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Game-based learning intervention: the effect of baamboozle on science learning interest in primary education

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Abstract

This study aims to analyze the effectiveness of the educational game Baamboozle as a *gamification* intervention in enhancing learning interest in Science and Social Studies (IPAS) among fifth-grade primary school students. This research is motivated by the existing challenge of low student interest and engagement in IPAS, often exacerbated by the dominance of conventional teaching methods, which fail to counter student apathy and concentration decline, particularly during post-recess sessions.The methodology adopted was quantitative, quasi-experimental, with a nonequivalent control group posttest-only design, and a total sample of 45 students from the accessible population.Data was collected via a 20-item Likert scale questionnaire (Cronbach's alpha = 0,956). The results demonstrate that the experimental group achieved a higher mean score (M = 75.82) than the control group (M = 57.27).The *t*-test yielded t(43) = 0,000, p < .001, confirming a significant difference in learning interest. The effect size was calculated as Cohen's d = 5.14, indicating a large effect. This suggests that Baamboozle serves as an interactive, collaborative tool that supports student engagement, aligning with constructivism and the ARCS motivation model. This research contributes to educational science by providing empirical data regarding the use of accessible digital *gamification* to foster learning interest in primary education.

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1. Introduction

The quality of primary education in Indonesia continues to face significant challenges in fostering students' interest in learning, particularly in the integrated subject of Science and Social Studies (IPAS) (Pratiwi et al., 2019). IPAS requires strong conceptual understanding and active engagement; however, field data indicate that students often lack motivation and tend to be passive during the learning process (Alfatonah et al., 2025; Maulana & Aramudin, 2024). This low engagement is fundamentally linked to teaching practices dominated by conventional methods, such as lecturing and reliance on textual assignments (Azmi et al., 2024; Leif et al., 2023; Purnama et al., 2024). Such teacher-centered approaches have proven ineffective at creating a stimulating learning environment and often lead to boredom, especially among primary school students with short attention spans (Lee & Boo, 2022; Liu & Cho, 2025; Markina & Mollá, 2022). Consequently, this results in a drastic decline in student concentration and affective involvement, which are key precursors to poor learning outcomes and difficulty in contextual knowledge transfer (Aisyah et al., 2017). This challenge is particularly pressing in the era of the Merdeka Curriculum, which mandates student-centered learning that is adaptive to technological advancements. Therefore, strategic innovation is required not only to deliver content but also to cultivate intrinsic student appeal and interest effectively. The adoption of digital technology and the concept of gamification (game-based learning) is now widely considered one of the most effective solutions for mitigating disengagement (Pranata, 2023; Raharjo et al., 2024).

This necessary innovation points to the integration of digital technology, particularly Game-Based Learning (GBL), which has been proven effective in transforming the learning environment into a more interactive and challenging one (Eyal & Hayak, 2024; Olayvar, 2023). GBL facilitates key elements of intrinsic motivation by providing instant feedback, challenges, and rewards, which are vital for cultivating sustained interest in learning among students (Reilly, 2020; Sugianto, 2023). Theoretically, the efficacy of GBL platforms like Baamboozle can be explained through two primary frameworks. Firstly, it aligns with Keller's ARCS Model of Motivation (Attention, Relevance, Confidence, Satisfaction) (Keller, 1987), where the competitive and visual elements of Baamboozle directly trigger Attention and provide instant Satisfaction (Wijaya et al., 2022). Secondly, this approach resonates with Vygotsky's Social Constructivism theory (Vygotsky, 1978), as the team-based quiz format mandates collaboration and social interaction. Through this process, knowledge is not merely absorbed; instead, it is collectively constructed, strengthening conceptual understanding through the negotiation of meaning within the Zone of Proximal Development (ZPD) (Malik et al., 2025). International research has confirmed that media like Baamboozle can significantly enhance cognitive and affective engagement among primary school students, especially in subjects that require visualization and interactive practice (Bryan, 2024; Koç & Kanadlı, 2025; Nguyen & Habók, 2022; Sabourin & Lester, 2014).

