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Elementary School Students' Mathematics Problem-Solving Skills through Teams Games Tournament Assisted by Number Mystery

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Abstract

Mathematical problem-solving remains challenging for elementary school students, particularly in understanding problem information, selecting appropriate strategies, executing solution procedures, and evaluating answers. This study aimed to examine differences in mathematical problem-solving skills between students taught through Teams Games Tournament (TGT) assisted by Number Mystery and those receiving conventional instruction, as well as to determine the effect of the intervention on students' performance. A quasi-experimental method with a nonequivalent control group design was employed, involving 63 third-grade students comprising 32 students in the experimental group and 31 students in the control group. The intervention was implemented over three instructional meetings. Data were collected through pretests, posttests, questionnaires, observations, student worksheets, and documentation and analyzed using the Shapiro–Wilk test, Levene's test, an independent-samples t test, and simple linear regression. The findings showed that the experimental group achieved a higher mean posttest score than the control group (85.47 vs. 71.13), with a statistically significant between-group difference, $t(61) = 9.433$, p

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< 0.001. Regression analysis yielded R = 0.770 and R^2 = 0.593, indicating that the intervention accounted for 59.3% of the variance in students' mathematical problem-solving performance. These findings demonstrate that TGT assisted by Number Mystery effectively enhances elementary students' mathematical problem-solving skills. The integration of cooperative learning activities, academic games, and concrete instructional media provides a practical pedagogical alternative for supporting students in understanding problems, formulating strategies, implementing solutions, and evaluating their results.

Keywords: Cooperative Learning; Elementary Mathematics; Mathematical Problem-Solving; Number Mystery; Teams Games Tournament

INTRODUCTION

Problem-solving skills are an important part of mathematics learning because it is not enough for students to just master calculation procedures (Widyadhari et al., 2024). The learning process also needs to form the ability to understand information, determine the relationship between concepts, choose appropriate strategies, implement solutions, and re-evaluate the answers obtained. These skills help students use mathematical knowledge more flexibly when facing problems that are not always the same as the examples given during learning (Sakundari & Rizqi, 2024).

The need to strengthen mathematical skills is still evident from the achievements of Indonesian students at PISA 2022. Indonesia's average mathematics score was recorded at 366, while the average of OECD countries reached 472. Only about 18% of Indonesian students achieve Level 2 or above in mathematics, well below the OECD average of 69%. These achievements show that most students still face difficulties when they have to use mathematical knowledge to understand and solve problems that require reasoning (OECD, 2023).

Problem-solving problems are also found in elementary school mathematics learning. Ihsan et al. (2023) found that students' ability to carry out the problem-solving stages has not developed evenly. The ability to understand problems is at a higher level than the ability to plan, execute, and re-examine solutions. The findings show that students can recognize information in a problem but are not necessarily able to process that information into appropriate resolution procedures. A similar condition was found by Romadoni et al. (2023), which shows that elementary school students have difficulties when dealing with math story

problems and need learning that specifically provides experience of solving problems gradually.

This problem also arises in third grade students of SDN Sidomulyo 04. Preliminary studies showed an average problem-solving ability of 60.16. The indicator of understanding the problem obtained an average of 66.78, drafting a plan 61.29, implementing a plan 58.29, while re-examining only reached 54.29. These achievements show a downward trend when students enter the problem-solving stage that requires further thinking processes. The supporting questionnaire produced an average of 59.63, while the response to the use of learning models and media was at an average of 57.82%. The initial data shows that students need a learning process that does not stop at the delivery of material, but provides space to discuss, try strategies, solve challenges, and check the results of work.

Learning that provides media and problem-solving activities becomes relevant to these needs. Pratiwi et al. (2024) showed that the use of interactive learning media that is oriented towards problem solving produces a *gain score* of 0.53 and helps students be more active in dealing with math problems. The findings show that the media has a broader function than just attracting attention. Media that is integrated with learning activities can be a means to bring students to interact directly with the problem and try various alternative solutions.

