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Page 1-12

The Effect of The Baamboozle-Assisted Group Investigation (GI) Learning Model on Elementary School Students' Mathematical Understanding

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ABSTRACT

Objective: This research was motivated by the problem of the low mathematical understanding skills in elementary school students. The study aimed to analyze the influence and the effect of implementing the Group Investigation (GI) cooperative learning model assisted by baamboozle media on elementary school students' mathematical understanding abilities of elementary school students, specifically concerning the topic of standard unit volume. **Method:** The research targeted fourth-grade students at SDN 066 Halimun, Bandung City, as the research population. Class IV D was the experimental group and Class IV A the control, chosen by purposive sampling. A quasi-experimental research method with a nonequivalent control group design was employed. Data were collected through tests, observations, interviews, and documentation. For data analysis, IBM SPSS Statistics 29.0 software was used to conduct normality tests, homogeneity tests, hypothesis tests and and manually calculated effect size tests. **Results:** Based on the research findings, the mathematical understanding ability profile of students in the experimental group was better than that of the control group, and the experimental group's data was more consistent around the mean. The results of the Mann–Whitney U test showed a significance value (2-tailed) of < 0.001 ($p < 0.05$), indicating that the Baamboozle-assisted Group Investigation (GI) cooperative learning model had a significant effect on elementary school students' mathematical understanding ability. Furthermore, the effect size test yielded a value of 2.424 (> 0.5), indicating a large effect of the use of the GI learning model and Baamboozle media in improving students' mathematical understanding ability. **Novelty:** The novelty of this research lies in the strategic integration of the Group Investigation (GI) Cooperative Model with the Baamboozle gamification platform to enhance students' mathematical conceptual understanding

INTRODUCTION

Improved education quality can drive the achievement of the Sustainable Development Goals (SDGs). The 4th SDG specifically focuses on quality, inclusive, and sustainable education in Indonesia, equipping younger generations with strong academic abilities, problem-solving skills, creativity, and moral and spiritual values (Sudipa et al., 2023). In line with the demands of the 21st century and Society 5.0, the use of interactive learning models and media is crucial. This is useful for boosting student motivation, mathematical understanding, and the ability to apply concepts, especially in mathematics education.

The essence of mathematics education is to stimulate students to be capable of problem-solving through critical and rational thinking (Mizaniya, 2020). Click or tap here to enter text.Students who comprehend mathematical concepts will more easily solve problems and quickly grasp the subject matter (Junitasari & Hayati, 2019). Students' understanding of learning material can simplify their learning process. Therefore, mastery of mathematical concepts depends on the understanding of each mathematical topic taught.

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IJORER, Vol. 7, No. 4, July 2026
Page 1-12

Mathematical Understanding Ability is defined as the skill of comprehending and interpreting a mathematical concept, connecting it with other concepts, and re-expressing it in mathematical forms (Sengkey et al., 2023). Meanwhile, Mathematical Understanding Abilitystudents are able to achieve higher learning mastery (Wahidah & Hasanuddin, 2018). Students are required to possess mathematical understanding ability because it is continuous with the 21st-century learning process. However, empirical evidence shows elementary students' mathematical understanding isn't yet optimal.

The level of mathematical understanding among fourth-grade students at SDN 066 Halimun Bandung remains low, highly because teachers lack innovation in selecting learning models and media. This is indicated by the results of a written test where, out of 28 students, only two answered all questions correctly, and 57.14% of students scored below the Criteria for Learning Objectives Mastery of 75. Monotonous and teacher-centered learning, coupled with minimal interactivity and technology use, leads to passive students who merely memorize without deep conceptual understanding, struggle with critical thinking, and are slow in solving problems. The varying learning styles of students, such as visual, auditory, and kinesthetic, also pose a challenge for educators. This demands that educators become more creative in selecting learning models and media that align with diverse student learning styles, so that mathematics is no longer perceived as difficult.

In line with the above phenomena, the solution proposed by the researchers is the implementation of the Group Investigation (GI) cooperative learning model. This learning model positions educators as motivators and facilitators in encouraging active student contribution to learning.Click or tap here to enter text.GI model stimulates students to discover material independently to achieve indicator and learning objectives (Rizzaludin et al., 2024). Group Investigation (GI) learning model stimulates students to actively participate, communicate, and collaborate in groups, thereby optimizing their mastery of mathematical material (Pribadi et al., 2022). The stages of the Group Investigation (GI) learning model, according to Slavin (Hertina et al., 2024) include Grouping, Planning, Investigation, Organizing, Presenting, and Evaluating.

