Education and Human Development Journal Vol. **11** No.**1**, 57–68 (2026)
doi: 10.33086/ehdj.v11i1.8501

EHDJ | Education and Human Development Journal

ARTICLE

The Effect of Smartboard-Based Interactive Media on Learning Interest and Mathematics Achievement of Elementary School Students

Lilik Muji Hastutik, Muhajir,* Nuril Huda, and Sri Yuni Hanifah

Master's Program In Educational Technology Faculty Of Educational Sciences And Literature, Universitas Dr. Soetomo Surabaya, Surabaya, Indonesia

*Corresponding author: muhajir98@unitomo.ac.id

(Received: 01 December 2025; Accepted: 07 January 2026; Published: 30 April 2026)

Abstract

Integrating digital learning media in primary education has become increasingly important to enhance student engagement and academic achievement, particularly in subjects that students often perceive as difficult, such as mathematics. Interactive technologies such as Smartboards provide dynamic visual and interactive learning environments that can potentially improve students' interest and learning outcomes. This study aims to examine the effect of interactive Smartboard media on students' learning interest and mathematics achievement among fourth-grade students at SDN Kebun 2 Kamal. The research employed a quasi-experimental design with a quantitative approach. The sampling technique used was saturation sampling, involving the entire population of 50 students from classes IV-A and IV-B. The research instruments consisted of a mathematics learning achievement test and a questionnaire measuring students' learning interest. Data were analyzed using IBM SPSS version 21, including tests of validity, homogeneity, normality, and an independent samples t-test. The findings reveal a statistically significant improvement in both students' interest and learning outcomes after the implementation of Smartboard-based instruction, with a significance value of 0.000 ($p < 0.05$). The results indicate that the use of Smartboard media effectively enhances students' engagement and academic performance in mathematics. Therefore, Smartboard technology can be recommended as an alternative instructional medium to support the achievement of learning competencies in elementary mathematics education

Keywords: Interactive Media; Learning Interest; Learning Outcomes; Smartboard-Based.

1. Introduction

Advances in information and communication technology have significantly transformed educational practices, including the design and implementation of the elementary school curriculum. According to [1], the integration of technology into the core curriculum represents an essential strategy for improving the quality and effectiveness of learning. This digital transformation requires educators

 ISSN 2541-0156 (print), 2599-0292 (online).

to adopt innovative approaches in presenting instructional content in order to enhance interactivity and meet the learning characteristics of students in the 21st century. In this context, technology-based learning environments not only function as channels for disseminating information but also serve as mechanisms that facilitate active student engagement and interaction [2], [3]. Consistent with this perspective, [4] emphasizes that teachers' proficiency in utilizing technological tools as pedagogical instruments plays a crucial role in improving learning effectiveness and student outcomes.

In primary education, the development of mathematical competence is particularly important because it supports the growth of students' logical, analytical, and systematic thinking abilities [5]. Mathematics education not only provides learners with numerical knowledge and procedural formulas but also fosters problem-solving skills that are applicable to everyday situations [6]. However, the abstract and symbolic nature of mathematical concepts often creates learning challenges for elementary school students, particularly when instructional delivery does not align with their cognitive development and learning preferences [7]. Consequently, the integration of interactive digital media into mathematics instruction has emerged as an effective strategy for addressing these learning difficulties and enhancing conceptual understanding [8], [9].

One example of such technology is the Smartboard, which represents a form of digital interactive media capable of creating more engaging and contextually relevant learning experiences. Digital interactive media constitutes an innovative instructional approach that integrates visual elements, audio features, and interactive components into a cohesive learning environment [10]. Empirical studies have demonstrated the educational value of Smartboard-based learning. For instance, [11] found that Smartboard media used in third-grade elementary mathematics instruction achieved a validity score of 4.25, indicating that it is highly appropriate for classroom implementation. Furthermore, [12] reported that the use of Smartboards significantly improved students' mathematics learning outcomes, particularly in topics related to multiplication and division. Interactive features such as animation, simulation, and digital assessment tools encourage active student participation and contribute to more meaningful learning experiences. In this regard, [13] emphasizes that teachers' creativity and competence in utilizing Smartboard technology play a significant role in enhancing students' learning motivation and academic achievement.

