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Mathematical Critical Thinking Skills Based on Self-efficacy in Teams Games Tournament (TGT) Cooperative Learning Assisted by Baamboozle

Ana Faila Shuffa[1*], Masrukan[1]

[1]Mathematics Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang

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ABSTRACT

Mathematical critical thinking skills play a crucial role in helping students analyze information, determine problem-solving strategies, and make logical decisions when solving mathematical problems. Efforts to develop these skills require instruction that encourages active student participation while also taking into account internal factors, such as *self-efficacy*. This study aims to (1) test the effectiveness of implementing *Teams Games Tournament* (TGT)-style cooperative learning supported by Baamboozle on mathematical critical thinking skills and (2) describe the characteristics of these skills based on levels of *self-efficacy*. The study employed a mixed-methods approach with a sequential explanatory design. A total of 64 seventh-grade students at SMP Negeri 13 Semarang participated in the quantitative phase using a pretest-posttest control group design, while six students were selected via purposive sampling for the qualitative phase. Data were collected using a mathematical critical thinking skills test, a *self-efficacy* questionnaire, and interviews. The instrument validation results showed that all test items and questionnaire items were valid , with reliability coefficients of 0.929 and 0.921, respectively, which fall into the very high category. Quantitative analysis included classical achievement tests, tests of the difference between two means, tests of the difference between two proportions, and normalized gain (N-Gain) analysis, while qualitative analysis used the Miles and Huberman model, which encompasses data reduction, data presentation, drawing conclusions, and triangulation of techniques. The research results show that (1) TGT-type cooperative learning supported by Baamboozle meets the criteria for effectiveness in improving mathematical critical thinking skills and (2) students with high *self-efficacy* demonstrate more optimal achievement of the indicators compared to students with moderate or low *self-efficacy*. These findings reinforce the notion that *self-efficacy* contributes to the development of mathematical critical thinking skills and should therefore be considered as an important aspect in the design of mathematics instruction.

Corresponding Author:

Ana Faila Shuffa,
Mathematics Education Study Program,
Faculty of Mathematics and Natural Sciences,
Universitas Negeri Semarang,
Jalan Taman Siswa, Gunung Pati, Semarang, Central Java 50229, Indonesia,
anafaila@students.unnes.ac.id

Introduction

In 21st-century education, mastery of mathematical critical thinking skills plays a vital role. A number of recent studies indicate that this competency continues to be a major focus in mathematics education research, as these skills have been shown to help students analyze information, formulate solutions, and make rational decisions in various situations (La'ia & Sarumaha, 2025). The modern learning paradigm is shifting; its focus is no longer merely on memorizing formulas or concepts, but rather on strengthening critical thinking skills, creativity, collaboration, and communication as crucial tools for navigating the complexities of the modern world (Mhb & Mukhlis, 2023). Furthermore, these critical thinking competencies are closely related to students' ability to analyze data, weigh various problem-solving options, and present valid arguments for their chosen solutions (Agusman et al., 2025). In mathematics classes, critical thinking skills guide students to analyze problems, connect supporting data, design problem-solving strategies, review each step of the process, and formulate conclusions in a logical sequence (Facione, 2011). This argument is supported by the findings of Sarwanto et al. (2021) who concluded that stimulating critical thinking has a direct impact on students' conceptual understanding and problem-solving effectiveness. Thus, fostering mathematical critical thinking skills is a strategic priority to help students become accustomed to addressing various challenges in a structured, logical, and reflective manner.

The low level of students' mathematical critical thinking skills in Indonesia remains an urgent issue that must be addressed immediately. This is clearly evident in the 2022 Programme for International Student Assessment (PISA) report, in which the national mathematics score stood at 366—still far below the average for OECD member countries (OECD, 2023). This situation suggests that the majority of students still face significant challenges when confronted with problems that require analytical precision, sharp reasoning, appropriate strategies, and logical consistency in drawing conclusions. This finding is supported by the perspective of Siagian et al. (2023), who emphasize that solving mathematical problems goes beyond simply memorizing formulas; it requires a process of reasoning, analytical examination, and the selection of relevant procedures. Consequently, the implementation of instructional designs specifically designed to foster the development of students' critical thinking skills has become imperative.

These national-level findings are consistent with the conditions observed at Semarang Public Junior High School No. 13. Based on a series of interviews with seventh-grade mathematics teachers and a preliminary field assessment, it was determined that students' indicators of mathematical critical thinking have not yet reached an optimal level. Students still struggle to grasp the essence of problems, design a logical sequence of steps to solve them, and formulate valid conclusions based on available data. On the other hand, the classroom learning ecosystem remains heavily reliant on conventional student worksheets (LKPD), while the use of interactive media tools to boost active engagement remains minimal. This situation indicates that the learning experiences currently in place do not fully provide students with the space to actively analyze problems, engage in dialectical thinking, and formulate strategies independently. Therefore, an intervention is needed in the form of a collaborative, student-centered learning model that not only boosts classroom engagement but also comprehensively accelerates students' capacity for critical mathematical thinking.

In response to these various challenges, a learning framework is needed that can stimulate students' active participation while enhancing their capacity for critical mathematical thinking. One reliable strategic alternative is the implementation of the Teams Games Tournament (TGT) cooperative learning model. According to Slavin (2015), the TGT model focuses on

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collaboration within heterogeneous learning groups, which is realized through five main phases: content presentation, team work, academic competition, tournament, and group recognition to spark full student engagement. Through the dynamics of group discussions, educational games, and inter-team tournaments, students are motivated to exchange ideas, test the validity of arguments, evaluate alternative solutions, and work together to master concepts comprehensively. A number of contemporary studies have demonstrated that the TGT model is effective in boosting learning engagement while stimulating mathematical critical thinking through healthy discussion and competition (Azizah et al., 2026). These findings align with the study by Sa'adilla et al. (2022), which confirms that the use of TGT opens up ample opportunities for students to explore their critical thinking skills at every stage of problem-solving. To further optimize the interactive nature of TGT, its implementation can be combined with digital tools. Such integration has been shown to provide a dynamic learning experience and encourage students to solve mathematical problems collaboratively (Ditia & Saragih, 2026). In addition, Mufida and Nurtjahyani (2024) note that combining TGT with technology-based media can liven up the classroom atmosphere, boost motivation, and strengthen social interaction among students. As a concrete example of utilizing this technology, game-based learning platforms such as Baamboozle can be integrated as a tool for interactive quizzes that effectively boost enthusiasm in the classroom (Wardani & Kiptiyah, 2024). Furthermore, Hilda and Prasetyaningtyas (2024) confirm that the use of Baamboozle in the mathematics learning ecosystem not only creates a fun classroom atmosphere but also positively supports students' ability to solve various types of problems.

