: a pretest to assess initial ability before treatment and a posttest to measure competence after treatment.

The implementation of the Think Pair and Share (TPS) model assisted by Pop Up Book media was conducted in three main stages. In the Think stage, students were individually presented with fraction related problems using Pop Up Book media and were given time to observe, analyze, and formulate initial answers independently. In the Pair stage, students worked in pairs to discuss their ideas, compare solutions, and refine their understanding of the concepts presented in the Pop Up Book. In the Share stage, each pair communicated the results of their discussion to the whole class, followed by feedback and clarification from the teacher. The Pop Up Book media was integrated throughout the learning process to provide concrete visual representations of fractions, facilitate conceptual understanding, and increase students' engagement in learning activities. The treatment was implemented during the fraction learning unit according to the lesson plans developed for the study. The visual layout of this design is summarized as follows Table 1:

Table 1. Non Equivalent Control Group Design Layout

Group	Pretest	Treatment	Posttest
Experimental Group (Class VA)	O1	X1	O2
Control Group (Class VB)	O3	X2	O4

Source: Sugiyono (2013)

The study population consisted of all fifth grade students enrolled at SDN 1 Dawuan during the current semester, totaling 42 students. Purposive sampling was used, selecting samples based on specific characteristics relevant to the research goals. The principal and fifth grade teacher recommended Class VA and Class VB for their similar average academic ability, the same teacher, and equal number of students. As a result, Class VA (21 students) was chosen as the experimental group, and Class VB (21 students) as the control group, making a total of 42 research subjects.

The research instrument consisted of 15 multiple choice questions designed to measure Higher Order Thinking Skills (HOTS) in mathematics, particularly on fraction topics. Prior to administration, the instrument was subjected to validity and reliability testing to ensure its quality. The items were developed based on Bloom's Revised Taxonomy at cognitive levels C3 (Applying), C4 (Analyzing), C5 (Evaluating), and C6 (Creating). Questions at the C3 level required students to apply fraction concepts and procedures to solve contextual problems. C4 items required students to analyze relationships among fractions, identify patterns, and distinguish relevant information. C5 items required students to evaluate alternative solution strategies, determine the correctness of mathematical reasoning, and justify answers. C6 items encouraged students to generate new solution methods,

formulate mathematical ideas, or solve non routine fraction problems creatively. These HOTS oriented characteristics were incorporated to assess students' higher level cognitive abilities beyond simple recall and comprehension. For example, C3 items required students to apply fraction operations in contextual situations, C4 items required identification of errors and relationships among fractions, C5 items required evaluation of alternative solution strategies, and C6 items required students to generate original approaches to solve non routine fraction problems.

Instrument

The primary instrument for measuring cognitive mathematics learning outcomes was a multiple choice test with 15 items, each having four options (A, B, C, D). The test focused on fractions, covering equivalent fractions, addition, and subtraction with different denominators. Questions were designed to assess Higher Order Thinking Skills (HOTS) according to revised Bloom's taxonomy, including Application (C3), Analysis (C4), Evaluation (C5), and Creation (C6). Before use, the test underwent validity testing using the Pearson Product Moment correlation with SPSS. All 15 items were statistically valid, as their correlation values exceeded the critical value at a 5% significance level. Reliability was tested using the Kuder Richardson 20 (KR 20) formula, yielding a coefficient of 0.818, classified as "Very High," meeting requirements for experimental research. Additionally, a non test observation sheet with 12 core operational indicators was used by external observers to evaluate the implementation of the learning model in the experimental class.

Data Analysis

This study's data processing involved two main phases: descriptive and inferential statistical analyses. Descriptive statistics summarized raw data by reporting the lowest score, highest score, and average (mean) for each group. Inferential statistics tested the hypotheses. Before conducting parametric inferential tests, two prerequisite analyses were performed:

1. Normality Test: Using the Shapiro-Wilk method (appropriate for small samples, N=21) to check if pretest and posttest scores followed a normal distribution. Data are considered normal if the significance value is greater than 0.05 ($p > 0.05$).
2. Homogeneity Test: Using Levene's Test to assess whether the variances between the experimental and control groups were equal. Homogeneity is confirmed if $p > 0.05$.

Once these conditions were met, the Independent Samples T-Test was used to evaluate the significance of differences in average scores. Additionally, the Normalized Gain (N-Gain) index was calculated to measure the effectiveness of learning outcome improvements between the two groups. Hake's (1998) formula:

$$g = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}}$$

The N-Gain results were classified into three index criteria: High ($g > 0.70$), Medium ($0.30 \leq g \leq 0.70$), and Low ($g < 0.30$). All statistical calculations were computed digitally via the IBM SPSS version 21 program.