Game activities can also be used to create a more participatory math experience. Muslikasari & Rusnilawati (2023) found that combining learning models with digital games resulted in better mathematical problem-solving skills compared to comparative learning. Games in learning provide situations that demand students to be involved, make decisions, and complete tasks based on specific rules or challenges. These characters are in accordance with the learning needs of elementary school age which require concrete activities and opportunities to interact while understanding concepts (Rani, 2022).

The *Teams Games Tournament* (TGT) model has a structure that accommodates such activities through teamwork, academic games, tournaments, and group awards. The structure of TGT allows students to not only receive the material individually, but also to discuss knowledge with group members before using it in game activities and academic competitions. Udiani et al. (2024) found that the application of TGT has a significant influence on the mathematical creative thinking ability of elementary school students. Real problem-solving

activities, peer tutoring, games, and tournaments provide space for students to deepen their understanding while developing mathematical thinking skills.

The power of the learning model can be expanded using media that is integrated with game activities. The Number *Mystery* media in this study is designed as a concrete medium that presents mathematical challenges through group activities. Students need to find problems, read available information, discuss possible solutions, determine strategies, implement chosen steps, and double-check answers. This pattern of activities makes the media not stand as mere props but become part of the problem-solving process.

The use of learning tools that are deliberately designed to follow the problem-solving stage has shown positive results in previous studies. Fatma et al. (2023), for example, developed mathematics learning based on the Polya stages and obtained results that the tools used were more effective than previous teaching materials. These results show the importance of directing learning activities systematically from the time students understand the problem by obtaining and evaluating solutions.

Existing studies show three trends. First, interactive media can support problem-solving skills. Second, games can increase student engagement in math activities. Third, TGT provides a cooperative and competitive learning environment that can encourage thinking activities. However, research that specifically integrates the TGT model with concrete Number *Mystery* media to develop mathematical problem-solving skills in grade III students is still limited. Some of the research used digital media, Wordwall, Canva-assisted modules, or TGT without *Number Mystery*. These differences open space to test forms of integration of learning that are more in line with the character of elementary school students in the lower classes.

The novelty of the research lies in the integration *of Teams Games Tournament* with *Number Mystery* as a concrete game media directed directly at the process of solving mathematical problems. Game activities are not only used to repeat the material but are designed for students to go through the process of understanding problems, strategizing, implementing solutions, and evaluating results. This study aims to analyze the difference in mathematical problem-solving skills between students who participate in Number Mystery-assisted TGT and the control group and analyze the influence of the application of this learning on the problem-solving ability of elementary school students.

METHODS

The research uses a quantitative approach with *quasi-experimental research* methods and *nonequivalent control group* design. The design involves two groups that receive a pretest before learning and a posttest after the entire learning series is completed. The experimental group followed the learning using *the Teams Games Tournament* (TGT) model with the help of *Number Mystery* media, while the control group followed the TGT learning without the help of *Number Mystery* media. Comparisons of the two groups were used to see differences in mathematical problem-solving abilities after treatment.

The research will be carried out at SDN Sidomulyo 04 in 2026 through three mathematics learning meetings. The population includes all grade III students, as many as 63 students. The sampling technique uses saturated sampling because all members of the population are involved as samples. The experimental group consisted of 32 students, while the control group consisted of 31 students. The use of pre-formed classrooms became the basis for the selection of pseudo-experimental designs because individual randomization of students was not carried out.

The treatment variable was in the form of a TGT learning model assisted *by Number Mystery*, while the outcome variable was in the form of mathematical problem-solving skills. Measuring problem-solving ability refers to the four stages of Polya, including understanding the problem, developing a solution plan, executing the plan, and re-examining the results. The four stages were chosen because they were able to describe the process of solving problems in stages, not just the accuracy of the final answer. Research by Ahmad et al. (2024) also shows that differences in students' abilities can be recognized through the achievement of each stage of Polya problem-solving.

The experimental classroom learning procedure follows the five main components of TGT, namely the presentation of material, group formation, academic games, tournaments, and group awards. Media *Number Mystery* is placed mainly in game activities and challenge completion. Students work in groups to find problems or challenges, understand the available information, discuss alternative solutions, execute the chosen strategy, and then examine and communicate the results. The control group studied the same material through TGT without using *Number Mystery*. The treatment was carried out for three meetings so that the stages of learning and the development of task completion could be observed repeatedly.