The use of learning media, such as Baamboozle, can support the success of the Group Investigation (GI) model. Baamboozle is an audio-visual learning medium in the form of a game or edugame that resembles a quiz competition (Iskandar et al., 2022) . The use Baamboozle media can increase student engagement, learning motivation, and problem-solving skills in mathematics education (Nisvia et al., 2024). This means that applying the Group Investigation (GI) model, supported by Baamboozle media, is expected to enhance mathematical understanding ability, increase engagement, and foster student enthusiasm for more effective and meaningful learning.

Therefore, the researchers are interested in conducting a quasi-experimental study titled "The Influence Of Group Investigation (GI) Cooperative Learning Model Assisted Baamboozle Media On Elementary School Students Mathematical Understanding Abilities". This research integrates the Group Investigation (GI) cooperative learning model with the Baamboozle gamification platform to improve elementary school students' mathematical understanding. It also aims to determine the profile of students' mathematical understanding ability, analyze the effect, and describe the magnitude of the effect of the Baamboozle-assisted Group Investigation (GI) cooperative learning model on elementary school students' mathematical understanding ability in the topic of volume using standard units.

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IJORER, Vol. 7, No. 4, July 2026
Page 1-12

RESEARCH METHOD

The approach adapted in this research is the quantitative approach. The quantitative approach is an inferential type, meaning research conclusions are based on the statistical testing of empirical data collected through measurement (Djaali, 2020). The method used in this research is quasi-experimental.

This research was conducted using a pretest-posttest with non-equivalent control group design. Pretest-posttest with non-equivalent control group design as a research design that does not involve random assignment of groups, comparing two groups through pretest and posttest, by selecting comparable groups to ensure the validity of the results (Abraham & Supriyati, 2022). The experimental design can be illustrated:

Table 1. Pretest and Posttest with Non-Equivalent Control Group Design

Group	Pretest	Treatment	Posttest
Experiment	O_1	X	O_3
Control	O_2	-	O_4

Information:

O_1 : The pre-test given in the experimental class
O_2 : The pre-test given in the control class
O_3 : The posttest given in the experimental class
O_4 : The posttest given in the control class
X : Treatment using the Group Investigation (GI) Cooperative Learning Model assisted by Baamboozle

The research was conducted at SDN 066 Halimun Bandung, involving a population of 108 fourth-grade students from the 2024/2025 academic year, focusing on the standard unit volume material. The sample was selected using purposive sampling, where the researcher intentionally chose individuals considered most relevant and able to provide information aligned with the research objectives. Sampling in this study was performed using Surakhmad's formula (Rudie et al., 2025), as follows:

$$S = 15\% + \frac{1000-n}{1000-100} \text{ x } (50\% - 15\%)$$
$$S = 15\% + \frac{1000-108}{1000-100} \text{ x } (50\% - 15\%)$$
$$S = 45\%$$
$$S = 108 \text{ x } 45\%$$
$$S = 49 \textit{ Student}$$

Based on these calculations, the required sample is 45% of the total population. This percentage calculation indicates that the minimum sample size needed for the study is 49 students. This study sampled 52 students, consisting of 26 students in the experimental class and 26 students in the control class. The sample size used in the study has met the minimum requirements for sample usage in research. The research instruments included tests (pretest and posttest) and non-tests (observation, interviews, and documentation).

A pretest is administered before instruction to measure students' initial abilities, while defines a posttest as a test conducted after teaching and learning activities are completed (Siregar et al., 2023). Data collection techniques as procedures utilized to gather data in research, thereby obtaining valid and objective data (Nashrullah et al., 2023).

Data analysis utilized inferential statistical tests such as normality, homogeneity, and hypothesis tests (Independent Sample T-Test or Mann Whitey U) with assistance from

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Page 1-12

IBM SPSS Statistics 29.0 software, and effect size test. This provides a clearer picture of the effectiveness of the learning model used. The interpretation of the effect size index (Pasambo & Radia, 2022) is presented in Table 2 below.