Additional empirical evidence further supports the effectiveness of Smartboard-based instruction. A study conducted by [14] revealed that the use of interactive Smartboard media improved students' learning outcomes, with a performance percentage of 77% based on test results from 24 students. Similarly, research by [15] indicated that Smartboard learning media received highly positive responses from students, with 94% of large-group responses and 93% of small-group responses categorized as "very good." These findings suggest that Smartboard-based instructional media can effectively enhance elementary school students' learning outcomes in mathematics.

Moreover, another study conducted by [16] demonstrated that students who learned using interactive media exhibited higher levels of motivation and interest in the learning process compared to students who did not use such media. In addition, interactive media was found to improve student learning outcomes by increasing instructional effectiveness.

Although numerous studies have confirmed the effectiveness of Smartboards in improving learning outcomes, a notable research gap remains regarding the specific dimensions of student motivation in the learning process. Most previous studies have primarily focused on cognitive learning outcomes, media validity, and general motivational improvements associated with Smartboard implementation. However, comprehensive investigations that explore how Smartboard use influences elementary school students' learning engagement—particularly the emotional and affective dimensions that support sustained academic performance—remain relatively limited. Therefore, this study seeks to

address this gap through an integrated analysis that examines the relationship between Smartboard utilization, students' learning interest, and their learning outcomes.

Learning interest, as demonstrated by student engagement, is a significant determinant of academic performance. [17] argues that students with high interest show greater persistence and enthusiasm, while [18] illustrates that reduced interest negatively impacts engagement. These results indicate that digital interactive media enhances learning outcomes and fosters students' intrinsic motivation. Text, graphics, music, and video can all be combined in interactive digital media like Smartboards to enhance student-teacher communication and increase learning interest [19], [20]. Student learning outcomes indicate their mastery of the acquired material [21]. [22] states that learning outcomes encompass cognitive, emotional, and psychomotor dimensions. Efficient, enjoyable, and student-centered learning results in improved educational outcomes [23]. The use of a Smartboard as a digital interactive tool is expected to increase student engagement and academic performance in mathematics [24].

Initial classroom observations conducted at Kebun 2 Kamal Elementary School indicate that the learning process remains largely dominated by conventional instructional approaches, particularly lecture-based teaching methods supported primarily by textbooks and limited use of instructional media. In mathematics classes, this instructional pattern often results in low levels of student participation, limited learning interest, and a lack of enthusiasm for engaging in classroom activities [25]. Such conditions suggest that the current instructional practices have not fully facilitated active learning or effectively stimulated students' motivation to participate in the learning process.

This situation highlights the urgent need for the integration of innovative, contemporary, and interactive learning tools capable of fostering greater student engagement and participation. In response to this challenge, the present study explores the implementation of Smartboard technology as an interactive learning medium within the instructional context of Kebun 2 Kamal Elementary School. The originality of this research lies in its examination of Smartboard utilization within a real classroom environment where traditional teaching methods remain dominant.

Specifically, this study investigates the effectiveness of Smartboard-based learning in improving students' mathematics learning outcomes while simultaneously enhancing their interest in learning. By analyzing these dimensions, the study aims to contribute to the development of more relevant and interactive instructional strategies that align with the learning needs of elementary school students in the digital era.

This research was conducted to answer the following questions:

1. Is there an influence of using Smartboard-based interactive media on elementary school students' interest in learning mathematics?
2. Is there an influence of using Smartboard-based interactive media on elementary school students' mathematics learning outcomes?

