Game-Based Learning Bamboozle on Math Anxiety Level and Mathematical Conceptual Understanding

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Abstract
This study aims to analyze the application of the Game-Based Learning (GBL) method assisted by Baamboozle on the reduction of mathematical anxiety and the improvement of students' mathematical concept understanding. This study uses a qualitative approach with a case study method on three high school students in Cirebon City. The instruments used included a mathematical anxiety questionnaire, pretest and posttest questions, and interviews. The research results show that the application of the GBL method assisted by Baamboozle successfully reduced students' mathematical anxiety levels, with the proportion of students in the high-anxiety category decreasing from 12.5% to 3.1%, and those in the low-anxiety category increasing from 3.1% to 15.6%. Students' mathematical conceptual understanding also improved significantly, with the percentage of students in the high category rising from 15.6% to 62.5%, while no students remained in the low category. These findings indicate that the GBL method is effective in enhancing students' mathematical concept comprehension by creating a more enjoyable and interactive learning atmosphere. This research is expected to contribute to the development of more innovative and effective teaching methods in mathematics education and serve as a reference for educators in creating a supportive learning environment.

Keywords: Baamboozle, Case Study, Conceptual Understanding, Game-Based Learning, Mathematics Anxiety

INTRODUCTION

Education plays a crucial role in improving the quality of human resources, which ultimately drives the progress of a region or nation. In this regard, mathematics holds a strategic position as a core subject that not only serves as the foundation for the development of science and technology but is also relevant in everyday life (Raj Acharya, 2017). However, many students still face obstacles in understanding mathematical concepts, often accompanied by psychological symptoms such as mathematics anxiety (Rais, 2020). This anxiety causes discomfort and even physical symptoms when dealing with mathematical material, which then disrupts focus and lowers students' motivation to learn (Juliyanti & Pujiastuti, 2020;Rais, 2020)

The impact of mathematical anxiety is not only limited to emotional aspects but also directly affects the decline in the ability to understand basic mathematical concepts, which are essentially the foundation for developing students' critical, analytical, and creative thinking skills (Biantari, 2022; Juliyanti & Pujiastuti, 2020). The ability to understand mathematical concepts includes the ability to recognize and relate mathematical concepts, as well as to apply them correctly in solving problems (Biantari, 2022). This ability is essential because it allows learners to integrate new knowledge with the knowledge they already possess and to apply it in a broader context. When students master basic concepts deeply, they will be more prepared to face various problems and mathematical challenges (Tamrin et al., 2024).

Students with a high ability to understand mathematical concepts tend to absorb material and solve problems more efficiently. However, in reality, many learners still struggle to develop this ability, which results in low academic achievement in mathematics (Juliyanti & Pujiastuti, 2020). Research reveals a negative relationship between high mathematical anxiety and the ability to understand mathematical concepts, where this anxiety decreases students' motivation

and confidence in this subject (Biantari, 2022; Ismail & Zulkarnaen, 2023; Yuliany et al., 2025). This anxiety often stems from unpleasant learning experiences, social pressure, and teaching methods that are unengaging and do not meet students' needs (Dewi & Yuniarsih, 2020; Siska Dwi Astiati & Ilham, 2023). Mathematical anxiety has been proven to negatively impact students' math performance as well as their conceptual understanding (Zhang et al., 2019). As a result, students tend to avoid mathematics, creating unhealthy learning patterns and causing a decline in academic performance. If not appropriately addressed, math anxiety can trigger a negative cycle that worsens students' psychological and academic conditions.

The traditional learning approach, which is monotonous and lacks interactivity, actually reinforces the fear of mathematics, while the limitations in resources, methods, and learning media also diminish the quality of the learning process (Hamid & Rahmawati, 2024). Therefore, innovative and enjoyable learning methods that can enhance student motivation and understanding are needed (Dewi & Yuniarsih, 2020; Fauziyah et al., 2023). One of the relevant approaches is Game Based Learning (GBL), which is a method that integrates game elements into the learning process to create an interactive and enjoyable experience through healthy competition and entertainment that motivates students. The application of GBL has proven effective in reducing mathematical anxiety while simultaneously enhancing students' understanding of mathematical concepts in mathematics learning (Ramli et al., 2019; Rocha & Dondio, 2021). One of the platforms used in the implementation of GBL is Baamboozle.