Table 2. Indeks Effect Size

Effect Size Value	Interpretation
0,20 < δ ≤ 0,50	Small Effect
0,51 < δ ≤ 0,80	Medium Effect
δ > 0,80	High Effect

RESULTS AND DISCUSSION

Results

The Influence of the Group Investigation (GI) Cooperative Learning Model Assisted by Baamboozle Media and the Conventional Learning Model on Elementary School Students' Mathematical Understanding Ability

1. Normality Test of Pretest Data Distribution

The results of the normality test for pretest data are presented in Table 4, as follows:

Table 3. Output of Normality Tests for Pretest Data

		Kolmogorov-Smirnov			Shapiro-Wilk		
Test	**Class**	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Pretest	Experiment	0,166	26	0,062	0,960	26	0,391
	Control	0,169	26	0,054	0,926	26	0,061

The results of the normality test on the experimental class's pretest data showed a significance value of 0,062 > 0,05, so the H_0 is accepted. This means the sample comes from a normally distributed population. The significance value for the control class's pretest data is 0.054 > 0.05, so the H_0 is accepted. This means the sample comes from a normally distributed population too. Therefore, it can be concluded that the pretest data for both classes has a normal distribution.

2. Homogeneity Test of Pretest Data

The results of the homogeneity test for pretest data are presented in Table 5, as follows:

Table 5. Output of Homogeneity of Variances Tests for Pretest Data

Test of Homogeneity of Variance					
		Levene Statistic	**df1**	**df2**	**Sig.**
Pretest of Mathematical Understanding Ability	Based on Mean	.204	1	50	.653
	Based on Median	.281	1	50	.598
	Based on Median and with adjusted df	.281	1	45.938	.598
	Based on trimmed mean	.215	1	50	.645

The results of the homogeneity test for the pretest data showed a significance value (Sig. Based on Mean) of 0.653 for both the experimental and control classes. The significance value is > 0.05, which means we can conclude that the pretest data for both the experimental and control classes have homogeneous variances, and the H_0 is accepted.

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IJORER, Vol. 7, No. 4, July 2026
Page 1-12

3. Hypothesis Testing for Pretest Data

The results of the hypothesis test for pretest data are presented in Table 6, as follows:

Table 6. Output of Independent Samples T-Test for Pretest Data

Independent Samples Test

		Levene's Test for Equality of Variances		*t-test for Equality of Means*							
						Significance		*Mean Difference*	*Std. Error Difference*	*95% Confidence Interval of the Difference*	
		F	**Sig.**	**t**	**df**	*One-Sided p*	*Two-Sided p*			*Lower*	*Upper*
Pretest of Mathematical Understanding Ability	*Equal variances assumed*	0,204	0,653	0,311	50	0,378	0,757	0,577	1,854	-3,147	4,301
	Equal variances not assumed			0,311	49,969	0,378	0,757	0,577	1,854	-3,147	4,301

Based on the results of the T-test on the pre-test data, the two-sided p-value (2-tailed) was 0,178 > 0.05. Referring to the T-test's decision-making basis, it can be inferred that H_0 is accepted. The results indicate there's no significant (or notable) influence on the pre-test scores of mathematical comprehension ability between the experimental and control groups.

4. Normality Test of Posttest Data Distribution

The results of the normality test for posttest data are presented in Table 7, as follows:

Table 7. Output of Normality Tests for Posttest Data

		Kolmogorov-Smirnov			**Shapiro-Wilk**		
Test	**Class**	**Statistic**	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Posttest	Experiment	0,144	26	0,178	0,923	26	0,054
Value	Control	0,177	26	0,035	0,957	26	0,342

The normality test results for the experimental class post-test data showed a significance value of 0,178 > 0.05, so the H_0 is accepted. Therefore, the sample was drawn from a normally distributed population. The significance value for the control group's post-test data was 0,035 < 0.05, so H_0 is rejected. Consequently, the sample was drawn from a non-normally distributed population. Therefore, we can conclude that the post-test data is not entirely normally distributed. This is because only the experimental group met the assumption of normality, while the control group did not have a normal distribution.