Beyond merely boosting learning interest, game-based interventions like Baamboozle demonstrate a strong relevance to the development of 21st-Century Skills (the 4Cs), namely Critical Thinking, Creativity, Collaboration, and Communication (Lisa & Muthohar, 2024; Mukhammad Nur Muzakka et al., 2025). The team-based game format inherently fosters collaboration and effective communication, as students are required to formulate answers collectively (Riivari et al., 2021). Furthermore, the gamification system actively trains critical thinking through problem-solving under time pressure, a core requirement of the Merdeka Curriculum (Nadhiroh & Anshori, 2023).

Although the global literature extensively demonstrates the general benefits of GBL, specific empirical research on the effectiveness of the Baamboozle platform in enhancing IPAS learning

interest in the Indonesian primary school context remains limited (Andini et al., 2024; Salsanila & Faisal, 2025). Strong empirical validity, particularly supported by rigorous quantitative data and effect-size analysis, is crucial for providing accountable pedagogical recommendations to educational practitioners. Based on this contextual background and the identified literature gap, the primary aim of this research is to analyze the effectiveness of the Baamboozle educational game in enhancing IPAS learning interest among Fifth-Grade primary school students.

2. Method

2.1 Research design

This study employed a quantitative approach using a Quasi-Experimental Design, specifically the Nonequivalent Control Group Posttest-Only Design, which was chosen because the participants were pre-existing, non-randomized groups (intact classes). The research was conducted in UPT SDN 01 Limo Kaum, Tanah Datar Regency, West Sumatra Province, during May 2024. The study population comprised all fifth-grade students (N=45), with participants selected via total sampling of the accessible population: the experimental group (n=23) and the control group (n=22). Initial equivalence between the groups was established by confirming that all assumption tests (normality and homogeneity) were met and by performing an Independent Samples t-Test on prior academic scores, which showed no statistically significant difference ($p>0.05$). The final assignment of the experimental and control designations was performed using a cluster-level random allocation (lottery method) to determine which intact class served as the treatment group.

2.2 Instruments and technical specifications

Data were collected using a learning interest questionnaire comprising 20 items, rated on a 5-point Likert scale. This instrument measures four core indicators (enjoyment, attention, involvement, and curiosity) and was derived from the framework established by (Almagofi et al., 2023). Three expert validators rigorously verified content and construct validity. Empirical item validity was calculated using the Pearson Product-Moment Correlation, resulting in 19 valid items with coefficients ranging from 0.443 to 0.896. Reliability was confirmed with a Cronbach's Alpha coefficient of 0.956, indicating high internal consistency and empirical item validity was calculated using the Pearson Product-Moment Correlation coefficient. Reliability was determined using Cronbach's Alpha (α). The intervention utilized specific technical equipment: a Windows 10/11 laptop, LCD Projector, and reliable Wi-Fi internet access (minimum 5 Mbps) to facilitate the Baamboozle web-based educational platform, which served as the primary GBL media for the experimental group.

2.3 Intervention procedures and data analysis

The core intervention spanned three instructional sessions (a total of 8 hours) focused on the IPAS curriculum. Each session lasted approximately 140–160 minutes. The Experimental Group received Game-Based Learning (GBL), where content delivery and collaborative group work culminated in an interactive Baamboozle quiz (*team mode*). In team mode, students were divided into 4–5 small groups, competing to answer randomized questions with integrated game features such as "Power-Ups" and "Point Steals" to maintain engagement. Conversely, the Control Group received identical curriculum content (Chapter 7: Daerahku Kebanggaanku) delivered through a Conventional Teaching Method utilizing Visual Media. To ensure equivalence, both groups were taught by the same teacher using the same time allocation and learning

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objectives. Following the final session, the learning interest questionnaire (Posttest) was administered to all N=45 participants under standardized conditions to mitigate response bias.

3. Results

3.1 Descriptive statistics of student IPAS learning interest scores

This section presents the descriptive statistics of student IPAS learning interest scores following the intervention. These statistics serve as a preliminary basis for comparing the efficacy of the Game-Based Learning (GBL) Baamboozle treatment with the conventional method using picture media. The complete results are provided in Table 1.

