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The Effect of PMRI Approach Assisted by Baamboozle Media on Student Learning Outcomes in Arithmetic Sequences

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Abstract. *This study aims to analyze the effectiveness of the Indonesian Realistic Mathematics Education (PMRI) approach assisted by Baamboozle media in improving students' learning outcomes in arithmetic sequences. An experimental method with a Pretest-Posttest Control Group Design was applied to 67 tenth-grade students at SMA Negeri 1 Jarai, divided into an experimental group (n=34) using PMRI with Baamboozle and a control group (n=33) with conventional instruction. Data were collected through written tests and analyzed using normality tests, homogeneity tests, and an independent t-test. The results indicated a significant improvement in the experimental group, with an average post-test score of 80, compared to the control group (70). Statistical analysis reinforced this finding ($t = -7.136$, $p < 0.05$), confirming that the integration of PMRI and Baamboozle not only enhanced learning outcomes but also fostered active student engagement. The implications of this study support the use of interactive digital media in context-based mathematics learning approaches.*

Keywords: *PMRI, Baamboozle, arithmetic sequences, learning outcomes, mathematics education*

INTRODUCTION

Mathematics is a fundamental discipline that plays a pivotal role in developing logical, analytical, and systematic thinking skills. However, the PISA 2022 survey revealed that 73% of Indonesian students performed below the minimum proficiency level in mathematics, with arithmetic sequences being one of the most frequently misunderstood topics (OECD, 2023). This finding is corroborated by a preliminary study at SMA Negeri 1 Jarai, where 65% of tenth-grade students scored below the minimum mastery threshold (KKM) in this topic. The primary challenges lie in comprehending the concept of common differences and applying the n-th term formula, which are often taught abstractly through conventional lecture methods (Hartati, 2021; Rohmah & Warmi, 2021; Wulandari & Setiawan, 2021). These issues necessitate innovative solutions in mathematics instruction.

Addressing this problem requires an approach that integrates contextual learning and interactive media. The Indonesian Realistic Mathematics Education (PMRI) framework offers a promising solution by emphasizing real-world problem-solving. Prior studies on PMRI demonstrate its effectiveness in enhancing academic achievement and self-confidence (Suhendar, 2016), improving mathematical literacy (Hasanah et al., 2016), and strengthening problem-solving skills (Rahmawati & Putri, 2019). A literature review further indicates that Realistic Mathematics Education (RME) can significantly improve students' learning outcomes and mathematical skills (Utami, 2023). However, most PMRI research has focused on elementary (Dewi & Agustika, 2020; Dwipayana & Diputra, 2019; Ratnasari, 2020) and junior high school students (Suparni, 2019; Yulia & Jamaliah, 2016), with limited exploration at the senior high school level. For instance, Napitupulu et al. (2023) examined PMRI's application in solving word problems among high school students, while Umaysy Sabillah & Hasratuddin (2023) focused on PMR-based teaching materials.

The implementation of PMRI often faces challenges due to the lack of engaging instructional media. One such tool that has shown potential in enhancing student interest in mathematics is Baamboozle. Several studies involving Baamboozle as a learning medium have reported positive outcomes. For example, Khoiroh & Sari (2025) found that Baamboozle significantly increased students' interest in mathematics at the Aisyiyah Pandan Malaysia Tutoring Center. Similarly, Shiddiq et al. (2025) demonstrated that Baamboozle combined with Project-Based Learning (PBL) improved learning outcomes while providing a more interactive and engaging experience. Furthermore, Baamboozle facilitates collaboration, competition, and interaction in a fun learning environment, thereby deepening students' understanding of mathematical concepts. Thus, Baamboozle presents a viable alternative for integration with the PMRI approach.

Nevertheless, the effectiveness of combining PMRI and Baamboozle in teaching arithmetic sequences warrants further investigation, particularly given the characteristics of high school students, who tend to be more critical yet easily distracted by technology. Previous studies, such as Mariani et al. (2022), revealed

that gamified media without a strong contextual foundation only yielded short-term motivational benefits without significant improvements in conceptual understanding. Therefore, this study not only examines cognitive learning outcomes but also analyzes how the PMRI-Baamboozle hybrid model facilitates deep conceptual understanding through authentic mathematical activities, such as project-based problem-solving and collaborative discussions. This approach is expected to not only enhance student performance but also cultivate higher-order thinking skills aligned with the demands of 21st-century curricula.