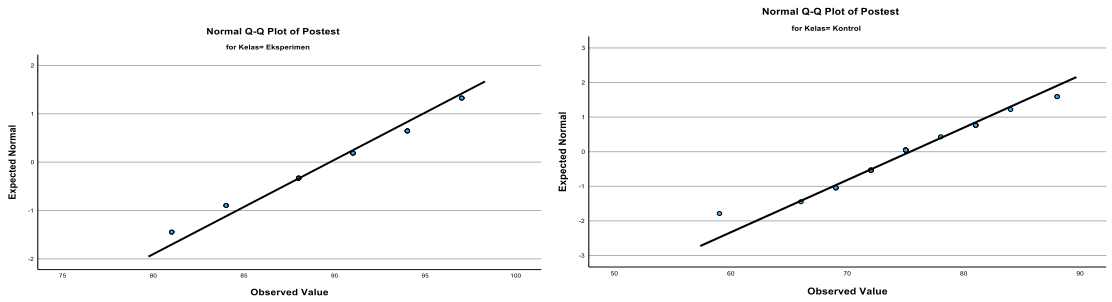

Figure 1. Normality Q-Q Plot of Posttest Data for Experimental and Control Classes

Examining the Q-Q plots, the experimental class's posttest data points aligned closely with the linear pattern, confirming a normal distribution. In contrast, the control class's posttest Q-Q plot displayed significant deviations, indicating a non-normal distribution.

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IJORER, Vol. 7, No. 4, July 2026
Page 1-12

5. Homogeneity Test of Posttest Data

The results of the homogeneity test for posttest data are presented in Table 8, as follows:

Table 8. Output of Homogeneity of Variances Tests for Posttest Data

Test of Homogeneity of Variance					
		Levene Statistic	**df1**	**df2**	**Sig.**
Posttest of Mathematical Understanding Ability	Based on Mean	.494	1	50	.486
	Based on Median	.322	1	50	.573
	Based on Median and with adjusted df	.322	1	41.563	.573
	Based on trimmed mean	.555	1	50	.460

The results of the homogeneity test for the post-test data of the experimental and control groups yielded a value of 0,494. The significance value (p-value) was greater than 0.05, leading to the conclusion that H_0 is accepted and the post-test data from both the experimental and control groups exhibit homogeneous variances.

6. Hypothesis Testing for Posttest Data

The results of the hypothesis test for post-test scores in the experimental and control groups using the Mann-Whitney U test are presented in Table 9, as follows:

Table 9. Mann-Whitney U Test Output for Posttest Data

Test Statistic	
	Posttest
Mann-Whitney U	31,000
Wilcoxon W	382,000
Z	-5,659
Asym. Sig. (*2-tailed*)	<0,001

Based on the output of the Mann-Whitney U test on the post-test data in Table 4, a two-tailed significance value (p-value) of < 0.001. This value is below the 0.05 level of significance. Therefore, it can be concluded that H0 is rejected. This is statistically formulated as $H_1 : \mu_1 \neq \mu_2$, and this means there's a significant influence of the Cooperative Group Investigation learning model assisted by Baamboozle media compared to conventional learning models on students' Mathematical Understanding Ability in elementary school.

The Magnitude of the Influence of Applying the Cooperative Group Investigation (GI) Learning Model Assisted by Baamboozle Media on Elementary School Students' Mathematical Understanding Ability

The effect size was calculated using Cohen's d formula (Widyastuti & Airlanda, 2021), as presented below:

$$\delta = \frac{M_1 - M_2}{SD_{pooled}}$$

$$\delta = \frac{89{,}73 - 75{,}38}{5{,}919}$$

$$\delta = \frac{14{,}35}{5{,}919}$$

$$\delta = 2{,}424$$

$$SD_{pooled} = \sqrt{\frac{(SD_1^2 + SD_2^2}{2}}$$

$$SD_{pooled} = \sqrt{\frac{(5{,}127^2 + 6{,}616^2}{2}}$$

$$SD_{pooled} = 5{,}919$$

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 7, No. 4, July 2026
Page 1-12

Based on these calculations, the effect size was found to be 2.424, which is categorized as a high effect on elementary school students' mathematical understanding ability. This means that 2.424>0.5, indicating the Cooperative Group Investigation (GI) learning model assisted by Baamboozle media has a high influence on elementary school students' mathematical understanding ability.