Data collection used both test and non-test techniques. The main instrument is in the form of five description questions given as a pretest and posttest. Each question is arranged to measure students' abilities through the problem-solving stage. Supporting data were obtained from problem-solving ability questionnaires, student response questionnaires, learning implementation observation sheets, LKPD, and documentation. The problem-solving skills questionnaire contains 16 statements, while the response questionnaire is used to describe the students' experiences during learning. The observation sheet records the implementation of preliminary activities, core activities based on TGT and *Number Mystery*, as well as closing activities.

The quality of the test instruments is checked through validation, reliability, difficulty, and differentiating power. The five questions used had a validity coefficient between 0.500–0.794 and all of them were declared valid. Reliability testing yielded Cronbach's Alpha of 0.639. The difficulty level consists of one easy question, three medium questions, and one hard question. The differentiating power shows two questions in the good category and three questions in the good category. These results are the basis that five questions can be used to measure students' math problem-solving skills.

Data analysis was conducted using IBM SPSS Statistics. The normality of pretest and posttest data was checked using Shapiro–Wilk because the number of students in each group was less than 50. The homogeneity of the variance is checked through Levene's test. The difference in posttest scores between the experimental and control groups was then analyzed using *an independent-samples t test* with a significance level of 0.05. Pretest and posttest descriptive statistics were used to read the direction of change in the ability of both groups. Simple linear regression was used as a supporting analysis to see the relationship between learning group membership and variation in problem-solving ability. The R^2 value is used to read the proportion of score variations that can be explained by the regression model.

RESULTS

1. Analysis Prerequisites Test

Prerequisite testing is carried out before the analysis of differences in problem-solving ability. Normality was checked using the Shapiro–Wilk test, while the similarity of variance was tested through Levene's test. A summary of the test results is presented in Table 1.

Table 1. Normality and Homogeneity Test Results

Testing	Data	Statistics	df	Say.	Verdict
Shapiro–Wilk	Pretest experiment	0,967	32	0,422	Normal
Shapiro–Wilk	Pretest control	0,963	31	0,346	Normal
Shapiro–Wilk	Posttest experiment	0,943	32	0,093	Normal
Shapiro–Wilk	Posttest control	0,972	31	0,569	Normal
Levene	Posttest antarkelas	1,899	61	0,173	Homogeneous

Table 1. The results of the Normality and Homogeneity Test showed that the entire Shapiro–Wilk significance value was above 0.05. The pretest and posttest scores in both the experimental and control classes met the normal distribution assumptions. The results of Levene's test also produced a significance of 0.173 > 0.05, which showed the similarity of variance between groups. The fulfillment of these two assumptions supports the use of parametric statistics through *independent-samples t tests*.

2. Changes in Students' Problem-Solving Abilities

Changes in students' abilities can be read through a comparison of initial and final scores. A recap of the raw pretest and posttest data yields the picture in Table 2.

Table 2. Average Pretest and Posttest Problem-Solving Ability

Classes	N	Pretest	Posttest	Differences
Eksperimen	32	35,97	85,47	49,50
Control	31	43,71	71,13	27,42

Table 2. The Average Pretest and Posttest of Problem-Solving Ability show different patterns of change in both classes. The experimental class started the measurement with an average of 35.97, lower than the control class of 43.71. After learning, the average experimental class increased to 85.47, while the control class reached 71.13. The descriptive increase in the experimental class reached 49.50 points and the control class was 27.42 points. The pattern showed that the experimental group not only achieved a higher final score, but also experienced a greater change in score. Initial data that are not identical still need to be considered because the research design uses groups of classes that have been formed before.

The difference in final score was then tested using *an independent-samples t test*. The test results are shown in Table 3.

Table 3. Independent-Samples t Test Results

Variance Assumptions	F	Sig. Levene	t	df	Sig. (2-tailed)
Equal variances assumed	1,899	0,173	9,433	61	<0.001
Equal variances not assumed	–	–	9,401	57,539	<0.001

Table 3. The results of the Independent-Samples t Test showed a value of t = 9.433 with df = 61 and p < 0.001 on the *equal variances assumed line*. This value shows a significant difference in problem-solving ability between the experimental class and the control class. The average posttest of the experimental class of 85.47 was 14.34 points higher than that of the control class of 71.13. These results support the first hypothesis about differences in problem-solving abilities after the implementation of TGT assisted by Number Mystery.