In addition to external factors such as instructional models and media, internal aspects within the students themselves play a crucial role in determining the effectiveness of mathematics instruction; one such aspect is self-efficacy. This concept refers to students' subjective beliefs regarding their own capacity to complete tasks or overcome various obstacles (Bandura, 1994). Various recent studies indicate that students with high levels of self-efficacy tend to demonstrate superior performance in mathematical critical thinking. This is driven by a strong sense of self-confidence when they must sort through information, formulate strategies, and defend their arguments rationally (Suhartini et al., 2025). Essentially, self-efficacy builds students' mental resilience in analyzing problems and maintaining consistent effort until a solution is found. This view is reinforced by the findings of Sukma and Priatna (2021) which demonstrate a positive correlation between self-confidence and mathematical critical thinking ability. Therefore, in-depth studies of critical thinking ability must take this psychological aspect into account as a determining variable.

Although various previous studies have confirmed the effectiveness of the TGT model in boosting students' academic achievement and critical thinking skills, as well as the ability of game-based media such as Baamboozle to spark learning motivation, there remains a significant gap in the literature. Based on a review of the literature, studies that comprehensively integrate the Teams Games Tournament (TGT) cooperative learning model with Baamboozle, while simultaneously examining critical thinking skills based on self-efficacy categories particularly within the context of seventh-grade middle school statistics remain relatively scarce. Based on this gap, this study introduces an element of novelty through the synthesis of the Baamboozle-assisted TGT model and an in-depth mapping of variations in students' mathematical critical thinking skills as viewed through the lens of their self-efficacy levels. Thus, this study is specifically aimed at testing the effectiveness of implementing the Teams Games Tournament (TGT) cooperative learning model, supported by Baamboozle, on students' mathematical critical thinking skills, while also describing the profile of these critical thinking skills based on students' levels of self-efficacy.

Method

Type of Research

This study employed a mixed-methods approach using a sequential explanatory design (Creswell, 2019). The research was conducted in two phases. The initial phase applied a quantitative approach using a pretest-posttest control group design to analyze the effectiveness of implementing the Teams Games Tournament (TGT) cooperative learning model, supported by Baamboozle, on students' mathematical critical thinking skills. Subsequently, the second phase shifted to a qualitative approach using a descriptive case study design to describe students' mathematical critical thinking skills based on their individual levels of self-efficacy. The choice of this qualitative approach served to deepen the quantitative findings, thereby presenting a complete, in-depth, and comprehensive narrative regarding the dynamics of students' critical thinking skills in the classroom.

Table 1. Desain Pretest-Posttest Control Group

	Pre-test	Treatment	Post-test
Experimental Class	O_1	X_1	O_2
Control Class	O_1	X_2	O_2

Notes:
O_1: pretest scores for critical thinking skills
O_2: posttest scores for critical thinking skills
X_1: TGT-style cooperative learning supported by Baamboozle
X_2: Problem Based Learning (PBL)

Population and Samples

The study population consisted of all 297 seventh-grade students at Semarang Public Junior High School No. 13 for the 2025/2026 school year, distributed across nine classes. The sample was determined using a multistage sampling procedure (Firmansyah et al., 2022), resulting in the selection of Class VII B as the experimental group and Class VII A as the control group, each consisting of 32 students. The experimental group underwent a Teams Games Tournament (TGT)-type cooperative learning scheme assisted by Baamboozle, while the control group was taught using the Problem-Based Learning (PBL) method. The demographics of the research sample are presented in Table 2.

Table 2. Research Sample Demographics

Group	**Class**	**Number of Students**
Experimental Class	VII B	32
Control Class	VII A	32
Total		64

The subjects for the qualitative research phase were selected using purposive sampling. The selection process began by administering a self-efficacy questionnaire to all students in the experimental class. The self-efficacy scores obtained were then calculated and grouped into high, moderate, and low categories based on the mean (μ) and standard deviation (σ). Students with scores of $X < (\mu - 1\sigma)$ were categorized as having low self-efficacy; students with scores of $(\mu - 1\sigma) \leq X < (\mu + 1\sigma)$ were categorized as having moderate self-efficacy; and students with scores of $X \geq (\mu + 1\sigma)$ were categorized as having high self-efficacy. Based on these results, there were 4 students with high self-efficacy, 22 students with moderate self-efficacy, and 6 students with low self-efficacy. Next, using purposive sampling, two

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students were selected from each category, resulting in six research subjects consisting of two students with high self-efficacy, two students with moderate self-efficacy, and two students with low self-efficacy. These six subjects were then interviewed to obtain more in-depth information regarding the students' mathematical critical thinking processes in solving math problems.

Implementation of Teams Games Tournament (TGT) Cooperative Learning with Baamboozle

Instruction in the experimental class was conducted using the Teams Games Tournament (TGT) cooperative learning model, supported by Baamboozle, over three sessions covering seventh-grade statistics. The implementation of this model followed the Teams Games Tournament syntax developed by Slavin (2015), namely class presentation, team learning, games, tournament, and team recognition. In this study, Baamboozle was integrated into the games and tournament stages as a game-based learning medium that presented statistics problems aligned with the learning objectives of each session, thereby encouraging active student engagement. Through the implementation of the games and tournament stages aided by Baamboozle, students are encouraged to identify information, evaluate data, devise solution strategies, and draw conclusions through group discussions as well as game and tournament activities in an interactive, collaborative, and competitive learning environment. The implementation sequence of the Teams Games Tournament (TGT) cooperative learning model supported by Baamboozle in this study is outlined in Table 3.