Table 1. Descriptive statistics of ipas learning interest posttest scores

Group	Test	N	Score Min	Score Max	Mean ($\bar{x}$)	SD
Experiment (Using Baamboozle)	Post-test	23	70	82	75.82	3.499
Control (Picture Media)	Post-test	22	52	65	57.27	3.718

As illustrated in Table 1, a clear distinction exists between the posttest scores of the two groups. The experimental group (N=23) that received the Baamboozle intervention achieved a mean learning interest score of 75.82. Their scores ranged from 70 to 82, with a relatively small standard deviation (SD) of 3.499. This small SD indicates that the scores within the experimental group were closely clustered around the mean, signifying high consistency. Conversely, the control group (N=22), which was instructed using picture media, recorded a substantially lower mean score of 57.27. Their scores ranged from 52 to 65, with a standard deviation of 3.718. Comparatively, the mean posttest score of the experimental group ($\bar{x}$=75.82) is dramatically higher than that of the control group ($\bar{x}$=57.27). This raw difference of 18.55 points provides a strong initial indication that the GBL Baamboozle treatment exerted a considerably greater positive influence on student learning interest than the conventional instruction using picture media.

3.2 Analysis of parametric assumptions

Before conducting the Independent Samples t-Test to compare the posttest means, the data were subjected to assumption tests to ensure the appropriateness of using parametric statistical methods. Specifically, Normality and Homogeneity of Variances were tested using the posttest scores of the students' learning interest. The results of these prerequisite tests are summarized in Table 2.

Tabel 2. Results of normality and homogeneity tests for student IPAS learning interest data

Test	Data	Test Type	Test Statistic	*p*-value	Decision	Interpretation
Normality	Experimental Group Posttest Scores	Shapiro-Wilk	0.949	0.280	$\alpha > 0.05$	Data is Normally Distributed
	Control Group Posttest Scores	Shapiro-Wilk	0.918	0.070	$\alpha > 0.05$	Data is Normally Distributed

Test	Data	Test Type	Test Statistic	*p*-value	Decision	Interpretation
Homogeneity	Posttest Score Variances	Levene's	0.003	0.959	α > 0.05	Data is Homogeneous

3.3 Hypothesis testing and cohen's effect size

To test the research hypothesis regarding the influence of Game-Based Learning (GBL) Baamboozle on student learning interest, an Independent Samples t-Test was conducted to compare the average posttest scores for learning interest between the experimental and control groups. This testing aims to determine how a treatment influences another under certain conditions. The goal of the experiment is to determine the relationship between the independent and dependent variables. The statistical decision is based on comparing the calculated significance value (*p*-value) with the predetermined significance level (α=0.05). The paradigm of this experiment model can be depicted in Table 3.

Table 3. Results of hypothesis testing (*independent samples t-test*)

Variable Tested	t-count	*df*	Sign. (*p*-value)	Critical Value (α=0.05)	Decision H_0
Difference in Mean Posttest Scores for IPAS Learning Interest	17.245	42	0.000	α < 0.05	Reject H_0, Accept H_a

Based on Table 3, the t-test conducted to determine whether there is a significant difference in learning outcomes between the two student groups yielded a t-statistic of 17.245 with 42 degrees of freedom (df) and a significance value (Sig. 2-tailed) of 0.000. Since this significance value is below the 0.05 threshold, it can be concluded that there is a significant difference in learning outcomes between the two groups. Thus, H_0 is rejected and H_a is accepted.

Given that H_0 is rejected, the next step is to calculate the Effect Size using Cohen's d to find out the magnitude of the influence exerted by the treatment. Cohen's d is a measure of effect size that expresses the difference between two means in standard deviation units. The calculation of the Effect Size is presented in Table 4.

Table 4. Cohen's *d* effect size

Group	N	Mean	SD	SD_{Pooled}	Cohend's *d*	Interpretation
Experimental (Baamboozle)	23	75.82	3.499	3.608	5.142	Very Large Effect
Control (Picture Media)	22	57.27	3.718			

Based on the calculation results in Table 4, the Cohen's d value obtained is 5.142. This value indicates that the treatment effect on students is classified as a "Very Large Effect." This finding indicates that the use of Baamboozle has a large influence on student learning interest.