3. Data Supporting Problem-Solving Capabilities

The questionnaire is used as supporting data to see the tendency of students' abilities during the problem-solving process. The results of each aspect are presented in Table 4.

Table 4. Results of Questionnaire Supporting Problem-Solving Ability

Aspects	Eksperimen	Control
Problem orientation	70,83%	46,23%
Formulating/organizing learning	79,69%	40,32%
Research with Number Mystery	71,88%	47,31%
Processing/analyzing data	68,75%	44,08%
Check the completion steps	78,13%	50,53%
Examine and conclude answers	70,31%	51,07%
Average	73,26%	46,59%

Table 4. The results of the Problem-Solving Ability Support Questionnaire showed the superiority of the experimental class in all aspects observed. The average experimental class reached 73.26%, while the control class was 46.59%, with a difference of 26.67 percentage points. The highest achievement of the experimental class appeared in the aspect of formulating and organizing learning at 79.69%, followed by the examination of completion steps at 78.13%. The findings show that differences in test results gain support from students' responses to problem-solving activities during learning.

Developments during the learning process were also observed through the results of the LKPD which was carried out at three meetings. The data is presented in Table 5.

Table 5. LKPD Results at Each Meeting

Classes	Meetings	Average	Criteria
Eksperimen	1	60,31	Enough
	2	72,34	Good
	3	85,00	Very good
Average experiment		72,55	Good
Controls	1	49,68	Less
	2	59,52	Enough
	3	72,26	Good

Average control		60,48	Enough

Table 5. The results of the LKPD at each meeting showed a gradual improvement in both classes, but the achievement of the experimental class was consistently higher. The value of the experimental class moved from 60.31 at the first meeting to 85.00 at the third meeting. The control class increased from 49.68 to 72.26. The overall LKPD of the experimental class reached 72.55, while the control class was 60.48. The difference of 12.07 points strengthens the finding that the development of abilities is not only seen in the posttest but also appears throughout the learning process.

4. Contribution of Regression Models to Problem-Solving Abilities

Regression analysis was used as a supporting analysis to read the relationship between class membership and problem-solving ability after learning. A summary of the results of the coefficients and determinations is presented in Table 6.

Table 6. Coefficients and Summary of Regression Models

Components	Value
Constant (B)	99,808
Class coefficient (B)	-14,340
Beta	-0,770
t	-9,433
Say.	<0.001
R	0,770
R Square	0,593
Adjusted R Square	0,587
Std. Error of Estimate	6,032

Table 6. Coefficients and Summary of Regression Models show that predictors of class membership are significantly related to problem-solving ability, shown by $t = -9.433$ and $p < 0.001$. An R value of 0.770 indicates a strong relationship, while an R Square of 0.593 means that the class membership-based regression model explains the 59.3% variation in problem-solving ability scores. After adjustment, the *Adjusted R Square value* was recorded at 0.587 or 58.7%. Another 40.7% of the variation was not explained by the regression model.

The B coefficient of -14.340 needs to be read based on the direction of the classroom coding, not as evidence that the treatment lowers students' abilities. The magnitude of the coefficient is identical to the difference in the average difference of the posttest of the two classes, while the experimental class obtained a higher average. Negative signs appear because

the predictor variable in the SPSS output is in the form of a class membership code. This report is important so that the direction of the coefficient is not misinterpreted.

5. Implementation of Learning

Observations were made at three meetings to see the consistency of learning implementation. The results of the observations are presented in Table 7.

Table 7. Implementation of Learning at Each Meeting

Classes	Meeting 1	Meeting 2	Meeting 3	Average
Eksperimen	66,65%	75,65%	80,40%	74,23%
Control	54,23%	63,64%	73,52%	63,79%

Table 7. The implementation of learning at each meeting showed an improvement in both classes. The implementation of the experimental class increased from 66.65% to 80.40%, while the control class increased from 54.23% to 73.52%. The results of the calculation of the three meetings averaged 74.23% for the experimental class and 63.79% for the control class. This development shows that the learning process is becoming more stable as the number of meetings increases.