Table 3. Implementation of the Teams Games Tournament (TGT) Syntax Using Baamboozle

TGT Syntax	Teacher Activities	Student Activities	Implementation of Baamboozle
Class Presentation	The teacher explains the learning objectives, motivates the students, and explains the statistics material through examples and a question-and-answer session	Students listen to the teacher's explanation, observe the examples provided, and ask and answer questions.	The teacher introduced Baamboozle as the platform that will be used during the game and tournament phases.
Learning in Teams	The teacher divides the students into heterogeneous groups and guides their discussion on completing the worksheets.	Students discuss, exchange opinions, complete worksheets, and prepare to participate in games and tournaments.	Students prepare problem-solving strategies to help them participate in the game using Baamboozle.
Games	The teacher explains the rules of the game, operates Baamboozle, and guides the game as it progresses between groups.	Students take turns selecting questions on Baamboozle, discussing them with their groups, and then sharing their answers.	Baamboozle is used as a game platform that presents statistics questions based on the material covered in each session.
Tournament	The teacher facilitates the tournament, gives other groups a chance to answer if the answer is incorrect, and keeps track of each group's score.	Students compete to answer questions, provide feedback on other groups' answers, and devise strategies to achieve the highest score.	Baamboozle is used to display questions in rotation and track scores throughout the tournament.
Team Recognition	The teacher announced the scores, presented awards to the top-performing groups, and led a reflection on the learning experience.	Students receive their tournament results, reflect on the learning process, and share their learning experiences.	The final scores obtained through Baamboozle were used as the basis for awarding prizes to the top teams.

To support the learning process, Baamboozle is used as a game-based medium in the games and tournament phases. Figure 1 shows the Baamboozle game interface used during the learning process.

Figure 1. Screenshots of the Baamboozle game in the Games and Tournament sections.

Figure 1 shows the Baamboozle game interface used in the game and tournament phases of this study. Through this platform, students take turns selecting questions, discussing solutions with their group members, and then submitting their answers according to the game rules. The use of Baamboozle supports interactive and competitive learning and facilitates students' active engagement throughout the learning process. Details regarding the implementation of Teams Games Tournament (TGT)-style cooperative learning supported by Baamboozle in each session are presented in Table 4. The table lists the content, learning activities, and learning objectives to be achieved in each session.

Table 4. Cooperative Learning Design Using the Teams Games Tournament (TGT) Method with Baamboozle Support for Each Session

Session	Topic	Learning Activities	Learning Objectives
I	Data Presentation and Processing	Students identify types of data, collect simple data through group discussions using worksheets, and then reinforce their understanding by solving problems on Baamboozle.	Students are able to identify types of data, collect simple data, and present data in tabular form.
II	Bar Chart.	Students present data in the form of bar charts, interpret the information presented through group discussions, and then reinforce their understanding by solving problems on Baamboozle.	Students are able to present data in the form of bar charts and interpret the information presented in the charts.
III	Pie Chart	Students present and interpret data in the form of pie charts through group discussions, then reinforce their understanding by solving problems on Baamboozle.	Students are able to present data in the form of pie charts, interpret the information presented, and solve problems related to data presentation.

To support the learning process in each session, Baamboozle includes a question bank designed in accordance with the learning materials and objectives. An example of the question bank used in each session is shown in Figure 2.

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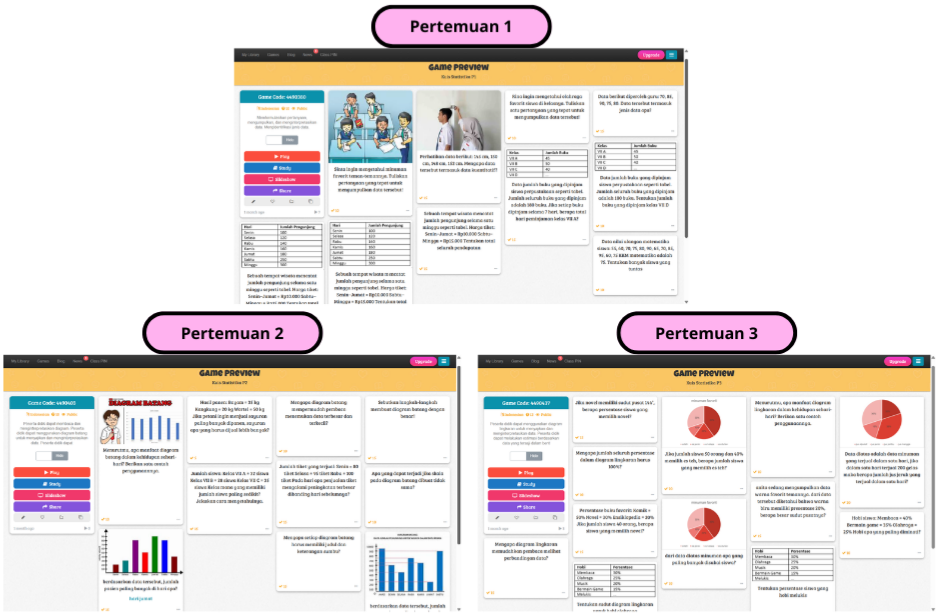

Figure 2. Baamboozle Question Bank

Figure 2 shows the Baamboozle question bank used in each learning session. The question bank is organized according to the content and learning objectives of each session. In the first session, the questions focused on data presentation and processing. The second session included questions on the presentation and interpretation of bar charts, while the third session contained questions on the presentation and interpretation of pie charts. By compiling a question bank tailored to the learning material, Baamboozle supports games and tournaments designed to reinforce students' conceptual understanding. Based on this implementation, the Teams Games Tournament (TGT) cooperative learning model, supported by Baamboozle, was applied in the experimental class over three sessions in accordance with the designed instructional syntax, content, and learning objectives. This application served as the treatment in the study prior to data collection using a mathematical critical thinking test, a self-efficacy questionnaire, and interviews.

Data Collection, Instruments, and Techniques

Research instruments were designed in accordance with the competencies being measured so that the data obtained could provide a comprehensive picture of the students' abilities. According to Masrukan (2017), assessment is a systematic process for collecting various types of information regarding students' achievement of competencies through the use of instruments appropriate to the characteristics of the abilities being measured. Therefore, this study used a mathematical critical thinking test, a self-efficacy questionnaire, and interview guidelines as data collection instruments. The mathematical critical thinking test was used to measure students' mathematical critical thinking skills before and after instruction. The self-efficacy questionnaire was used to determine students' self-efficacy categories as the basis for selecting participants in the qualitative study. The interview guide was used to elicit more in-depth information regarding students' mathematical critical thinking processes in solving mathematical problems. All research instruments underwent content validation by three expert validators before being used in the study. Subsequently, the mathematical critical thinking ability test was pilot-tested to determine the validity, reliability, difficulty level, and discriminative power of the test items, while the self-efficacy questionnaire was pilot-tested to determine its validity and reliability.