To address this research gap, this study aims to quantify the extent to which the PMRI approach assisted by Baamboozle improves learning outcomes in arithmetic sequences compared to conventional methods. The research questions are formulated as follows: (1) What is the significant difference in learning outcomes between classes using PMRI with Baamboozle and those using conventional instruction? (2) What factors influence the effectiveness of this hybrid model? The findings are expected to serve as a reference for educators in integrating technology into mathematics instruction while supporting the Merdeka Curriculum's emphasis on differentiated learning.

RESEARCH METHOD

This study employed an experimental method with a Pretest-Posttest Control Group Design to measure the effect of the PMRI approach assisted by Baamboozle media on student learning outcomes. The research population comprised all tenth-grade students at SMA Negeri 1 Jarai during the 2024/2025 academic year, with the sample consisting of two randomly selected classes: Class X.B as the experimental group (n=34) and Class X.C as the control group (n=33). Random sampling was implemented to minimize bias and ensure equivalence in initial abilities between the two groups.

The research instrument consisted of an essay test comprising five pretest and posttest questions designed to measure students' understanding of arithmetic sequences. The questions were validated using Product Moment correlation analysis with SPSS, where each item was deemed valid if the r_{xy} value exceeded

the r-table value at a 0.05 significance level. Additionally, a reliability test was conducted to ensure instrument consistency.

The experimental group received instruction using the PMRI approach integrated with Baamboozle, while the control group was taught via conventional methods. The learning activities spanned four sessions, each lasting 2 x 45 minutes.

The collected data were analyzed in several stages. First, normality was assessed using the Shapiro-Wilk test, and homogeneity was evaluated via Levene's Test to verify parametric assumptions. Subsequently, an independent samples t-test was conducted to compare learning outcomes between the experimental and control groups. Furthermore, effect size was calculated using Cohen's d to determine the magnitude of the treatment effect. All data analyses were performed using SPSS version 25, with a significance level of $\alpha = 0.05$.

RESULT AND DISCUSSION

The study was conducted over four instructional days in both the experimental and control classes. The experimental class employed the PMRI approach assisted by Baamboozle media, while the control class followed conventional instruction. A pretest comprising five essay questions on arithmetic sequences was administered to both groups (Figure 1). The pretest results indicated no significant difference in initial ability between the experimental and control classes ($p > 0.05$), confirming baseline equivalence.

Figure 1. Students completing the pretest

Figure 1 depicts students completing the pretest. Following this, the experimental class engaged in PMRI-based learning, which adhered to the four-phase PMRI framework: (1) presenting real-world problems, (2) problem modeling, (3) mathematization, and (4) developing mathematical models (Sholehah, 2020).

Figure 2. Learning Using the PMRI Approach and Baamboozle Media

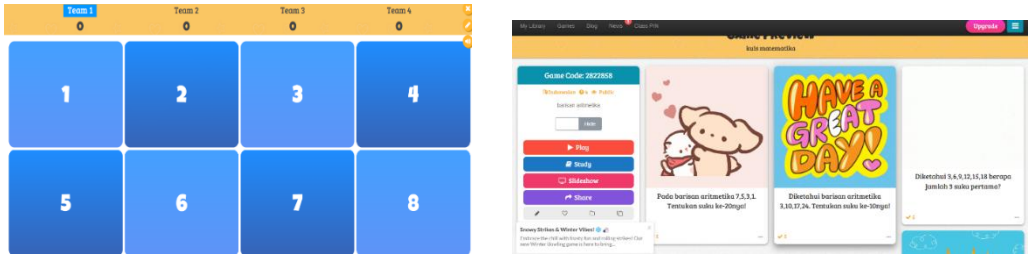

Figure 3. Display of the Baamboozle Quiz Media

Figure 4 illustrates the implementation phase, where students were divided into six heterogeneous groups (5-6 students per group). Each group received student worksheets (LKPD) and participated in Baamboozle educational quizzes designed to reinforce conceptual understanding through gamification.

Figure 4. Learning Process in the Control Class

Post-intervention assessments revealed distinct performance differences between the groups (Table 3). Key findings include:

Table 3. Research Results Statistics

Statistics	EC	CC
Number of Students (N)	34	33
Highest Score	94	88
Lowest Score	66	60
Mean Score	84	72

Based on Table 3, it can be concluded that the average learning outcomes of the Experimental Class (EC) were higher than those of the Control Class (CC). The research results indicate that the highest score achieved in the experimental class was 94, while the highest score in the control class was 88. According to the student competency assessment proposed by Anwar et al. (2021), scores within the 70-100 range are classified as excellent. The implemented study revealed significant differences in learning outcomes between students who experienced the PMRI approach with Baamboozle media and those who underwent conventional teaching methods.