Baamboozle is an interactive web-based quiz media designed to help teachers create and deliver learning materials in the form of educational games that can be played in groups (Murtia, 2024). Using Baamboozle, students do not just passively receive information but actively engage in a challenging yet enjoyable learning process. Such a learning environment has been proven to significantly reduce students' anxiety towards mathematics because their focus shifts to aspects of play and social interaction rather than just academic pressure (Prasetyo & Juandi, 2023). Research by Rahayu & Rukmana (2022) shows that the application of Baamboozle is capable of improving students' abilities in multiplication operations, as evidenced by the increase in pretest and posttest scores.

Baamboozle provides immediate feedback that helps students quickly identify and correct mistakes, thereby accelerating their understanding of the material (Hartanto & Kusuma, 2024). Gurning (2024) adds that the use of Baamboozle not only improves students' learning outcomes but also encourages teachers to be more innovative in designing lessons. Other research also supports that game-based learning media such as Baamboozle, Kahoot, and Wordwall can enhance students' interest, motivation, and understanding of mathematics (Pratiwi et al., 2023). Therefore, the use of Game-Based Learning assisted by Baamboozle becomes an effective strategy to address levels of mathematical anxiety while simultaneously enhancing students' understanding of mathematical concepts.

Baamboozle has specifically been proven to enhance students' motivation, engagement, and mathematical problem-solving skills. It fosters active participation and provides immediate feedback, which accelerates comprehension and helps reduce anxiety by shifting the focus toward games and social interaction (Hilda & Prasetyaningtyas, 2024). This study demonstrates the use of Baamboozle as an interactive web-based game learning medium that effectively improves fifth-grade students' problem-solving abilities in the topic of plane figures. The use of this medium also received positive responses from students, who stated that learning became more engaging and their motivation increased.

Other studies have shown that the implementation of Game-Based Learning has a positive impact on students' conceptual understanding and problem-solving abilities by making the learning process enjoyable and interactive, thereby enhancing confidence and motivation in mathematics (Deandra et al., 2023; Pabela et al., 2025).

This study aims to analyze the use of Game-Based Learning assisted by Baamboozle on students' levels of mathematical anxiety and their ability to understand mathematical concepts. It is hoped that the findings of this research can contribute to the development of innovative and adaptive learning methods, making mathematics learning more engaging, positively challenging, and capable of optimizing students' potential.

RESEARCH METHODS

This research uses a qualitative approach with a case study method to delve into the phenomenon of mathematical anxiety and students' ability to understand mathematical concepts in learning using the game-based learning method assisted by Baamboozle. The case study method was chosen because it provides an in-depth exploration of students' experiences and responses in a specific learning context while also considering the contextual factors that influence these dynamics (Nauli et al., 2019; Siregar & Murhayati, 2024). The subjects consisted of 32 tenth-grade high school students in Cirebon who were purposively selected based on the results of a mathematical anxiety questionnaire before the intervention and then grouped into three categories of anxiety (high, medium, low), with one student from each category analyzed in depth. The instruments include a mathematical anxiety questionnaire, pretest and posttest questions on mathematical concept comprehension ability, and interviews to explore students' experiences and perceptions of the Game-Based Learning method assisted by Baamboozle.

The indicators of mathematical anxiety in this study refer to three main aspects: cognitive, affective, and psychomotor (Mulyana et al., 2021). The cognitive aspect includes students' ability to understand the material, focus while studying, and difficulties in solving problems independently, such as confusion with new material and difficulty explaining concepts. The affective aspect relates to emotional feelings, such as anxiety, fear, restlessness, and self-confidence when facing math lessons, for example, anxiety before exams or nervousness during presentations. Meanwhile, the psychomotor aspect encompasses students' attitudes and behaviors during learning, such as the activity of asking questions, enjoyment in attending lessons, or the tendency to avoid when facing difficulties, such as the activity of asking questions, enjoyment in attending lessons, or the tendency to avoid when facing difficulties. Indicators of mathematical concept comprehension ability refer to students' ability to (1) restate concepts in their own words, (2) present concepts in various mathematical representations, (3) select and use appropriate procedures or operations, and (4) apply concepts in problem-solving effectively (Gusmania & Agustyaningrum, 2020). Data analysis techniques include grouping students based on anxiety levels, analyzing the relationship between mathematical anxiety and initial mathematical concept understanding through pretests, assessing improvement in understanding through posttests, and interview analysis to understand the impact of game-based learning on students' mathematical anxiety and mathematical concept understanding.