The test instrument was pilot-tested on 32 students. The results of the validity test for mathematical critical thinking skills showed that all test items were valid ($r = 0.644 - 0.826 > r_{table} = 0.349$). The reliability of the mathematical critical thinking skills test was 0.929 (very high category). The test's discriminant power fell into the fair to good range ($0.278 - 0.528$), and the difficulty level of the mathematical critical thinking test was in the moderate to difficult range. The results of the self-efficacy questionnaire validity test showed that all questionnaire items were valid ($r = 0.449 - 0.688 > r_{table} = 0.349$). The reliability of the questionnaire was 0.921 (very high category). Based on these test results, all instruments were deemed valid, reliable, and suitable for use in this study.

Table 5. Sample Test Items for Mathematical Critical Thinking Skills

Sample Instrument	Instrument Characteristics
Ms. Sinta conducted a survey on the career aspirations of seventh-grade students. The data shows the percentage of students who aspire to become teachers (30%), doctors (25%), police officers (20%), businesspeople (15%), and soldiers (10%) out of a total of 40 students. The students were asked to determine the number of students in each category, present the data in the form of a pie chart, then compare the results and provide reasons based on the data obtained.	Contextual essay questions on statistics designed to measure indicators of mathematical critical thinking skills—namely, clarification, assessment, strategies, and inference—based on Perkins and Murphy (2006).

Research data were collected through tests, questionnaires, and interviews, following the steps shown in Figure 3.

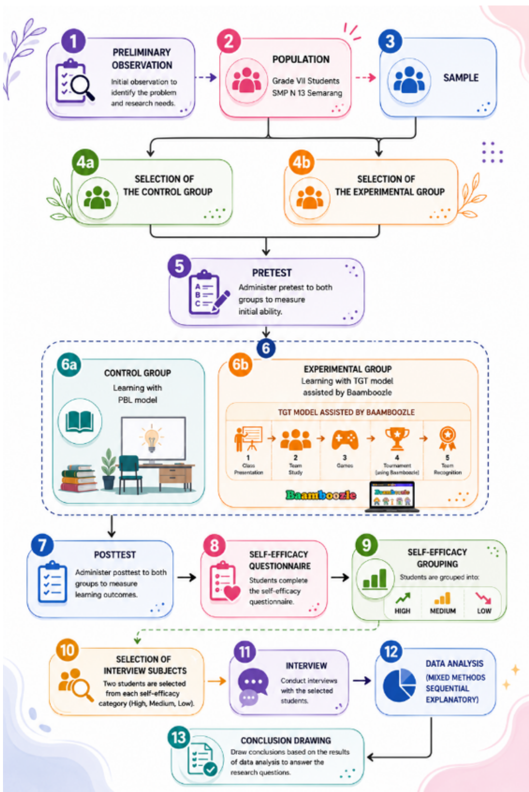

Figure 3. Research Data Collection Process

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Figure 3 shows that data collection began with preliminary observations at the school to gather information about learning conditions and determine the research population. Next, a sample was selected using a multistage sampling technique to identify an experimental class and a control class. Both classes took a pretest to assess their initial mathematical critical thinking skills; subsequently, the experimental class received Teams Games Tournament (TGT)-style cooperative learning supported by Baamboozle, while the control class received Problem-Based Learning (PBL). After the instruction period ended, both classes took a posttest. Subsequently, students in the experimental class completed a self-efficacy questionnaire used to categorize them into high, moderate, and low groups. Based on these results, two students were selected from each category using purposive sampling for interviews, yielding both quantitative and qualitative data that were subsequently analyzed in accordance with the research design.

Data Analysis

Quantitative data were analyzed using statistical software. The analysis began with prerequisite tests, including normality and homogeneity tests. Next, the analysis was conducted to test the research hypotheses, which included: (1) the achievement of classical mastery of students' mathematical critical thinking skills; (2) the difference in the mean mathematical critical thinking skills between students who received Teams Games Tournament (TGT)-type cooperative learning supported by Baamboozle and students who received Problem-Based Learning (PBL); (3) the improvement in students' mathematical critical thinking skills after participating in Teams Games Tournament (TGT)-style cooperative learning supported by Baamboozle; and (4) the difference in the proportion of students achieving mastery between the experimental and control classes. Hypothesis testing was conducted using the classical mastery test, the t-test for two means, the N-Gain test, and the test for the difference between two proportions.

Qualitative data were analyzed using the Miles and Huberman data analysis model, which includes data reduction, data presentation, and drawing conclusions (Miles et al., 2014). The interview data were first transcribed, and then each subject was coded according to self-efficacy categories: ST (high self-efficacy), SS (moderate self-efficacy), and SR (low self-efficacy), followed by the subject's serial number within each category. Next, data reduction was performed by selecting and focusing on relevant data based on indicators of mathematical critical thinking skills according to Perkins and Murphy (2006), namely clarification, assessment, strategies, and inference. The reduced data were then presented descriptively to illustrate students' mathematical critical thinking abilities based on their level of self-efficacy. Data validity was ensured through triangulation by comparing test results and interview findings, thereby yielding credible data (Sugiyono, 2019).

Research Findings

The Effectiveness of *Teams Games Tournament*s Cooperative Learning Supported by Baamboozle

A normality test was conducted as a prerequisite before hypothesis testing to determine whether the posttest data from the experimental and control classes came from normally distributed populations. The Shapiro–Wilk test was used because the sample size in each class was less than 50 students. The results of the normality test are presented in Table 6.

Table 6. Results of the Normality Test for Posttest Data

Class	Shapiro-Wilk	Sig.	Conclusion
Experiment	0,939	0,070	Normally Distributed
Control	0,944	0,097	Normally Distributed

Based on Table 6, the significance values of the Shapiro–Wilk test were 0.070 for the experimental class and 0.097 for the control class. Both significance values were greater than 0.05, indicating that the posttest data for both classes were normally distributed. Next, a homogeneity test was conducted to determine whether the variances of the posttest data in the experimental and control classes were equal. The test was conducted using Levene's test. The results of the homogeneity test are presented in Table 7.

Table 7. Results of the Posttest Data Homogeneity Test

Test	Statistics	Sig.	Conclusion
Levene's Test	0,762	0,386	Homogeneous Variance

Criteria: Data are considered to have homogeneous variance if the significance value is greater than 0.05.

Based on Table 7, the results of the homogeneity test showed a significance value of 0.386. Since this value is greater than 0.05, the variances of the posttest data in the experimental and control classes are considered homogeneous. With the assumptions of normality and homogeneity met, a classical mastery test was then conducted to determine whether the proportion of students in the experimental class who achieved the Learning Objective Achievement Criteria (KKTP) met the classical mastery standard. The results of the classical mastery test are presented in Table 8.