2. Methods

2.1 Research Methodology

This study employs a quantitative research approach using a quasi-experimental design. Specifically, a two-group pre-test–post-test design was implemented to compare students' mathematics learning outcomes and learning interests between two groups: an experimental group that utilized interactive Smartboard media and a control group that followed a conventional teaching approach. This design enables researchers to measure changes in students' performance before and after the intervention and to examine the differences between the two groups systematically. Moreover, the quasi-

experimental method allows the study to generate empirical evidence regarding the effectiveness of the intervention through statistical hypothesis testing, thereby identifying whether significant differences exist between the experimental and control groups.

The sampling technique employed in this study was purposive sampling, which involves selecting participants based on predetermined criteria relevant to the research objectives. The sample was determined according to the following criteria: (1) students enrolled in the fourth grade at SDN Kebun 2 Kamal; (2) students who were participating in mathematics learning based on the applicable curriculum; and (3) students who maintained consistent attendance throughout the research period. These criteria were established to ensure that the selected participants were appropriate and representative for evaluating the effectiveness of Smartboard-based learning media. By applying these criteria, the study aims to accurately examine the extent to which Smartboard technology can enhance student engagement and improve mathematics learning outcomes in primary education.

2.2 Population and Sample

The study population consists of all fourth-grade students at Kebun 2 Kamal Elementary School. The study sample comprises 50 students, categorized into two classes: Class IV-A (25 students) serves as the experimental group, while Class IV-B, with 25 students, functions as the control group. The selection strategy used is purposive sampling, which involves sampling based on the presence of similar features within a class, thereby increasing the internal validity of the research results.

2.3 Research Tools

This study uses two types of instruments: a learning interest questionnaire to assess students' participation, motivation, and enthusiasm in mathematics education. Mathematics performance assessment, including pre-tests and post-tests conducted before and during the intervention to evaluate students' cognitive performance. Both measures underwent an initial assessment for content validity and reliability using statistical tests to confirm their suitability for the study.

2.4 Research Procedure

A pretest was administered to both groups to assess students' basic competencies. 2) Treatment: The experimental group engaged in learning thru interactive Smartboard media, while the control group learned thru lecture techniques and conventional media. A post-test was administered to both groups to assess learning outcomes after the intervention. The interest questionnaire was administered after the treatment to assess changes in students' interest in learning mathematics.

2.5 Data Analysis Methods

The data obtained were analysed through some methodical stages. The first phase includes an initial evaluation covering assessments of validity, reliability, homogeneity, and normality. The validity of the instrument was established through expert evaluation, with all statement items considered suitable for use. The instrument's reliability was assessed using Cronbach's Alpha coefficient, yielding a value of 0.87, which indicates excellent internal consistency. The Levene test is used to assess homogeneity, which indicates that the variances between groups are homogeneous. The Kolmogorov-Smirnov test is used to assess data normality, yielding a significance level above 0.05, which indicates that the data follows a normal distribution.

The second step involved inferential analysis using IBM SPSS software version 21 for Windows, employing an independent samples t-test approach. This study identified significant variations in learning interest and mathematics outcomes between the experimental and control groups. The analytical findings facilitate stronger conclusions regarding the effectiveness of Smartboard media in teaching basic mathematics.

3. Results and Discussion

3.1 Results

Independent samples t-tests were used to test the relationship between interest and learning outcomes of fourth-grade students and the use of smartboard media. The findings of this analysis are as in Table 1.

Table 1. Statistical Evaluation of Student Learning Interest Levels

Group Statistics

	Class	N	Mean	Std. Deviation	Std. Error Mean
Learning Interest	Experiment Class	25	61.00	7.932	1.586
	Control Class	25	51.52	8.412	1.682

The descriptive statistical findings in Table 1 indicate differences in mean values between the experimental and control groups for the variables studied in mathematics learning. The experimental group using interactive Smartboard media for learning had an average interest level of 61.00, with a standard deviation of 7.932 and a standard error of the mean of 1.586. This figure indicates that students in the experimental group showed a relatively high and homogeneous level of learning interest among individuals. The control group, which used traditional teaching techniques, achieved an average learning outcome of 51.52, with a standard deviation of 8.412 and a standard error of the mean of 1.682. Independent sample t-tests are needed to evaluate the statistical significance of these changes and to strengthen conclusions about the effectiveness of the learning media used, as shown in Table 2.