Table 1. Pretest and posttest instruments for understanding mathematical concepts

Indicator	Type of Test	Questionnaire
Restate concepts in their own words	Essay	You said the average daily temperature this week is 30°C, but your friend feels that today is much hotter. How do you explain that the mean does not always reflect specific daily conditions?
Present concepts in various	Essay	Data on the number of active smokers in Indonesia from 2018–2024:

mathematical representations		2018: 57 million people, 2019: 59 million people, 2020: 60 million people, 2021: 63 million people, 2022: 65 million people, 2023: 68 million people, and 2024: 70 million people. Present the data in the form of a line chart and a bar chart, and explain the trends that occur from the data!
Select and use appropriate procedures or operations	Essay	A streaming application manager wants to know the average time users watch movies weekly. He grouped the viewing duration data from 50 users as follows (in hours): What are the estimated average hours of movie-watching for users of that application?
Apply concepts in problem-solving effectively	Essay	In a provincial-level Silat Championship Event in West Java, the city of Cirebon sent several athletes to participate in the event. The weight data of the athletes to be sent is (in kg): 56, 60, 60, 64, 67, 68, and 72. If an athlete weighing 80 kg joins, how will it affect the mean, median, and mode?

View Duration (in hours)	Frequency
0-4	3
5-9	7
10-14	15
15-19	14
20-24	7
25-29	4

RESULT AND DISCUSSION

The research subjects were divided into three groups based on their level of mathematics anxiety measured through a questionnaire: high, moderate, and low anxiety. Three students from each category were selected as samples. The distribution of mathematics anxiety levels is presented in Table 2.

Table 2. Frequency Distribution of Mathematics Anxiety Categorization

Interval	Category	Mathematics Anxiety			
		Pretest		**Posttest**	
		Frequency	**Percentage %**	**Frequency**	**Percentage %**
20-39	Low	1	3.1	5	15.6
40-59	Moderate	27	84.4	26	81.3
60-80	High	4	12.5	1	3.1

Based on the frequency distribution data of mathematics anxiety, the learning intervention using the game-based learning method assisted by Baamboozle successfully reduced students' anxiety levels significantly. In the pretest, the majority of students (84.4%) experienced moderate anxiety, with 12.5% in the high category and 3.1% in the low category. After the intervention (posttest), the high-anxiety category drastically decreased to 3.1%, while the low-anxiety category increased to 15.6%, although the moderate category still dominated slightly at

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81.3%. This change indicates that the learning method effectively created a more conducive learning environment and reduced overall mathematics anxiety. These findings align with recent studies showing that game-based learning, particularly using number line media, can improve learning outcomes, motivation, and students' confidence in mathematics through an interactive and enjoyable learning atmosphere (Indriani & Utami, 2025; Pratama et al., 2023).

Students' conceptual understanding of mathematics was measured using a test consisting of four questions. The results of the statistical analysis of the frequency distribution of mathematical conceptual understanding are presented in Table 3.

Table 3. Frequency Distribution of Mathematical Conceptual Understanding

| Interval | Category | Mathematical Conceptual Understanding | | | |
| | | Pretest | | Posttest | |
		Frequency	Percentage %	Frequency	Percentage %
x < 20	Low	3	9.4	0	0
20 ≤ x < 46	Moderate	24	75	12	37.5
x > 46	High	5	15.6	20	62.5

Based on Table 3, there was a significant improvement in students' conceptual understanding after the intervention. During the pretest, most students (75%) were in the moderate category, 15.6% in the high category, and 9.4% in the low category. In the posttest, the number of students in the high category increased to 62.5%, the moderate category decreased to 37.5%, and no students remained in the low category. This indicates that the learning intervention effectively enhanced students' conceptual understanding of mathematics overall. Previous research supports this finding, indicating that the use of game-based learning assisted by Baamboozle significantly improves students' conceptual understanding and motivation compared to conventional learning. The gamification elements, interactivity, and fun competition atmosphere in Baamboozle made students more enthusiastic in engaging with mathematics learning, which is typically perceived as difficult. Moreover, the use of Baamboozle also reduced students' anxiety and increased their confidence in solving math problems (Rahayu & Rukmana, 2022; Wardani & Kiptiyah, 2024).