Table 8. Results of the Classical Proficiency Test

Number of Students Murid	Students Complete the Course	Achievement Percentage	Z_{score}	Z_{table}	Conclusion
32	29	90,6%	2,041	1,645	H_0 Rejected

Based on Table 8, of the 32 students in the experimental class, 29 students (90.6%) achieved the minimum passing score (75). The results of the classical achievement test show that the calculated Z-score of 2.041 is greater than the critical Z-score of 1.645; therefore, H_0 is rejected. Thus, the proportion of students who achieved the KKTP exceeded 75%, so classical mastery in the experimental class was deemed achieved. After classical mastery was achieved, a two-sample t-test was conducted to determine whether there was a difference in mathematical critical thinking ability between students in the experimental class and the control class after being given different treatments. The results of the two-sample t-test are presented in Table 9.

Table 9. Results of the Test for the Difference Between Two Means

Experimental Class Average	Control Group Average	T-test	t_{table}	Conclusion
83	72	4,069	1,669	H_0 Rejected

Based on Table 9, the calculated T-test of 4.069 is greater than the critical T-test of 1.669; therefore, H_0 is rejected. These results indicate that the mean mathematical critical thinking ability of students in the experimental class was higher than that of the control class after being exposed to the different instructional approach. Next, a post-test was conducted to determine whether the students' mathematical critical thinking skills in the experimental

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class improved after the implementation of *Teams Games Tournament* (TGT)-style cooperative learning supported by Baamboozle. The results of the post-test are presented in Table 10.

Table 10. Results of the Enhancement Test

Pretest Average	Posttest Average	T-test	t_{tabel}	Conclusion
61,46	83,46	25,525	2,039	H_0 Rejected

Based on Table 10, the calculated T-test was 25.525, which is greater than the critical T-test of 2.039; therefore, H_0 is rejected. These results indicate that the students' mathematical critical thinking skills in the experimental class improved after the implementation of *Teams Games Tournament* (TGT)-style cooperative learning supported by Baamboozle. To determine the extent of the improvement in the students' mathematical critical thinking skills, an N-Gain analysis was conducted. The results of the N-Gain analysis are presented in Table 11.

Table 11. N-Gain Analysis

Average N-Gain	Category
0,6021	Medium

Based on Table 11, the average N-Gain was 0.6021, which falls into the moderate category. This indicates that the improvement in students' mathematical critical thinking skills after participating in *Teams Games Tournament* (TGT)-style cooperative learning supported by Baamboozle was moderate. Next, a two-proportion test was conducted to determine whether the proportion of students who met the Learning Objective Achievement Criteria (KKTP) in the experimental class was higher than that in the control class. The results of the two-proportion test are presented in Table 12.

Table 12. Results of the Test for the Difference Between Two Proportions

Achievement Rate of the Experimental Class	Achievement Rate of the Control Class	Z_{score}	Z_{tabel}	Conclusion
90,6%	56,3%	4,403	1,645	H_0 Rejected

Based on Table 12, the proportion of students who achieved the KKTP in the experimental class was 90.6%, while in the control class it was 56.3%. The results of the test for the difference between two proportions showed that the calculated Z-score of 4.403 was greater than the critical Z-score of 1.645, so H_0 was rejected. These results indicate that the proportion of students who achieved the KKTP in the experimental class was higher than in the control class. Based on the results of the classical mastery test, the t-test for the difference between two means, the gain test, the N-Gain analysis, and the t-test for the difference between two proportions, the *Teams Games Tournament* (TGT)-type cooperative learning assisted by Baamboozle met all the effectiveness indicators established in this study. Therefore, *Teams Games Tournament* (TGT)-style cooperative learning supported by Baamboozle is deemed effective in improving students' mathematical critical thinking skills.

A Description of Mathematical Critical Thinking Skills as Viewed Through the Lens of Students' *Self-efficacy*

After finding that *Teams Games Tournament* (TGT)-style cooperative learning supported by Baamboozle is effective in improving mathematical critical thinking skills, a qualitative analysis was then conducted to describe students' mathematical critical thinking skills based on their level of *self-efficacy*. The analysis was conducted on six research subjects selected using purposive sampling, each group consisting of two students with high, moderate, and low levels of *self-efficacy*. Given that the characteristics of mathematical critical thinking skills in each *self-efficacy* category showed relatively similar patterns, this article presents one representative subject from each category. The results of the analysis of the other subjects were used as supporting data to confirm the consistency of the findings. Information regarding the qualitative research subjects is presented in Table 13.

Table 13. Qualitative Research Subjects

Student ID	**Subject Code**	***Self-efficacy* Category**	**Critical Thinking Score**	***Self-efficacy* Score**
E-25	ST-1	High	100	89
E-02	ST-2	High	98	90
E-08	SS-3	Medium	81	80
E-17	SS-4	Medium	81	80
E-27	SR-5	Low	60	56
E-07	SR-6	Low	58	50

Based on Table 13, students with high *self-efficacy* are represented by subject ST-1, those in the moderate category by subject SS-1, and those in the low category by subject SR-1. These three subjects were selected to represent their respective categories because they exhibited characteristics consistent with other subjects in the same category. Furthermore, mathematical critical thinking skills in each category were described based on test results and interview findings, referring to the indicators of clarification, assessment, strategies, and inference according to (Perkins & Murphy, 2006).

Students with high self-efficacy

Based on the results of the ST-1 test and interview shown in Figure 4 and Figure 5, ST-1 demonstrated excellent mathematical critical thinking skills in solving statistical problems. ST-1 was able to identify the given information in the problem, namely the data on the scores of 30 students and the Learning Objective Achievement Criteria (KKTP) threshold of 75, as the basis for determining which students had met the learning objectives and which required remedial instruction. Furthermore, ST-1 constructed a frequency distribution table by determining the frequency for each class interval and then presented the data in the form of a bar chart. In addition, ST-1 was able to explain the steps for creating a bar chart in a logical sequence according to the instructions in the problem. Based on the results obtained, ST-1 concluded that the majority of students had met the KKTP because the number of students who met the criteria was greater than the number requiring remedial instruction. The interview results supported this finding because ST-1 was able to explain the information provided in the question, the rationale for using the KKTP as the basis for grouping, the steps taken to solve the problem, and the basis for drawing conclusions. These findings indicate that ST-1 was able to meet all indicators of mathematical critical thinking according to Perkins and Murphy (2006), namely clarification, assessment, strategies, and inference. This achievement was demonstrated through ST-1 ability to identify relevant information, use that information as a basis for decision-making, develop systematic problem-solving strategies, and draw conclusions based on the results of the analysis.