To demonstrate the superior learning outcomes in the experimental class (KE), we proceeded with data analysis using an independent samples t-test to compare the two group means. The results of this statistical test are presented in Table 4.

Table 4. Independent Samples t-Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
hasil	Equal variances assumed	,314	,577	-7,136	65	,000
	Equal variances not assumed			-7,125	63,806	,000

The results of the independent t-test analysis showed a statistically significant difference with Sig. (2-tailed) = 0.000 < α (0.05), supported by the t-statistic of -7.136 which exceeded the critical t-value of 1.668. These results lead to the rejection of the null hypothesis (H_0) and acceptance of the alternative hypothesis (H_a), indicating that students who learned through the PMRI approach demonstrated significantly better learning outcomes than those taught with conventional methods. This finding provides empirical evidence that the PMRI approach assisted by Baamboozle media positively impacts student achievement in arithmetic sequences. The effectiveness of this intervention was clearly observable during classroom activities, particularly in students' performance on Baamboozle educational quizzes. Post-intervention assessment results revealed excellent performance levels among participants, with most students achieving outstanding scores on their assigned tasks.

Furthermore, this approach facilitates students' comprehension in determining the n-th term of arithmetic sequences while actively engaging them in the learning process. However, the PMRI approach assisted by Baamboozle also presents limitations, particularly in that the Baamboozle platform remains exclusively controlled by the researcher. Following the implementation of the PMRI-based learning model, students demonstrated improved competency in completing the student worksheets (LKPD) distributed to each group. This method effectively guided students in solving the structured problems within the worksheets. The study concludes that the PMRI approach integrated with Baamboozle significantly enhances learning outcomes for arithmetic sequences among tenth-grade students.

This study implemented a Realistic Mathematics Education (PMRI) approach supported by Baamboozle interactive media in teaching arithmetic sequences. The intervention was conducted in Class X.B as the experimental group, while Class X.C served as the control group receiving conventional instruction. During implementation, the researcher actively guided students to enhance their engagement in the learning process.

Based on observations during the learning process, it was found that several students experienced difficulties in learning mathematics due to various factors. Internal factors included learning interest, study habits, and motivation toward mathematics. Meanwhile, external factors involved family environment and school environment. The lack of learning interest was evident from students' attitudes of not paying attention to the teacher's explanations during lessons.

To assess the effect of the PMRI approach assisted by Baamboozle media on learning outcomes, researchers administered a written test consisting of five essay questions. Students were instructed to complete the test independently, aiming to evaluate their mastery level of the material following the implementation of the instructional model.

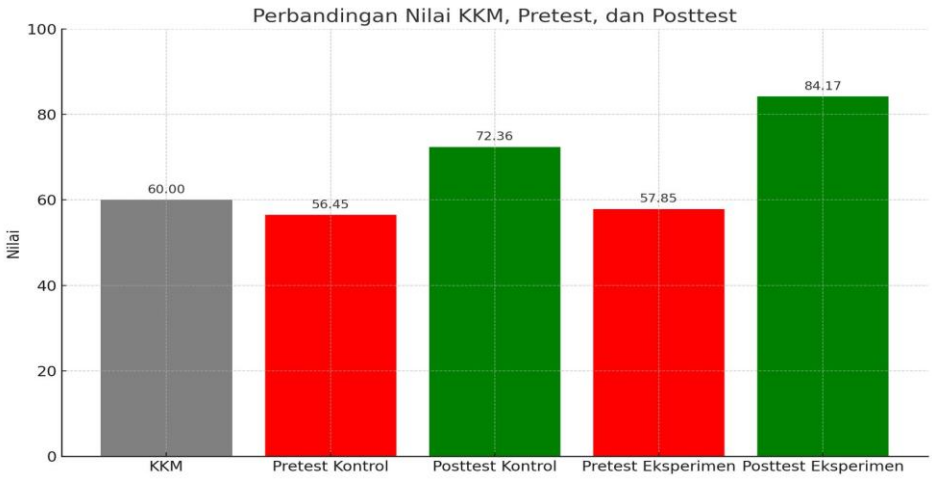

Figure 5. Comparison of Pretest and Posttest Scores Between Experimental and Control Classes

Table 4. Pretest and Posttest Results

Class	Pretest	Posttest	Passing Score
Control	56,45	72,36	60
Experimental	57,85	84,17	60

The data reveal an increase in mean scores from pretest to posttest in both classes. However, the improvement observed in the experimental class (from 57.85 to 84.17) was significantly greater than that in the control class (from 56.45 to 72.36), with the experimental class demonstrating an 11.81-point higher gain in scores.