The improvement in students' conceptual understanding can also be observed from their answers to the pretest and posttest questions using the Baamboozle-assisted game-based learning method, as follows:

Student N (High Mathematics Anxiety Category)
Answer to question 1:

Figure 1. Pretest Answer

Figure 2. Posttest Answer

Student N, who initially was only able to provide a procedural answer regarding the mean during the pretest, demonstrated an improvement in conceptual understanding during the posttest by being able to explain the limitations of the mean contextually and restate the concept in their own words.
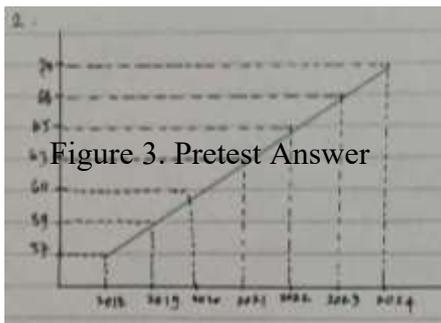
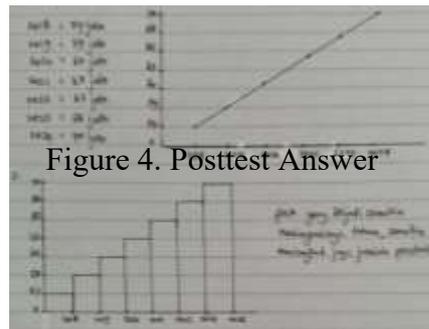**Answer to question 2:**

Figure 3. Pretest Answer

Figure 4. Posttest Answer

In the pretest, student N was only able to present data using a line graph without explaining the trend or including a bar chart, indicating limited understanding. In the posttest, the student showed progress by presenting the data consistently in both line and bar charts and was able to conclude the increasing number of smokers each year. This development indicates improvement in data representation and interpretation skills, highlighting the success of the game-based learning method assisted by Baamboozle.

Answer to question 3:

Figure 5. Pretest Answer

Figure 6. Posttest Answer

In the pretest, student N managed to compile a frequency distribution table and record the class midpoints but did not complete the average calculation. In the posttest, the student correctly executed all the steps to calculate the average. This improvement reflects enhanced procedural skills resulting from the game-based learning method supported by Baamboozle.
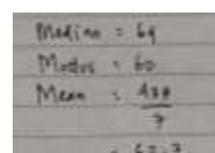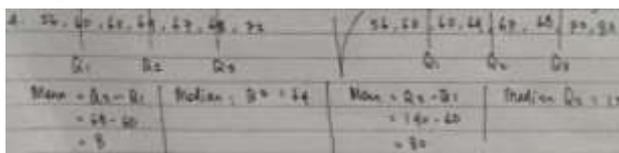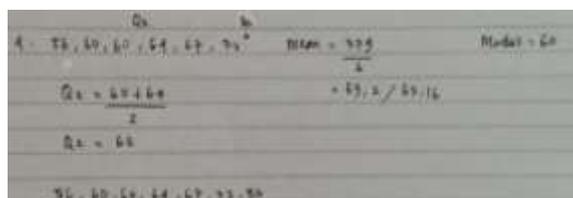
Answer to question 4:

Figure 7. Pretest Answer

Figure 8. Posttest Answer

Based on student N's results on question 4, an improvement in basic statistical conceptual understanding was observed after the Baamboozle-assisted game-based learning. In the pretest, the student mentioned measures of central tendency such as quartiles, median, and mean, but the calculations and notations were inaccurate. In the posttest, although the answer was incomplete and data input errors occurred, the student showed greater effort in explaining and calculating

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central tendency measures. This progress indicates the effectiveness of the game-based learning method in reducing mathematics anxiety and enhancing students' ability to explain concepts independently, even if their calculations were not yet perfect.

Student F (Moderate Mathematics Anxiety Category)
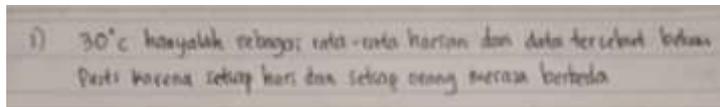
Answer to question 1:

Figure 9. Pretest Answer   Figure 10. Posttest Answer

In the pretest, student F was unable to explain the basic concept of the mean in their own words and merely wrote the question number, indicating a lack of understanding that the mean does not always represent a specific value in the data. In the posttest, the student showed improvement by stating that "30°C is just the daily average and the data is uncertain because each day and each person feels differently," reflecting the understanding that averages are general and do not always depict specific values. Although the reasoning was not perfect, this response demonstrates the effectiveness of the Baamboozle-assisted game-based learning in enhancing conceptual understanding, especially for students with moderate mathematics anxiety.
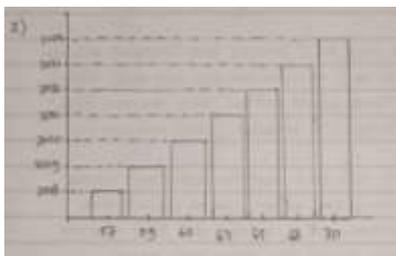
Answer to question 2:

Figure 11. Pretest Answer

Figure 12. Posttest Answer

In the pretest, student F presented data with a bar chart showing the increase in active smokers from 2018 to 2024 without a line chart or trend explanation, suggesting limited data representation and interpretation skills. In the posttest, the student presented the data using both bar and line charts with consistent and neat scales, making it easier to read, although they still failed to explain the data trend, indicating that data interpretation was still underdeveloped. This suggests the need for further practice to help students link data representation with statistical meaning more critically.

Answer to question 3:

Figure 13. Pretest Answer   Figure 14. Posttest Answer

In the pretest, student F was able to construct both frequency and cumulative frequency tables and attempted to determine quartiles and interquartile ranges but did not correctly follow the procedure for estimating the average. In the posttest, the student successfully calculated the average of 14.7 hours systematically by determining the midpoint of each class, multiplying by the frequency, summing, and dividing by the total frequency. This progress demonstrates the success of the Baamboozle-assisted game-based learning method in improving students' basic statistical operations.

Answer to question 4:

Figure 15. Pretest Answer

Figure 16. Posttest Answer

Based on the results for question 4, a significant improvement was observed from the pretest to the posttest, indicating an increased conceptual understanding of basic statistics. In the pretest, the student did not provide an answer, reflecting a lack of understanding regarding measures of central tendency. In the posttest, the student correctly calculated the mean, median, and mode and concluded the effect of adding new data on the mean and median but not on the mode. This development indicates the effectiveness of the Baamboozle-assisted game-based learning method in improving students' conceptual understanding and reducing mathematics anxiety.

Student A (Low Mathematics Anxiety Category)
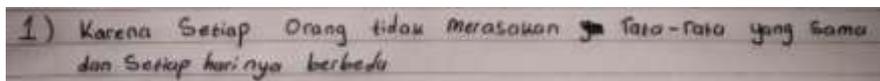
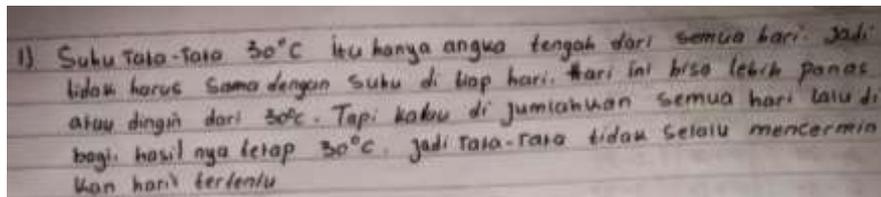 **Answer to question 1:**

Figure 17. Pretest Answer

Figure 18. Posttest Answer

In the pretest, the student understood that the average temperature may differ due to individual perception and daily variations, although the explanation was still general and statistically inaccurate. In the posttest, the student was able to explain that the average temperature of 30°C represents the weekly mean rather than a consistent daily temperature and provided examples of daily temperatures that could be higher or lower than the average. This demonstrates a deeper understanding and the ability to restate the concept of the mean accurately and contextually.
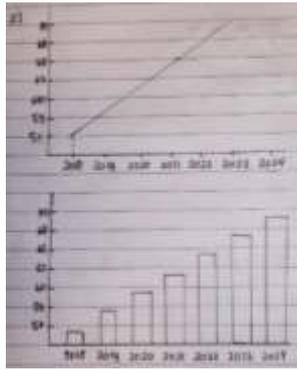
Answer to question 2:
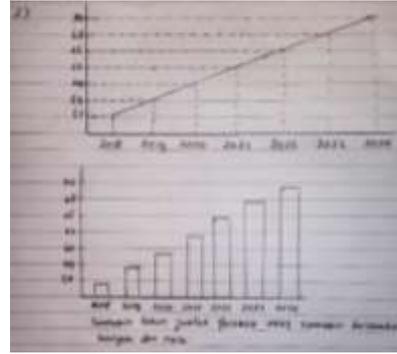