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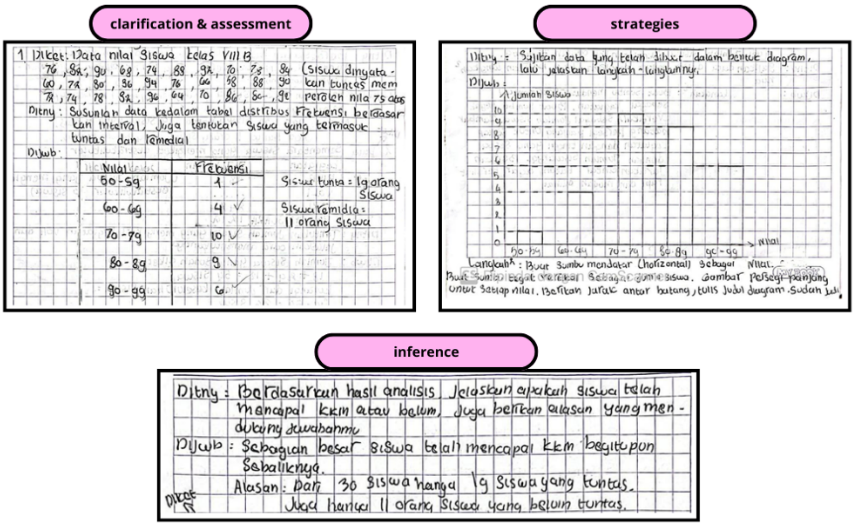

Figure 4. Subject ST-1 Answer to Question 1

Peneliti : Informasi apa saja yang kamu ketahui dari soal tersebut, dan bagaimana kamu menentukan siswa yang tuntas dan remedial? **ST-1** : Yang saya ketahui ada data nilai 30 siswa dan siswa dinyatakan tuntas kalau nilainya minimal 75. Jadi saya pakai nilai 75 itu sebagai patokan untuk menentukan siswa yang tuntas dan yang remedial, terus saya kelompokkan nilainya ke dalam interval supaya lebih mudah dihitung.	Clarification & Assessment
Peneliti : Bagaimana langkah-langkah yang kamu lakukan untuk menyelesaikan soal tersebut? **ST-1** : Saya buat tabel distribusi frekuensi dulu, terus saya hitung jumlah siswa di setiap interval. Setelah itu saya buat diagram batang berdasarkan tabel tersebut supaya lebih mudah melihat jumlah siswa pada setiap interval.	Strategies
Peneliti : Bagaimana kamu memperoleh kesimpulan tersebut? **ST-1** : Karena setelah saya hitung ada 19 siswa yang nilainya sudah mencapai 75, sedangkan yang belum tuntas ada 11 siswa. Jadi saya menyimpulkan sebagian besar siswa sudah mencapai KKM.	Inference

Figure 5. Excerpt from an Interview with Subject ST-1

Students with medium self-efficacy

Based on the results of the SS-1 test and interview shown in Figure 6 and Figure 7, SS-1 demonstrated strong mathematical critical thinking skills in solving statistical problems. SS-1 was able to identify the given information in the problem, namely the data on the scores of 30 students and the Learning Objective Achievement Criteria (KKTP) threshold of 75, as the basis for determining which students met the criteria and which required remedial instruction. Furthermore, SS-1 constructed a frequency distribution table by determining the frequency for each class interval and then presented the data in the form of a bar chart. However, SS-1 did not write out the complete steps for creating the bar chart as required in the question. Based on the results obtained, SS-1 concluded that the majority of students had met the KKTP because the number of students who met the criteria was greater than the number requiring remedial instruction. The interview results supported this finding because SS-1 was able to explain the information provided in the question, the problem-solving process followed, and the reasoning behind the conclusion. Nevertheless, the explanation provided was still relatively brief, so the problem-solving process was not explained in detail. These findings indicate that SS-1 was able to meet all indicators of mathematical critical thinking according to Perkins and Murphy (2006), namely clarification, assessment, strategies, and inference. However, performance on the “strategies” and “inference” indicators was not yet optimal because the solution and explanation provided were still incomplete.

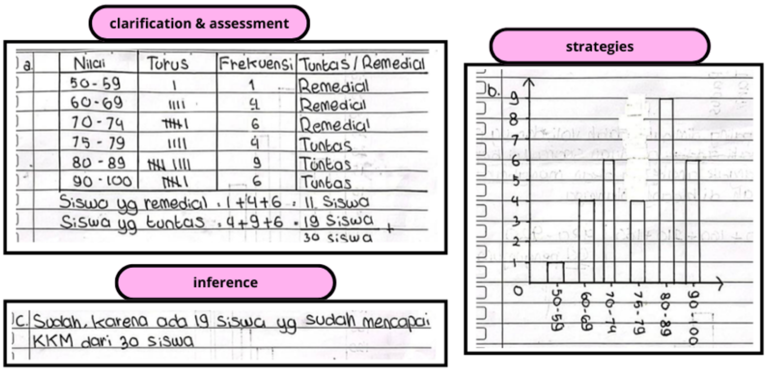

Figure 6. Subject SS-1 Answer to Question 1

Peneliti : Dari soal itu, apa saja yang kamu pahami? **SS-1** : Yang saya tahu ada data nilai 30 siswa. Terus kalau nilainya 75 ke atas berarti tuntas, yang di bawah 75 remedial. Jadi saya hitung dulu supaya tahu ada berapa yang tuntas sama yang remedial.	Clarification & Assessment
Peneliti : Setelah itu, kamu mengerjakannya bagaimana? **SS-1** : Saya buat tabel distribusi frekuensi dulu, terus saya hitung jumlah siswa di setiap kelompok nilai. Habis itu baru saya gambar diagram batangnya. **Peneliti** : Di soal kan diminta juga menjelaskan langkah membuat diagram batang, tapi di jawabanmu cuma ada diagramnya. Kenapa? **SS-1** : Iya Bu, saya lupa nulis langkah-langkahnya. Saya kira yang penting diagramnya sudah benar.	Strategies
Peneliti : Kenapa kamu menyimpulkan kalau sebagian besar siswa sudah mencapai KKTP? **SS-1** : Soalnya yang tuntas ada 19 siswa, terus yang remedial cuma 11 siswa. Jadi menurut saya yang sudah mencapai KKTP lebih banyak.	Inference