4. Discussion

This study indicates the effectiveness of incorporating the Baamboozle educational game in fostering students' interest in learning in the Science and Social Studies (IPAS) subject. This intervention addresses common pedagogical challenges in primary education, particularly those related to the abstraction of IPAS material and low student engagement. Quantitative statistical analysis revealed a significant disparity between the groups. The experimental group

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(Baamboozlele) achieved a mean posttest score (M=75.83) that was higher than that of the control group (M=57.27). This difference was statistically confirmed by an independent-samples t-test, which yielded a p-value < 0.05, suggesting that the use of Baamboozle positively correlates with higher student learning interest.

Furthermore, the findings possess high practical significance, evidenced by an Effect Size (Cohen's d) of 5.14, which is considered exceptionally large according to conventional thresholds. This magnitude suggests that Baamboozle has a substantial impact on the measured affective variable within this specific context. This outcome aligns with literature emphasizing the crucial role of gamification-based interventions as catalysts for positive changes in learning behavior at the primary level (Sitepu et al., 2024; Smiderle et al., 2020).

The observed effectiveness of Baamboozle is fundamentally rooted in its integration of solid pedagogical and motivational principles. The platform successfully establishes a highly interactive, collaborative, and competitive learning environment, which is directly supported by Vygotsky's Social Constructivism (Vygotsky, 1978). The team-based game mechanics inherent in Baamboozle may encourage students to engage in peer discussion, negotiate meaning, and collectively construct complex concepts, thereby strengthening the internalization of these concepts through crucial social dynamics (Foko & Amory, 2008; Obikwelu & Read, 2012).

Furthermore, these findings strongly align with Keller's ARCS Model of Motivational Design (Efriyenef & Fitria, 2021; Keller, 1987). Baamboozle captures Attention through gamified elements; establishes Relevance via its familiar digital format; builds Confidence through a supportive team structure; and provides Satisfaction via immediate feedback and point systems (Chang et al., 2018; Fang et al., 2024; Hamzah et al., 2015). While literature suggests that GBL can potentially reduce cognitive load, moderate anxiety, enhance self-efficacy, sustain attention through appealing visual Aesthetics, or induce flow (Foko & Amory, 2008; Goh & Yang, 2021; Hwang et al., 2017; Jafarkhani et al., 2024; Nikolaos Drakatos et al., 2025; Pérez-Puelles et al., 2022; Riivari et al., 2021; Spieler et al., 2020; Su, 2017; Yang et al., 2020; Zhang, 2024), this study confirms explicitly its impact on learning interest

The integration of Baamboozle also has the potential to foster 21st-Century Skills, such as the 4Cs (Critical Thinking, Creativity, Collaboration, and Communication). Although not directly measured in this study, the mandatory team interaction and rapid problem-solving inherent in the game mechanics are hypothesized to support these competencies (Gómez Niño et al., 2024; Nursetyo et al., 2024; Samala et al., 2023). Platforms that mandate collaborative learning have been proven to enhance students' ability to manage conflict and participate in team decision-making (collaboration). The elements of time pressure and rapid problem-solving embedded in games like Baamboozle directly train quick, adaptive critical thinking skills (Akçayır & Akçayır, 2017; Arici et al., 2019; Smith et al., 2020). Furthermore, Bindra (2025), Zeng et al. (2024), and Rzabayeva et al. (2024) highlight the crucial role of gamified platforms in bridging the gap between school curricula and global skill demands. Consequently, Baamboozle aligns with the philosophy of the Indonesian Merdeka Curriculum, which emphasizes participatory, contextual, and enjoyable learning (Fauzan et al., 2023; Hadi et al., 2023; Marthawati & Setyo, 2024). This alignment also adheres to UNESCO's recommendations for integrating educational games to promote social and emotional competence (Koç & Kanadlı, 2025). However, it is important to note that as a posttest-only quasi-experiment, baseline equivalence cannot be as strongly demonstrated as in a pretest-posttest design, and the possibility of a novelty effect should be considered given the three-session duration.