Discussion

The Influence of the Group Investigation (GI) Cooperative Learning Model Assisted by Baamboozle Media and the Conventional Learning Model on Elementary School Students' Mathematical Understanding Ability

Based on the normality test results, the pretest scores for students in both classes were normally distributed. This was shown by the significance value of the experimental class pretest data, which was 0.062 > 0.05. Similarly, the control class had a significance value of 0.054 > 0.05. Therefore, H_0 was accepted for both, and the pretest data for the control class was also considered normally distributed. The normal distribution of pretest data indicates that the spread of students' initial scores in both classes did not deviate extremely and was symmetrical. This means the initial conditions between the two classes were balanced and equivalent. Therefore, the normality test results indicate that the data is suitable for parametric analysis. This is because it has met one of the main requirements for parametric testing: the data must be normally distributed. The results of the pretest homogeneity test indicate that the variances of the pretest data between the two classes are homogeneous. This is shown by the significance value (Based on Mean) of 0.653, which is greater than 0.05 (0.653>0.05). Therefore, the null hypothesis (H_0) is accepted, which means there is no significant difference in variances between the two groups.

Since the data has been confirmed to be normally distributed and homogeneous, we then proceeded with hypothesis testing using a parametric test, specifically the Independent Samples T-Test. Based on the T-test results for the pretest data from both the experimental and control classes, conducted with SPSS version 29.0 and a 5% significance level, under the "equal variances assumed" condition, the two-sided significance value (p-value 2-tailed) was 0.757, which is greater than 0.05 (0,757 > 0,05). Therefore, it can be concluded that there was no significant (real) influence between the pretest scores of students' Mathematical Understanding Ability in the experimental class and the control class. The acceptance of the H_0 in this test allows for subsequent inferential statistical analysis of posttest data. This will investigate the influence of the treatment on students' Mathematical Understanding Ability.

The normality test conducted on the posttest data of fourth-grade elementary school students revealed that the experimental class posttest data had a significance value of 0.178 > 0.05. This means that the posttest data in the experimental class originated from a normally distributed population. Meanwhile, the control class yielded different results, with the normality test's significance value being 0.035 < 0.05. This means that the posttest data from the control class did not originate from a normally distributed population. Based on these results, it's evident that the posttest score data for students in both classes did not fully meet the assumption of normality. The homogeneity test on the students' posttest data revealed a significance value (Based on Mean) of 0.204 > 0.05. Therefore, based on the decision-making criteria for Levene's test, the null hypothesis (H_0) was accepted. This means that there is no significant difference in variances between the

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IJORER, Vol. 7, No. 4, July 2026
Page 1-12

posttest data of the two classes. Based on the analysis of the posttest data's normality and homogeneity tests, it's evident that the data didn't fully meet the assumption of a normal distribution, even though it exhibited homogeneous variances. Therefore, an alternative, appropriate method was chosen: the non-parametric Mann-Whitney U test.

In line with this, the output from the Mann-Whitney U test showed a (2-tailed) significance value of < 0.001, which is far below the predetermined significance threshold ($p < 0.05$). Based on the decision-making criteria for the Mann-Whitney U test, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. This indicates that the Cooperative Group Investigation (GI) learning model, supported by Baamboozle media, had an impact on the Mathematical Understanding Ability of elementary school students. The Group Investigation (GI) model significantly influenced and improved the Mathematical Understanding Ability of fourth-grade elementary school students compared to the use of conventional models (Nurhamidah et al., 2025). Baamboozle media in mathematics instruction can significantly improve concept comprehension and student engagement in fourth-grade elementary school (Ariyanti & Junaidi, 2025).

Observations of teacher and student activity over four meetings in the experimental class revealed exceptionally high engagement. Teacher activity reached 96% and student activity was 98%, indicating significant involvement with the Group Investigation (GI) model and Baamboozle media. Conversely, the control class, using a conventional model, showed teacher activity at 89% and student activity at 93%. While these figures indicate a reasonable level of activity, they were not as interactive as the experimental class. This difference in percentages supports the finding that the GI model and Baamboozle media successfully created a more meaningful, engaging, interest-provoking learning process that encouraged active student participation within groups. Interest in learning is crucial for improving elementary school students' understanding of subject matter (Indriani et al., 2024). Interview results with both teachers and students also support these research findings.

Based on interviews and four observations, the class teacher confirmed that implementing the Group Investigation (GI) learning model with Baamboozle media significantly improved students' understanding of material, particularly standard unit volume, and increased their engagement. This approach fostered independence and discussion, making learning more captivating. The teacher plans to continue using this model and suggests improving time management and providing further training. In their interviews, students also stated that the material was easier to understand, they became more active in asking and answering questions, and they felt very helped and enjoyed learning with Baamboozle and group discussions. Students expressed a desire to continue learning with investigation and Baamboozle, and suggested that teachers use these learning models and media more frequently.