Figure 7. Excerpt from an Interview with Subject SS-1

Students with low self-efficacy

Based on the results of the SR-1 tests and interviews shown in Figure 8 and Figure 9, SR-1 demonstrated suboptimal mathematical critical thinking skills in solving statistical problems. SR-1 was able to identify the given information in the problem, namely the data on the scores of 30 students and the Learning Objective Achievement Criteria (KKTP) threshold of 75 as the basis for determining which students had met the standard and which required remedial instruction. However, SR-1 still made errors in determining the frequencies for several class intervals, so the frequency distribution table they constructed did not match the data in the problem. As a result, the bar chart presented also follows the data in the frequency distribution table, which still contains errors. Additionally, SR-1 did not outline the steps for creating the bar chart as required in the problem. In the conclusion section, SR-1 states that the majority of students have achieved the Minimum Competency Standard (KKTP) because the number of students who scored above 75 is greater than the number of students who scored below 75. The interview results indicate that the errors in the frequency distribution table were caused by a lack of precision when calculating and grouping the data into class intervals. SR-1 also explained that after compiling the frequency distribution table, he immediately created the bar

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chart, so he did not write out the complete steps for its creation. Nevertheless, SR-1 determined the number of students who met the standard by directly recalculating the score data, so the resulting conclusion remained consistent with the actual conditions. These findings indicate that SR-1 understood the basic information in the problem, but his ability to analyze data was not yet optimal, resulting in suboptimal achievement of the "clarification" and "assessment" indicators. This situation impacted the development of solution strategies, leading to suboptimal achievement of those indicators as well. Meanwhile, regarding the "inference" indicator, SR-1 was able to draw appropriate conclusions based on the recalculated data, even though the previous problem-solving process still contained errors.

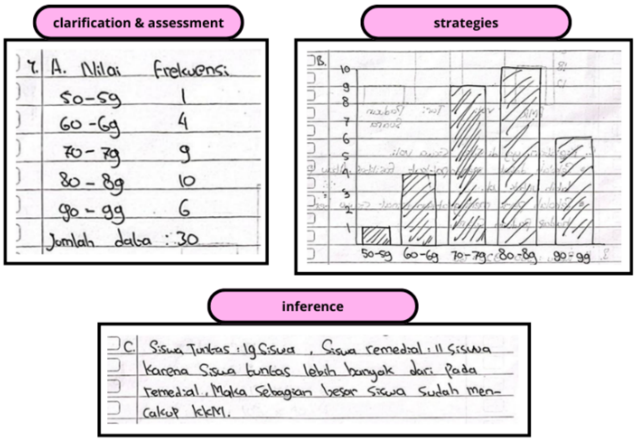

Figure 8. Subject SR-1 Answer to Question 1

Peneliti : Dari soal itu, apa saja yang kamu pahami? **SR-1** : Yang saya tahu ada data nilai 30 siswa. Terus saya diminta membuat tabel distribusi frekuensi, gambar diagram batang, sama menentukan siswa yang tuntas dan remedial. **Peneliti** : Setelah selesai mengerjakan, coba lihat lagi tabel yang sudah kamu buat. Menurutmu sudah sesuai dengan data pada soal? **SR-1** : (Melihat kembali jawabannya) Sepertinya belum, Bu. Tadi waktu ngitung kayaknya ada nilai yang salah saya masukin, jadi jumlahnya ada yang keliru.	Clarification & Assessment
Peneliti : Setelah membuat tabel distribusi frekuensi, apa yang kamu lakukan? **SR-1** : Habis selesai buat tabel, saya langsung gambar diagram batangnya sesuai data yang ada di tabel. **Peneliti** : Di soal juga diminta menjelaskan langkah-langkah membuat diagram batang, tapi di jawabanmu belum ada. Kenapa? **SR-1** : Iya, Bu. Saya lupa nulis langkah-langkahnya. Saya lebih fokus menggambar diagramnya dulu supaya selesai.	Strategies
Peneliti : Kenapa kamu menyimpulkan kalau sebagian besar siswa sudah mencapai KKTP? **SR-1** : Karena menurut saya yang nilainya 75 ke atas lebih banyak daripada yang di bawah 75. **Peneliti** : Terus, jumlah siswa yang tuntas itu kamu dapat dari mana? **SR-1** : Saya lihat lagi data nilainya satu-satu, Bu, terus saya hitung lagi.	Inference

Figure 9. Excerpt from an Interview with Subject SR-1

Next, to ensure the validity of the data, methodological triangulation was conducted by comparing the results of the mathematical critical thinking test and the interview results for each research subject. Methodological triangulation was conducted to ensure the consistency of the findings for each indicator of mathematical critical thinking ability based on the self-efficacy category. The results of the methodological triangulation are presented in Table 14.

Table 14. Results of Technical Triangulation for Each Category of *Self-efficacy*

Subject	Category
ST-1	Optimally meets all indicators of mathematical critical thinking skills (*clarification, assessment, strategies, and inference*).
SS-1	Meets all indicators of mathematical critical thinking skills. However, performance on the strategies and inference indicators is not yet optimal, as the solutions and explanations provided are still incomplete.
SR-1	Meets the *clarification* and *inference* criteria, but does not yet meet the *assessment* and *strategies* criteria because there are still errors in analyzing the data and formulating solution strategies.

Based on the results of technical triangulation in Table 14, it was found that the test results and interview results showed consistency across all research subjects. Students with high self-efficacy met all indicators of mathematical critical thinking skills optimally. Students with moderate self-efficacy also met all indicators, but their performance on the strategies and inference indicators was not yet optimal because their solutions and explanations were still incomplete. Meanwhile, students with low self-efficacy met the clarification and inference indicators but did not yet meet the assessment and strategies indicators because they still made errors in analyzing data and formulating solution strategies.

Discussion

The results of the study indicate that Teams Games Tournament (TGT)-style cooperative learning supported by Baamboozle is effective in improving students' mathematical critical thinking skills. This effectiveness demonstrates that the application of the TGT syntax is capable of creating a learning environment that encourages students' active engagement in constructing knowledge through group discussions, academic games, tournaments, and group rewards. According to (Slavin, 2015), these activities provide opportunities for students to exchange ideas, express opinions, and help group members understand the material, thereby making the learning process more meaningful. In this study, the implementation of the TGT syntax was reinforced by the use of Baamboozle as an interactive game platform that made students more enthusiastic about participating in tournaments, actively engaging in discussions, and motivated to solve the problems presented. These conditions enabled students not only to build conceptual understanding but also to develop systematic thinking skills in solving mathematical problems.