DISCUSSION

The main findings show a difference in mathematical problem-solving ability between the experimental class and the control class after learning. The average posttest of the experimental class reached 85.47, while the control class obtained 71.13. The difference of 14.34 points was strengthened by the results *of the independent-samples t test* with $t(61) = 9.433$ and $p < 0.001$, so that the difference in the final score of the two groups was declared significant. Descriptive data also showed that the experimental class had an average pretest of 35.97 and increased to 85.47, while the control class moved from 43.71 to 71.13. The score difference before and after learning was 49.50 points in the experimental class and 27.42 points in the control class, respectively. The change is used as a descriptive picture of the development of scores, not as a single basis for concluding that there is a difference in statistical improvement because the main hypothesis test is carried out on posttest scores between groups.

These differences can be read through the character of learning that combines group work, academic games, tournaments, and concrete media (Ramadhani et al., 2023). Number Mystery provides an object of problems to be observed and solved together, while the TGT structure provides a space for students to discuss information, compare strategies, and

account for answers to group members. This process makes problem solving not stop at the search for the result, but moves through understanding the problem, choosing strategies, implementing solution steps, and examining results. Research by Nugroho & Listyarini (2018) shows that successful problem solving is related to the ability of students to carry out the Polya stages sequentially, especially understanding problems, planning solutions, implementing plans, and evaluating answers.

The results of this study are in line with the findings of Rizqi et al. (2025), the study applied Fun Throw Ball-assisted TGT to elementary school students and found that the numeracy skills of the experimental class were better than the control class, accompanied by increased learning motivation. The similarity of the patterns shows that the strength of TGT lies not only in the element of competition, but also in the use of game media that gives students a reason to engage directly with math tasks. The difference in media between Fun Throw Ball and Number Mystery shows that the form of the tool can vary if the activity still directs students to involvement, discussion, and information processing.

Findings that are closer to the problem-solving variables obtained by Alifiani & Rizqi (2025) The application of TGT assisted by ULTADU resulted in an average problem-solving ability of 77.04 in the experimental group and 68.48 in the control group. The study also used a nonequivalent control group design and compared media-assisted TGT with media-assisted TGT. The pattern is like the Number Mystery study, namely the achievement of the group that received educational game support was above the comparison group. The similarity of the results strengthens the suspicion that the media does not only function as an element of entertainment, but also as a means that makes TGT game activities have mathematical content that must be analyzed by students.

Another perspective was given by Putra & Rizqi (2023) through Math Master-assisted game-based learning. The study found that game-based learning was effective in developing mathematical problem-solving skills, although the quality of student completion still showed variation based on the Intelligence Quotient. Students with high IQ categories were able to meet the overall stageof problem-solving, while other groups showed mastery of different stages. The findings are relevant because they confirm two sides at once: game-based learning designs can provide an environment that supports problem-solving, but each student's outcomes are still influenced by individual characteristics.

Support for test results is also seen in the questionnaire. The experimental class obtained an average of 73.26%, far above the control class of 46.59%. The largest difference

appeared in the activity of formulating or organizing learning, while high achievement was also found in the examination of completion steps. This pattern shows that Number Mystery-assisted learning provides more space for students not to answer problems directly. Students first need to read the challenge, discuss the information, determine how to solve it, and then re-check the results before entering a game or tournament activity.

The LKPD data reinforces the developmental patterns seen during the learning process. The average of the experimental class moved from 60.31 at the first meeting to 72.34 at the second meeting and 85.00 at the third meeting. The control class also showed a change from 49.68 to 59.52 and reached 72.26 at the third meeting. The descriptive pattern showed the development of achievement in both groups, with consistently higher experimental class scores over the three meetings. These advantages indicate that the use of *Number Mystery* with TGT provides a learning experience that is more supportive of problem-solving activities. Concrete media provide the same object of discussion for group members, while academic games encourage students to test solution strategies through more interactive activities (Setyawati et al., 2024).