In alignment with the quantitative data analysis, observational findings, and interview results, it can be concluded that there is a significant positive impact from implementing the Cooperative Group Investigation (GI) learning model, enhanced by Baamboozle media, on the Mathematical Understanding Ability of elementary school students. The Group Investigation learning model significantly impacts students' Mathematical Understanding Ability compared to conventional teaching methods (Hartiani et al., 2024). Mathematical Understanding Ability students improved when learning with Baamboozle media (Yuniar et al., 2023).

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 7, No. 4, July 2026
Page 1-12

The Magnitude of the Influence of Applying the Cooperative Group Investigation (GI) Learning Model Assisted by Baamboozle Media on Elementary School Students' Mathematical Understanding Ability

The effect size calculation indicates that the Cooperative Group Investigation (GI) learning model, enhanced by Baamboozle media, demonstrates a high effect, significantly impacting the learning process. This is evident from the effect size calculation of 2,424 > 0,5. Therefore, it can be concluded that the Cooperative Group Investigation (GI) learning model, enhanced by Baamboozle media, has a substantial impact on the mathematical understanding ability of elementary school students. The calculated effect size value demonstrates that utilizing the Group Investigation (GI) learning model, supported by Baamboozle media, successfully created a learning environment that highly promoted the improvement of mathematical understanding ability and increased students' interest in learning mathematics in an enjoyable way. Students with high learning interest are those who find mathematics instruction engaging (Fatimah et al., n.d.).

In contrast to the experimental class, students in the control class showed a lack of learning interest due to teacher-centered instruction and unengaging media. This led to passive, easily bored, and unmotivated students due to a lack of interaction and independent exploration (Putri et al., 2024). Therefore, the use of interactive learning models and media is essential in mathematics. The Group Investigation (GI) model effectively encourages students to learn collaboratively, delve into information, and engage in active discussions. Meanwhile, Baamboozle media enhances student motivation, concentration, and engagement, creating a competitive, lively, and dynamic learning atmosphere. Group Investigation model can create an enjoyable learning environment that supports collaboration and student independence in learning (Azizah, 2021). This, in turn, helps reduce student anxiety when learning mathematics and improves their academic achievement. Baamboozle media has proven effective for use in learning. Based on the various explanations, it is found that the use of the Cooperative Group Investigation (GI) learning model, supported by Baamboozle media, is effective in enhancing the mathematical understanding ability of elementary school students (Tyas, 2025).

CONCLUSION

Fundamental Finding: Based on the research findings, descriptively, the Mathematical Understanding Ability of students who learned using the Cooperative Group Investigation (GI) model with Baamboozle media was better than that of students who learned using the conventional model. This study conclusively demonstrates that the Cooperative Group Investigation (GI) learning model, enhanced by Baamboozle media, significantly influence elementary school students' mathematical understanding ability compared to conventional teaching methods. Furthermore, effect size analysis revealed a high and significant influence from this model's implementation on their mathematical understanding ability. **Implication:** The Baamboozle-assisted Group Investigation (GI) learning model can be used by teachers as an alternative approach to mathematics instruction that is more interactive and engaging. This model helps increase students' participation in learning and facilitates their understanding of mathematical concepts. The findings of this study provide evidence that the integration of the Group Investigation (GI) model with the Baamboozle gamification platform is effective in

p-ISSN : 2721-852X ; e-ISSN : 2721-7965
IJORER, Vol. 7, No. 4, July 2026
Page 1-12

improving students' mathematical understanding. These findings may serve as a reference for future research to further explore the use of similar models and media in other mathematical topics or mathematical abilities. **Limitation**: has limitations as it focused solely on fourth-grade students at SDN 066 Halimun Bandung. It only examined the application of the Cooperative Group Investigation (GI) learning model, assisted by Baamboozle media, on students' mathematical understanding of standard unit volume, and exclusively investigated the cognitive aspect of their mathematical understanding ability. **Future Research:** Future research should expand this study to other mathematical topics or abilities, conduct it at different educational levels or school settings to observe result consistency, and prioritize time planning and the technical execution of digital media for optimal learning.

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