The findings of this study are consistent with the theory proposed by Perkins and Murphy (2006) which states that critical thinking skills develop through the ability to identify information (clarification), use information as a basis for decision-making (assessment), formulate problem-solving strategies (strategies), and draw conclusions (inference). The results indicate that Teams Games Tournament (TGT)-style cooperative learning supported by Baamboozle facilitates students' development of the four indicators of mathematical critical thinking skills during the learning process. During the classroom presentation and group discussion phases, students are trained to identify known and unknown information, express their opinions, and evaluate various solution alternatives, thereby supporting the development of the clarification and assessment aspects. Furthermore, academic games and tournaments conducted through Baamboozle encouraged students to formulate solution strategies, defend their answers through intergroup discussions, and draw conclusions based on the results of the

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discussions, thereby fostering the strategies and inference aspects as well. However, the analysis revealed that the level of achievement for each indicator still varied among students. This indicates that mathematical critical thinking skills are influenced not only by the implementation of the Teams Games Tournament (TGT) cooperative learning model supported by Baamboozle but also by students' individual characteristics, particularly their level of self-efficacy. This finding is supported by the research of Sa'adilla et al. (2022) which reported that the implementation of the TGT model is able to facilitate students in meeting the indicators of mathematical critical thinking skills.

In addition, studies by Mufida and Nurtjahyani (2024), Wardani and Kiptiyah (2024), and Hilda and Prasetyaningtyas (2024) show that the use of game-based interactive learning media can increase student participation, motivation, and active engagement during mathematics instruction. Unlike previous studies, which primarily focused on the effectiveness of the TGT model or the use of Baamboozle in isolation, this study integrates the Teams Games Tournament (TGT) cooperative learning model supported by Baamboozle with an analysis of mathematical critical thinking skills based on self-efficacy levels. Through a sequential explanatory mixed-methods approach, this study not only demonstrates the effectiveness of the learning process but also provides a more in-depth understanding of the characteristics of students' mathematical critical thinking skills across each self-efficacy category.

Based on the analysis of qualitative data, it was revealed that the level of self-efficacy has a significant influence on students' mathematical critical thinking characteristics when solving statistical problems. Students with high self-efficacy demonstrated strong self-confidence at every stage of problem-solving, enabling them to filter data more effectively and determine solution steps more accurately. Conversely, students with low self-efficacy typically harbor doubts about their personal abilities, which makes them more prone to errors when analyzing information or formulating strategies. These findings align with (Bandura, 1994) theory regarding how self-confidence shapes the way a person thinks, makes decisions, and exerts effort when facing a challenge. These characteristics also demonstrate that students with high self-efficacy are able to master all the indicators of critical thinking outlined by Perkins dan Murphy (2006) far more comprehensively than those in the moderate- or low-self-efficacy groups. Furthermore, the conclusions of this study reinforce the findings of Sukma & Priatna (2021) which confirm a positive correlation between self-efficacy and students' capacity for mathematical critical thinking.

Taken together, the findings from the quantitative and qualitative analyses complement each other in explaining the effectiveness of Teams Games Tournament (TGT)-style cooperative learning supported by Baamboozle on students' mathematical critical thinking skills. Quantitative data demonstrate that this instructional intervention significantly boosted critical thinking skills, while qualitative analysis explains that variations in these skill levels are influenced by each student's level of self-efficacy. Thus, this study not only provides empirical evidence regarding the effectiveness of Baamboozle-assisted Teams Games Tournament (TGT) type cooperative learning but also enriches our understanding of the characteristics of students' mathematical critical thinking skills across each self-efficacy category. The findings of this study imply that teachers need to design instruction that is not only oriented toward improving learning outcomes but also takes into account students' psychological aspects particularly self-efficacy as a key factor supporting the development of mathematical critical thinking skills.

Conclusion

Based on the results of the quantitative analysis, Teams Games Tournament (TGT)-style cooperative learning supported by Baamboozle is effective in improving students' mathematical critical thinking skills. This success is reflected in the achievement of the classical mastery target, the difference in average critical reasoning scores between the treatment and control groups, the improvement measured via the N-Gain test, and the contrast in the learning completion rates between the two classes. This effectiveness was achieved through a combination of group discussion activities, educational games, and tournaments that consistently fostered full student engagement in the classroom. The results of the qualitative analysis indicate that students' mathematical critical thinking skills vary across different categories of self-efficacy. These findings indicate differences in the characteristics of mathematical critical thinking skills across each self-efficacy category, where students with high self-efficacy tend to meet the indicators of critical thinking skills more comprehensively and demonstrate better abilities in analyzing information, determining problem-solving strategies, and drawing conclusions compared to students with moderate or low self-efficacy.

This study has limitations because it was conducted on a single statistics course at one school and involved a limited number of qualitative subjects; therefore, the results cannot yet be generalized to a broader learning context. Therefore, future research is recommended to implement Teams Games Tournament (TGT) style cooperative learning assisted by Baamboozle across different subjects and educational levels, and to involve a more diverse group of participants in order to gain a more comprehensive understanding of the effectiveness of Teams Games Tournament (TGT) style cooperative learning assisted by Baamboozle on mathematical critical thinking skills as viewed from the perspective of self-efficacy.

Conflict of Interest

The authors declare that there are no conflicts of interest.

Auhor Contributions

A.F.S. was responsible for the conceptualization of the research, the investigation, data collection and analysis, visualization, writing the initial draft, and revising the manuscript. M. was responsible for the conceptualization, supervision, validation of the methodology, critical review of the manuscript, and approval of the final version for publication. The authors' contribution percentages are as follows: A.F.S.: 60% and M.: 40%.

Data Availability Statement

The authors state that the data supporting the results of this study will be provided by the corresponding author, [A.F.S.], upon reasonable request.

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Authors Biography

	**Ana Faila Shuffa** is an undergraduate student in the Mathematics Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Central Java, Indonesia. ✉ anafaila@students.unnes.ac.id
	**Masrukan** is a lecturer and researcher in the Mathematics Education Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang, Central Java, Indonesia. His research interests include mathematics education, assessment of mathematics learning, educational evaluation, and mathematics education research methodology. ✉ masrukan.mat@mail.unnes.ac.id u