Table 2. Output of the Independent Samples T-Test for the Learning Interest Variable

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Learning Interest	Equal variances assumed	1.110	.297	4.100	48	.000	9.480	2.312	4.831	14.129
	Equal variances not assumed			4.100	47.835	.000	9.480	2.312	4.830	14.130

The statistical test findings in Table 2 indicate a significant difference in students' learning interest between the experimental and control groups. The Levene's Test for Equality of Variances yielded a significance value of 0.297 (Sig. > 0.05), indicating that the assumption of equal variances across groups was met. As a result, the subsequent analysis uses the "Equal variances assumed" row. The t-test findings for equality of means show a t-value of 4.100, with degrees of freedom (df) = 48 and a significance value (Sig. 2-tailed) = 0.000. The significance value, which is much smaller than 0.05, indicates a statistically significant difference in learning interest between the experimental and

control groups. The average difference of 9.480 indicates that the students' learning interest in the experimental group exceeded that of the control group. The 95% confidence interval ranges from 4.831 to 14.129, indicating that the mean difference can be reliably found within this range with 95% confidence. Effect size testing is conducted to complement the statistical significance analysis by providing an overview of the real impact of Smartboard usage on students' interest in learning mathematics. The criteria for evaluating the effect size test or Cohen's d are as in Table 3.

Table 3. Interpretation of effect size test results

Result	Description
0,2 – 0,5	Low
0,5 – 0,8	Fair
0,8 – 1,2	High

The results of the effect size test on the variable of students' interest in learning mathematics can be seen in Table 4.

Table 4. Effect size results of the variable interest in learning mathematics

	Mean	Standard Deviation	Effect Size
Experiment Class	61.00	7.932	1.160
Control Class	51.52	8.412	1.160

The calculation of effect size (Cohen's d) in Table 4 shows a value that falls into the large category (1.160 > 1.2), which means the use of the Smartboard has a significant impact on increasing students' interest in learning mathematics. Independent samples t-test on learning outcomes presented in Table 5.

Table 5. Statistical Evaluation of Student Learning Outcomes Levels

Group Statistics					
	Class	N	Mean	Std. Deviation	Std. Error Mean
Learning Outcomes	Experiment Class	25	74.80	11.000	2.200
	Control Class	25	43.20	14.900	2.980

Table 3, which shows the mathematics learning outcomes for the experimental and control groups, indicates that the experimental group using interactive Smartboard media achieved an average score of 74.80, with a standard deviation of 11.000 and a standard error of the mean of 2.200. The control group using traditional techniques had an average learning outcome of 43.20, with a standard deviation of 14.900 and an error of the mean of 2.980. The average difference of 31.60 points between the two groups indicates a significant gap in learning outcomes. Additional inferential analyses, including t-tests, are needed to confirm the statistical significance of these differences, as presented in Table 6.

Table 6. Output of the Independent Samples T-Test for the Learning Outcomes Variable

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Learning Interest	Equal variances assumed	.336	.565	8.531	48	.000	31.600	3.704	24.153	39.047
	Equal variances not assumed			8.531	44.170	.000	31.600	3.704	24.136	39.064

The t-test results for the learning outcomes variable in Table 4 show that Levene's Test for Equality of Variances has a significance value of 0.565 (Sig. > 0.05), which confirms that the assumption of equal variances between groups is met. As a result, the research continued with the "Equal variances assumed" row. The t-test yielded a t-value of 8.531, with degrees of freedom (df) = 48 and a two-tailed significance value (Sig. 2-sided) = 0.000. The significance value, which is much smaller than 0.05, indicates a highly statistically significant difference in mathematics learning outcomes between the experimental and control groups. The mean difference between the two groups is 31.600 points, with a standard error of 3.704, indicating that the experimental group achieved significantly superior learning outcomes compared to the control group. The 95% confidence interval ranges from 24.153 to 39.047, indicating that the difference can be relied upon to fall within this range. Effect size testing is conducted to complement the statistical significance analysis by providing an overview of the real impact of Smartboard usage on students' outcomes in learning mathematics. The criteria for evaluating the effect size test or Cohen's d are as shown in Table 7.