3. Results and Discussion

Results

This study's empirical data presents a comparison of cognitive mathematics learning outcomes between the experimental group (Class VA) and the control group (Class VB) before (pretest) and after (posttest) the treatment. Before presenting the statistical results, it is important to describe the implementation of the treatment. The experimental class received instruction through the Think Pair and Share (TPS) model assisted by Pop Up Book media during the fraction learning unit. Students participated in the Think Pair and Share stages while using Pop Up Book visualizations to explore fraction concepts. Meanwhile, the control class received conventional instruction consisting of lectures, question and answer sessions, and textbook based exercises. After the treatment period was completed, both groups were administered a posttest to measure cognitive learning outcomes. The quantitative results collected are systematically summarized in Table 2:

Table 2. Descriptive Statistics Summary of Pretest and Posttest Results

Sample Group	Test Category	Minimum Value	Maximum Value	Average Score (Mean)
Experimental Group (VA)	Pretest	15.00%	55.00%	31.11%
	Posttest	40.00%	90.00%	58.41%
Control Group (VB)	Pretest	15.00%	50.00%	32.38%
	Posttest	20.00%	60.00%	38.41%

A detailed analysis of the descriptive data in Table 2 shows that the initial abilities (pretest) of students in both groups were balanced and relatively homogenous. The control group averaged 32.38%, while the experimental group was at 31.11%. Both groups struggled significantly with high difficulty fraction problems before the intervention. After different learning treatments, the control group, taught by conventional one-way lectures, showed only a slight average increase of 6.03%, from 32.38% to 38.41%, failing to meet the school's minimum mastery standard. In contrast, the experimental group, using the Think Pair and Share (TPS) model with Pop Up Book media, saw a substantial average increase of 27.30%, reaching 58.41%, with a maximum score of 90.00%. This marked difference indicates the positive impact of the learning model on student outcomes. Beyond test scores, learning quality in the experimental class was observed using an execution observation sheet. External observers recorded that 12 operational indicators were perfectly implemented by the teacher and students. The action implementation percentage was calculated using the following formula:

$$\text{Implementation Percentage} = \frac{\text{Executed Indicators}}{\text{Total Indicators}} \times 100$$

According to action feasibility standards, the achieved implementation score of 81.82% falls within the "Very Good" category. This observation scientifically confirms that the cooperative Think Pair and Share learning model supported by Pop Up Book media was applied realistically, consistently, and optimally in the classroom, following the lesson plan (RPP) designed by the researcher. Before drawing conclusions through parametric inferential hypothesis testing, it is important to verify that prerequisite statistical assumptions are met. The first step is to test the normality of learning outcome score distributions using the Shapiro-Wilk test. The summarized results of this analysis are detailed in Table 3:

Table 3. Summary of Normality Test Results (Shapiro-wilk)

Sample Group	Data Distribution Category	Statistic Value	Degrees of Freedom (df)	Significance (p-value)
Control Group	Pretest Score	0.912	21	0.583
	Posttest Score	0.935	21	0.081
Experimental Group	Pretest Score	0.924	21	0.122
	Posttest Score	0.941	21	0.094

The normality assumption is met if the significance value (p-value) exceeds the standard error level, $\alpha = 0.05$ ($p > 0.05$). Table 3 shows that all tested variables have significance values above 0.05: control pretest (0.583), control posttest (0.081), experimental pretest (0.122), and experimental posttest (0.094). Therefore, the distribution of mathematics learning outcome scores in both groups is normal, validating the use of parametric statistics. The second prerequisite, homogeneity of variance, was tested using Levene's Test on posttest scores. The significance value was 0.451, well above the 0.05 threshold, indicating equal variance between the experimental and control groups' learning outcomes. With these assumptions satisfied, the research hypothesis was tested using an Independent Samples T-Test via SPSS. This test evaluates whether the observed average score differences are due to the treatment effect or chance. The summary of the T-test results is presented in Table 4:

Table 4. Hypothesis Testing Results (Independent Samples T-Test

Testing Group	Significance Value (2-tailed)	Alpha Threshold Value (a)	Statistical Hypothesis Decision
Posttest Control Group and Experimental Group	0.000	0.05	H_0 Rejected H_1 Accepted