The significantly higher learning outcomes achieved by the experimental class demonstrate that the PMRI approach supported by interactive media such as Baamboozle effectively creates a more engaging, enjoyable, and stimulating learning environment for students. This approach positively impacts students' enthusiasm and active participation during the learning process, ultimately contributing to improved academic performance. In contrast, control class students who did not experience the PMRI approach tended to encounter difficulties in problem-solving, exhibited lower precision in their work, and produced less structured solutions.

Therefore, it can be concluded that the implementation of the PMRI approach assisted by Baamboozle media has a positive impact on improving students' mathematics learning outcomes in arithmetic sequences. These findings align with Joanna & Anwar's (2024) study which successfully enhanced mathematical problem-solving abilities and elementary students' motivation by combining Problem-Based Learning with Baamboozle. The results are also consistent with Sari & Ramadan's (2025) research that integrated Problem-Based Learning with Baamboozle in elementary education, though focusing on Civics learning outcomes.

The effectiveness of Baamboozle in this study aligns with previous research that has utilized Baamboozle as a learning medium to enhance student outcomes. For instance, Rahayu & Soleha (2025) explored the effectiveness of Baamboozle interactive media incorporating local wisdom elements in improving numeracy literacy among seventh-grade mathematics students. Their findings demonstrated that this media positively contributed to fostering student motivation and learning interest through contextual and engaging approaches. Similarly, another study by Rambe et al. (2025) found that Baamboozle implementation improved conceptual

understanding and active participation among fifth-grade students learning about plane figure perimeters. These consistent findings across different grade levels and mathematical topics further validate Baamboozle's efficacy as an instructional tool in mathematics education.

Although the use of PMRI (Indonesian Realistic Mathematics Education) has yielded positive learning outcomes, some students still encounter difficulties. Cahirati et al. (2020) revealed in their study that a portion of students struggled with conceptual understanding and problem-solving, particularly in word problems involving systems of linear equations with two and three variables. These challenges stemmed from student absenteeism, which led to gaps in material comprehension, insufficiently optimized pre-learning activities and discussions, and the teacher's limited facilitation of student participation in summarizing key lesson takeaways.

The implementation of Baamboozle in learning still presents challenges for some students. Low-achieving students particularly require additional teacher support and learning assistance. Furthermore, teachers play a crucial role in stimulating active student engagement in the learning process. This aligns with findings from Wibowo and Pardede (2019), who emphasize that teachers serve as key agents in educational success and are pivotal factors in ensuring smooth learning processes. To enhance student participation, educators should improve their teaching quality by implementing effective and appropriate instructional methods.

Nevertheless, digital tools like Baamboozle have proven significantly beneficial for most students, facilitating learning and boosting motivation (Anam & Mulasi, 2021; Rahma et al., 2024). Consequently, future mathematics education cannot be separated from digital media integration. The current educational landscape demands a balanced approach where teacher guidance complements technological innovation to optimize learning outcomes, particularly for students with varying academic capabilities. This dual approach addresses individual learning needs while harnessing the motivational benefits of gamified learning platforms.

CONCLUSION

Based on the research findings, it can be concluded that the PMRI approach assisted by Baamboozle media has a significant effect on improving student learning outcomes in arithmetic sequences. The experimental class achieved a higher average post-test score (84.17) compared to the control class (72.36), with a performance gap of 11.81 points. This approach not only enhances conceptual understanding of mathematics through realistic contexts but also promotes student engagement and motivation via the interactive features of Baamboozle. However, this study has certain limitations, including a limited sample size (confined to one school) and a relatively short intervention period. Therefore, future research should expand the sample scope, test the model's effectiveness on other mathematical topics, and consider technical factors such as supporting infrastructure availability. These findings provide empirical support for educators to integrate PMRI and interactive digital media into mathematics instruction, fostering a more dynamic and effective learning environment.

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