The regression results provide additional information about the relationship between group membership and problem-solving ability scores. An R value of 0.770 indicates a strong association, while an R^2 of 0.593 indicates that 59.3% of posttest score variations are statistically related to differences in group membership included as predictors in the model. The remaining 40.7% variation was not explained by the model and could potentially be related to other factors, such as early ability, students' cognitive characteristics, learning experiences, interaction between students, and problem-solving habits. The R^2 value does not mean that the use of *a single Number Mystery* causes 59.3% of problem-solving ability, because the predictor variable in the analysis is the class membership code. The regression results need to be understood as a reinforcement of the difference in scores between groups, while the conclusion about differences in ability still rests on the results of *the independent-sample t test*. The findings of Widyastuti & Airlanda (2021) which show variations in problem-solving abilities based on cognitive characteristics also support that student achievement is not only influenced by learning strategies.

The implementation of learning moved up at each meeting and reached 80.40% at the third meeting of the experimental class. This pattern indicates a process of adaptation to the rules of group work, games, the use of Number Mystery, and tournaments. Students need time to understand new activity patterns, while teachers also need to arrange stage changes

so that the game process still leads to academic goals. These results are in line with research by Suardin & Andriani (2021) which reported that the implementation of TGT assisted by learning media went well along with an increase in numeracy achievement and student motivation.

These differences in achievement can be explained through learning characteristics that combine group work, academic games, tournaments, and the use of concrete media. *Number Mystery* presents problems that need to be observed and solved together, while the TGT structure provides a space for students to discuss information, compare strategies, and account for answers to group members. The problem-solving process does not stop at the search for the final result, but involves the activity of understanding the problem, choosing a strategy, implementing the solution steps, and re-examining the results. Andriani & Wahyudi (2023) show that successful problem solving is related to students' ability to carry out the Polya stages sequentially, from understanding the problem to evaluating the solution.

The limitations of the study are related to the scope of the sample and the experimental design used. Participants only included 63 students from one school, and the treatment lasted over three meetings, so generalization of results to a wider population needed to be done carefully. The *nonequivalent control group* design used a pre-formed class group and showed a difference in the average initial ability, which was 35.97 in the experimental class and 43.71 in the control class. This condition is a consideration when interpreting the difference in the final score of the two groups. The changes in pretest-post test found in this study are still descriptive because the main test uses a comparison of post tests between groups. Subsequent studies may use gain analysis, ANCOVA, or other statistical approaches that control for initial ability, along with the number of schools and the broader duration of treatment. Advanced measurements are also needed to determine the sustainability of problem-solving skills after learning is completed.

CONCLUSION

Based on the results of the study, the application of the *Teams Games Tournament* (TGT) learning model assisted by *Number Mystery media* was able to improve the mathematical problem-solving skills of elementary school students. The average posttest of the experimental group reached 85.47, higher than the control group of 71.13. The *independent-samples t test* yielded $t(61) = 9.433$ with $p < 0.001$, indicating a significant difference in problem-solving ability between the two groups. Regression analysis also yielded $R = 0.770$

with $R^2 = 0.593$, which showed that the regression model was able to explain 59.3% variation in students' problem-solving abilities.

The increase was reinforced by supporting data during the learning process. The results of the questionnaire on the problem-solving ability of the experimental group reached 73.26%, higher than the control group of 46.59%. The development of LKPD also showed an increase in the achievement of the experimental group from 60.31 at the first meeting to 85.00 at the third meeting. The findings show that the combination of group work, academic games, tournaments, and the use *of Number Mystery* provides space for students to understand problems, strategize, implement solutions, and re-examine the results more actively.

The contribution of the research lies in the use *of Number Mystery* as a concrete medium that is directly integrated with the TGT stage to support the process of solving mathematics problems for grade III students. The strategy can be an alternative to mathematics learning that combines cooperative activities, educational games, and systematic thinking exercises. The next study needs to involve samples from several schools, extend the duration of treatment, and use analyses that can control differences in initial abilities between groups so that the effectiveness of TGT assisted *by Number Mystery* can be tested more broadly and in-depth.

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