Despite demonstrating positive results, this study possesses several methodological and contextual limitations that must be acknowledged. Methodologically, the reliance on a posttest-

only control group design and the relatively short duration of the intervention restrict the research's capacity to measure the long-term retention of learning interest or the sustained impact of Baamboozle over an extended period. Contextually, the focus on a single affective variable (learning interest) and execution within only one grade level (Fifth Grade) the generalizability of the findings. Finally, technical aspects—specifically the availability and consistency of student devices and the stability of the internet connection within the school setting—must be recognized as potential confounding variables. Future research should utilize more rigorous designs, such as pretest-posttest control groups, and include follow-up assessments after 1–3 months to investigate long-term impact.

Based on the acknowledged limitations, several recommendations are proposed to strengthen these findings in future studies. It is suggested that subsequent research utilize a more rigorous experimental design, such as a pre-test-post-test control-group design or a quasi-experimental time-*series* approach. These designs would allow for better control over baseline variables and enable a more comprehensive assessment of the intervention's initial impact and trajectory. Furthermore, it is crucial to investigate long-term retention by conducting a follow-up measurement of learning interest (a retention test) one to three months after the intervention concludes. Another key recommendation is to broaden the study's scope by expanding the dependent variables to include cognitive outcomes (e.g., learning achievement or critical thinking skills) and other affective variables (e.g., self-efficacy or intrinsic motivation) to gain a holistic understanding of Baamboozle's full impact. Finally, to validate the generalizability of this media's effectiveness across the curriculum, it is advised to expand the contextual population by applying Baamboozle at different grade levels or across various subject areas within primary education.

5. Conclusion and implications

This study indicates that integrating the Baamboozle educational game enhances primary students' interest in learning in the IPAS curriculum, providing an alternative to conventional teaching methods. The quantitative analysis, supported by an Independent Samples t-test, confirmed a highly statistically significant difference in posttest scores within this sample. Furthermore, the magnitude of this effect, quantified as a Cohen's d of 5.14, exceeds conventional thresholds for a considerable effect size, suggesting a substantial practical advantage for the participants involved. This finding contributes to the literature by providing preliminary empirical validation of the effectiveness of Game-Based Learning (GBL) in the affective domain within the specific context of an Indonesian primary school. Ultimately, the research suggests that Baamboozle serves as a feasible and interactive tool for educators seeking to cultivate student engagement. Potential implications include the support of 21st-century skills and alignment with the student-centered Merdeka Curriculum, although further research with broader samples and pretest-posttest designs is recommended to verify these broader outcomes

Credit authorship contribution statement

Safrizal: Conceptualization, Methodology (primary design), Formal Analysis, Data Curation, Writing – Original Draft, Writing – Review & Editing (final review). **Reva Selpia:** Resources (Baamboozle implementation), Literature Review, Validation of Theoretical Framework, Writing – Review & Editing

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(discussion and methodology). **Kavita Arafah:** Project Administration, Investigation (field coordination), Data Validation. **Jamiu Temitope Sulaimon:** Formal Analysis, Data Curation.

Declaration of competing interest

The authors declare that they have no known competing financial or personal interests that could have appeared to influence the work reported in this paper.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. Because the data include human participant information, they are not publicly available to protect participant privacy.

Ethical Declaration

The authors confirm that the study adhered to all ethical guidelines for the use of human subjects. Informed consent was secured from all participants' parents/guardians and school administration. Participation was strictly voluntary, and all collected data were treated confidentially and anonymously. The authors verify that the data presented are original and have not been fabricated or manipulated, ensuring full integrity and honest reporting of the research process and findings.

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Declaration of AI statement

In the preparation of this manuscript, artificial intelligence (AI) was utilized as a supporting tool in accordance with the Primary Journal AI policy. Specifically, the generative language model Manus was employed for several scaffolding tasks, including: (1) brainstorming and refining the article title to meet international journal standards; (2) structuring the introduction and methods sections based on academic best practices; (3) generating examples of tables for data presentation; (4) formatting the reference list according to APA 7th edition style; and (5) proofreading for language clarity and grammatical correctness. The AI was not used as a co-author or a citable source, and the authors bear full responsibility .for the final content, accuracy, and originality of this work. All content generated by the AI was thoroughly reviewed, edited, and validated by the authors, who take full responsibility for the final content.

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