Table 7. Interpretation of effect size test results

Result	Description
0,2 – 0,5	Low
0,5 – 0,8	Fair
0,8 – 1,2	High

The results of the effect size test on the variable of students' outcomes in learning mathematics can be seen in the following table:

Table 8. Effect size results of the variable outcomes in learning mathematics

	Mean	Standard Deviation	Effect Size
Experiment Class	74.80	11.000	2.413
Control Class	43.20	14.900	2.413

The calculation of effect size (Cohen's d) in table 8 shows a value that falls into the large category (2,413 > 1.2), which means the use of the Smartboard has a significant impact on increasing students' outcomes in learning mathematics.

3.2 Discussion

This study provides strong empirical evidence that the use of Smartboard-based interactive media in mathematics learning at Kebun 2 Kamal Elementary School significantly improves students' interest and learning outcomes. Statistical analysis shows that the experimental group achieved an average learning interest score of 61.00, surpassing the control group's score of 51.52. The 9.48-point difference indicates increased student engagement in the learning process. Math learning outcomes show a significant difference, with the experimental group achieving an average score of 74.80, while the control group scored an average of 43.20, resulting in a 31.60-point difference. The independent samples t-test yielded a significance value of 0.000 ($p < 0.05$), indicating that the difference is statistically significant. The effect size test results for the learning interest variable showed a value of 1.160 > 1.2 and for the learning outcome variable 2.413 > 1.2.

This discovery validates that the Smartboard serves not only as a visual aid but also as an educational tool that can enhance the interactivity and significance of the learning experience. The results of this study are consistent with research conducted by [26], which emphasizes that interactive contextual media improves the quality of the learning process. [27] shows that the use of interactive technology enhances the academic performance of elementary school children. [28] in EDUCARE: Journal of Education and Health provide evidence that interactive digital media consistently improves classroom dynamics and increases student engagement. This consistency in results indicates that the Smartboard not only serves as a visual aid but also as a learning medium that can transform classroom dynamics into a more active and engaging experience.

The constructivist theoretical framework underpins the findings of this research. Piaget and Vygotsky stated that learning occurs when students actively develop knowledge through direct experience [29]. Smartboards create an environment for students to explore, analyze, and solve problems independently, thereby improving learning outcomes. [30] revealed that students' active interest in the learning process is positively correlated with increased learning interest. Research conducted by [31] in the journal Sensors (MDPI) shows that Smartboards in the classroom can foster an adaptive and student-centered learning environment, facilitate individualized learning tailored to each student's learning preferences, and connect abstract concepts with real-world applications.

The effective implementation of a Smartboard depends on the teacher's role as a facilitator. First of all, educators must have the ability to create activities that are engaging, relevant, and tailored to the needs of the learners. [32] characterizes the Smartboard as a tool that facilitates collaborative and student-centered learning. [33] states that interactive media can connect academic ideas with students' real-life experiences. Research [34] in Education and Information Technology shows that Smartboards improve motivation and mathematics learning outcomes for elementary school students. [35] in ZDM Mathematics Education adds that digital technology has revolutionized mathematics classrooms by expanding access and increasing interactivity. [36] in Learning Environments Research also emphasizes that interactive whiteboards have great potential in stimulating mathematics learning through active student engagement. [37] in Applied Sciences (MDPI) shows that interactive technology-based media improves mathematics learning performance in elementary school. [38] in Education Sciences (MDPI) highlights that interactive technology-based gamification can increase students' intrinsic motivation while also improving academic learning outcomes. In addition, [39] in Educational Technology & Society emphasizes that teachers' beliefs about the effectiveness of Smartboards are crucial for their successful use in the classroom. [40] in the International Journal of Progressive Education adds that teachers' acceptance of technology differs between elementary

and secondary school levels, making teacher readiness an important factor in optimizing Smartboard integration.