The T-test results in Table 4 show a significance value of 0.000 (Sig. 2-tailed). Since this value is less than the threshold of 0.05 ($0.000 < 0.05$), the Null Hypothesis (H_0) is rejected, and the Alternative Hypothesis (H_1) is accepted. This confirms a significant effect of the Think Pair and Share learning model supported by Pop Up Book media on the mathematics learning outcomes of fifth grade students at SDN 1 Dawuan in fraction material.To evaluate the effectiveness of learning outcome improvements, the Normalized Gain (N-Gain) index was calculated. The mean N-Gain score for all 42 students was 0.3315. According to Hake's criteria, this score falls within the "Medium" effectiveness range ($0.30 \leq 0.3315 \leq 0.70$), indicating

a moderate overall improvement. Individually, the experimental group showed outstanding results, with the highest N-Gain reaching 0.90 (90%), reflecting excellent learning progress due to interactive media and cooperative learning. Conversely, the control group had several students with an N-Gain of 0.00%, indicating no improvement and highlighting the ineffectiveness of conventional teaching methods for some students.

Discussion

The results obtained from this quasi-experimental research offer unmistakable evidence about the advantages of using the cooperative learning approach of Think Pair and Share (TPS) along with tactile visualization through Pop Up Book media to enhance primary school students' understanding of mathematics. The notable success achieved by the experimental group, shown by a marked increase in the average posttest score (rising to 58.41% from an initial pretest score of 31. 11%), offers fresh perspectives for teachers on the significance of effectively managing the learning environment in the classroom. This indicates a crucial change in how the learning process is perceived, as students transition from being passive recipients of information provided by their instructors to becoming active participants in the creation of knowledge, both individually and collaboratively.

The improved learning results of the experimental group are closely linked to the strategic implementation of each phase in the TPS learning model, significantly enhanced by the visual aids from the Pop Up Book media. In the initial phase called Think (Independent Thinking), learners were introduced to cognitive challenges through real life problems related to adding or subtracting fractions, cleverly illustrated within the Pop Up Book. When the teacher or students opened the book's pages, vibrant images such as slices of pizza, divisions of fruit, or geometric patterns immediately emerged in three-dimensions, showcasing length, width, and height. These three-dimensional visuals are strongly aligned with the cognitive development theories proposed by Jean Piaget in 1976. Children aged 7 to 12, who are in the concrete operational stage, need realistic visual aids to grasp abstract ideas. Fractions, which were previously just numeric symbols on a board, now have tangible spatial representations that the students can easily comprehend. In this independent thinking stage, students were allowed sufficient time for reflection (think time). Providing this time is crucial as it fosters intellectual independence, sparks curiosity, and allows children to devise their own solutions to problems before being swayed by the opinions of others.

Once students had formed their independent thoughts, the learning process moved on to the second phase, Pair (Pairing). The teacher organized the students to sit with their classmates in pairs to share and discuss their ideas. This phase encouraged positive social engagement through a process of negotiating meaning. Students reviewed their visual interpretations of fraction divisions in the Pop Up Book, deliberated over the calculations behind their solutions, and reached a mutual agreement on the correct method to equalize denominators. This pairing phase fosters an environment where peer tutoring can naturally occur. Students who grasp concepts quickly are able to clarify misunderstandings for those who take longer to

learn. Conversely, learners who struggle with certain topics feel more at ease and unreserved when posing questions and addressing their gaps in knowledge among their peers, unlike when they engage with the teacher where anxiety might arise. The strong teamwork during this phase clearly alleviates math related stress and helps solidify long term memory regarding the methods involved in solving fraction issues.

The most advanced part of this model unfolds in the third step, labeled Share (Sharing). Various student pairs were either chosen at random or volunteered to present the ideas of their group to the entire class in a unified manner. This phase of sharing plays a crucial role in enhancing students' abilities to communicate mathematically. Pupils were encouraged to confidently express mathematical concepts, use accurate language, and present logical reasoning behind the strategies they selected for solving fraction problems. As presentations took place, the discussions evolved into comprehensive class conversations, with the teacher facilitating the dialogue. Classmates from different groups were encouraged to respond, pose questions, or offer different methods for tackling the problems. The teacher took on the role of a supporter and evaluator, affirming good points, correcting misunderstandings, and providing cognitive support. This reflective activity in class deeply reinforces the cognitive frameworks for all students.