Figure 19. Pretest Answer   Figure 20. Posttest Answer

In the pretest, student A was able to present data on the number of active smokers from 2018 to 2024 using both line and bar graphs, with neat drawings and consistent scales, but did not include any explanation of the data trend, indicating limited data interpretation. In the posttest, the student improved the neatness, added elements such as titles and gridlines, and wrote a descriptive sentence about the increasing number of smokers each year. However, the trend explanation remained general and not in-depth. This shows the need for further practice to relate visual representations with more critical statistical analysis.

Answer to question 3:

Figure 21. Pretest Answer

Figure 22. Posttest Answer

In the pretest, the student constructed a frequency distribution table but did not understand the procedure for estimating the average of grouped data, as they failed to calculate the class midpoints, multiply by the frequencies, and divide by the total frequency, indicating an inability to choose the correct calculation steps. In the posttest, the student correctly calculated the class midpoints and multiplied them by the frequencies, although the final calculation was incomplete. This reflects an improved understanding of the concept of the mean and the ability to apply appropriate procedures, thereby meeting the indicators of mathematical conceptual understanding.

Answer to question 4:

Figure 23. Pretest Answer

Figure 24. Posttest Answer

In the pretest, student A correctly calculated the mean, median, and mode from the initial data but did not analyze the impact of adding new data, indicating that their conceptual understanding had not yet been applied comprehensively. In the posttest, the student recalculated the measures of central tendency after adding a new data point (80) and understood that the mean and median changed due to the extreme value, while the mode remained unchanged because the highest frequency did not shift. This development indicates sound conceptual understanding and operational skills, as well as the effectiveness of the Baamboozle-assisted game-based learning method in enhancing mathematical understanding, increasing calculation accuracy, and enabling systematic and correct problem-solving.

Interviews with three students from different levels of math anxiety reinforce the finding that learning through the Game-Based Learning method with the help of Baamboozle has a significant positive impact. Students with high anxiety stated that this method made it easier to understand the material, especially statistical concepts like median, mean, and mode, although more practice is still needed to solve story problems. The use of interactive and enjoyable games boosts self-confidence and encourages the application of concepts in daily life. Students with moderate anxiety are expressing that the combination of conventional learning and games makes the material more engaging and interactive, thereby increasing understanding and boosting students' confidence in explaining and competing through practice questions. Diverse and enjoyable exercises also facilitate the application of mathematical concepts in solving story problems and everyday issues.

Meanwhile, students with low anxiety levels believe that the competitive and interactive game format makes the learning process less boring and the material easier to absorb. These students are able to explain statistical material independently and feel confident because the game encourages active participation and healthy competition. The use of real-life examples and situations in the game helps apply mathematical concepts in everyday life, not just understanding formulas theoretically.

Overall, this interview shows that mathematics learning using the Baamboozle-assisted game-based learning method is effective in improving the ability to understand mathematical concepts and reducing students' learning anxiety across various levels of anxiety categories. These findings are consistent with the research of Biassari et al. (2024) dan Safitri & Aziz (2024), which states that GBL is effective in reducing math anxiety and improving conceptual understanding across various levels of student anxiety.

CONCLUSION

The results of this study show that the Baamboozle-assisted game-based learning method effectively reduces students' mathematical anxiety levels while simultaneously improving their mathematical understanding across various anxiety categories. After the intervention, the number of students with high anxiety decreased from 12.5% to 3.1%, while the number of students with low anxiety increased from 3.1% to 15.6%, creating a more positive and supportive learning atmosphere. In terms of conceptual understanding, the proportion of students in the high category increased substantially from 15.6% to 62.5%, the moderate category declined from 75% to 37.5%, and no students remained in the low category. Students' ability to understand mathematical concepts also increased significantly, with a progression from procedural understanding to the ability to explain concepts contextually, represent data visually, and conduct more critical statistical analyses. Student interviews reinforce these findings, showing that interactive and enjoyable learning increases confidence, motivation, and ease of understanding the material. These findings prove that mathematics learning using the Baamboozle-assisted game-based learning method is very effective in creating meaningful learning experiences,

reducing mathematical anxiety, and enhancing mathematical understanding skills.

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