In contrast, the control group faced a halt in their learning progress due to being taught through a dull traditional method. The lack of tangible visual aids led students in this group to engage with concepts at an overly abstract and symbolic level that didn't align with their developmental stage. Consequently, the learning experience became excessively verbal and overly dependent on memorizing formulas that are prone to forgetfulness. Students soon found themselves feeling bored, lethargic, becoming passive, and missed chances to validate their understanding through group collaboration. This explains why the posttest average score for the control group remained disappointingly low, significantly below the school's minimum standard, at just 38.41%. The encouraging outcomes of this research are backed by numerous relevant studies in primary education and mathematics teaching. The results of this study correspond with the findings of (Mau'ida and Sutriyani 2024). which demonstrated that employing the Think Pair Share learning model with the Pop Up Book technique significantly enhances cognitive math learning results for elementary students focusing on fractions. Similar findings were reported by Khayyirah (2024) who demonstrated that cooperative learning models supported by interactive media significantly improved students' cognitive learning outcomes. Moreover, research conducted by Oktaviani, et al. (2020) revealed that combining cooperative strategies similar to the Think Pair Share approach with three-dimensional interactive visual tools can greatly boost students' mastery in learning and elevate their intrinsic motivation to learn.

From a theoretical perspective, the effectiveness of the TPS model assisted by Pop Up Book media in learning fractions can be explained through constructivist learning theory and dual coding theory. Constructivist theory emphasizes that students actively build their own understanding through interaction, discussion, and reflection. In the TPS learning process, students are first given opportunities to

think individually, then discuss their ideas with peers, and finally share their understanding with the whole class. This sequence encourages students to reconstruct their knowledge of fraction concepts and correct misconceptions through social interaction. At the same time, the Pop Up Book provides concrete visual representations of abstract fraction concepts, enabling students to connect symbolic mathematical representations with real and meaningful contexts. Compared with conventional instruction, where learning is often teacher-centered and students tend to receive information passively, the combination of TPS and Pop Up Book promotes active cognitive engagement and deeper conceptual understanding.

The findings of this study are consistent with previous studies reporting that TPS improves students' participation, communication skills, and mathematics achievement, while Pop Up Book media enhances students' motivation and conceptual understanding. Oktaviani, et al. (2020) state that the present study found that students who learned through interactive discussion and visual media achieved better learning outcomes than those who experienced conventional instruction. However, this study also presents several distinctive contributions. Unlike previous research that generally examined either the TPS model or Pop Up Book media separately, this study investigated the integration of both strategies specifically in fraction learning among elementary school students. Fractions are widely recognized as one of the most challenging mathematical topics for elementary learners because they require students to understand part whole relationships and abstract numerical representations. Therefore, the successful implementation of TPS assisted by Pop-Up Book media provides new empirical evidence that combining cooperative learning and three-dimensional visual media can effectively address students' difficulties in understanding fraction concepts.

Furthermore, this study contributes to the growing body of research on elementary mathematics education by demonstrating that learning effectiveness is not only influenced by instructional models but also by the quality of learning media used to support conceptual development. These findings also support Astuti and Fadly (2025) who concluded that the integration of innovative learning models and supporting media creates more meaningful learning experiences and improves student achievement. The results suggest that the synergy between collaborative learning activities and concrete visual representations creates a more meaningful learning experience, leading to improved cognitive achievement. This contribution extends previous findings and offers practical implications for teachers seeking innovative approaches to teaching abstract mathematical concepts in elementary schools.

Similarly, studies by Salsabillah and Aliyyah (2024) highlighted that the manipulative and spatial features of Pop Up Book media are very effective in realistically illustrating fraction parts, which greatly helps to minimize mathematical misunderstandings among primary school students. In general, the educational integration of a thoughtfully designed Think Pair and Share learning model along with interactive Pop Up Book media has been shown to be a highly effective learning approach. This combination effectively fosters a mathematics

learning environment that prioritizes not just the achievement of cognitive academic performance, but also cultivates a classroom setting that is democratic, cooperative, engaging, stimulating, and meaningful for young learners.

4. Conclusion

This study concludes that the Think Pair and Share (TPS) learning model assisted by Pop Up Book media has a positive effect on fifth-grade students' mathematics learning outcomes in fraction material at SDN 1 Dawuan. The findings indicate that the integration of cooperative learning activities and three-dimensional visual media successfully supports students in understanding abstract fraction concepts, encourages active participation, and promotes collaborative learning experiences. Therefore, the research objective was achieved, demonstrating that the TPS model assisted by Pop Up Book media can be implemented effectively in elementary mathematics learning. In addition to contributing to students' learning outcomes, this study provides practical implications for elementary school teachers. The combination of TPS and Pop Up Book media can serve as an innovative instructional alternative that helps create a more interactive, engaging, and meaningful learning environment, particularly when teaching abstract mathematical concepts. However, this study was limited to a relatively small sample from a single elementary school and focused only on fraction material in fifth grade. Consequently, the findings may not fully represent broader educational contexts. Future research is recommended to investigate the effectiveness of the TPS model assisted by Pop Up Book media in other mathematics topics, different grade levels, and more diverse educational settings to strengthen the generalizability and applicability of the findings.

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