The research findings indicate that using a Smartboard significantly improves the engagement and academic performance of elementary school students. This finding verifies that interactive media not only serves as a visual tool but also as a mechanism that enhances students' emotional engagement in learning. The observed increase in learning interest indicates that Smartboards can overcome motivational barriers often encountered in mathematics education, thus reinforcing the function of technology as an educational tool that integrates cognitive and emotional dimensions.

Critical analysis reveals a different emphasis compared to previous research, which prioritized instrument validity and cognitive learning outcomes. This study introduces the emotional aspect, namely learning interest, as an important element that has not been thoroughly researched. Comparison with previous research results shows consistency in the effectiveness of Smartboards on learning outcomes, however, this study broadens the scope by establishing a direct correlation between learning interest and learning outcomes. The resulting conceptual contribution offers a new trajectory for technology-based learning theory by establishing interest and learning outcomes as key mediating variables.

4. Conclusion

This study demonstrates that the use of Smartboard technology significantly enhances student engagement and academic achievement in mathematics learning at SDN Kebun 2 Kamal. The experimental group, which utilized Smartboard-based interactive learning, achieved a higher average score for learning interest (61) and learning outcomes (74.80) compared with the control group, which recorded mean scores of 51.52 for learning interest and 43.20 for learning outcomes. The results of the independent sample t-test indicate a significance value of 0.000 ($< \alpha = 0.05$), confirming that the differences between the two groups are statistically significant. These findings provide empirical evidence that the implementation of Smartboard technology contributes positively to improving both students' motivation to learn and their academic performance in elementary school mathematics.

Furthermore, the effect size analysis reinforces the strength of the intervention. The effect size value for the learning interest variable was 1.160 (> 1.2 threshold for a strong effect in the study context), while the learning outcome variable yielded an effect size of 2.413 (> 1.2), indicating a very strong impact of Smartboard-based instruction on students' academic achievement. These results suggest that Smartboards function effectively as interactive learning media that facilitate cognitive development while simultaneously stimulating students' emotional engagement and motivation during the learning process.

From a theoretical perspective, this research supports the view that interactive digital learning media can enhance both cognitive and affective dimensions of learning. Practically, the findings provide a pedagogical foundation for elementary school teachers to integrate Smartboard technology as a more effective and engaging instructional strategy in mathematics education.

Nevertheless, several limitations should be acknowledged. The study was conducted within a limited scope, involving only one school and focusing on a single subject area. In addition, the measurement of learning interest relied primarily on questionnaire-based instruments, which may restrict the depth of the evaluation. These limitations may affect the generalizability of the findings to broader educational contexts.

Therefore, future research should expand the scope of investigation by involving multiple schools and different educational levels. Further studies are also encouraged to examine the implementation of Smartboard technology in various subject areas beyond mathematics.

Additionally, the development of more comprehensive and multi-method instruments for measuring learning interest is recommended. Longitudinal research designs would also be valuable to investigate the long-term impact of Smartboard integration on students' motivation, engagement, and academic achievement over time

References

[1] A. Mukminin, A. Habibi, L. D. Prasojo, A. Idi, and A. Hamidah. "Curriculum reform in indonesia: Moving from an exclusive to inclusive curriculum". In: *Center for Educational Policy Studies Journal* 9.2 (2019), pp. 53–72. DOI: 10.26529/CEPSJ.543.

[2] M. P. Osiesi and S. Blignaut. "Impact of the teacher education curriculum on the development of 21st-Century skills: Pre-service teachers' perceptions". In: *Social Sciences & Humanities Open* 11 (Jan. 2025), p. 101317. DOI: 10.1016/J.SSAHO.2025.101317.

[3] V. C. Blândul. "Inovation in Education – Fundamental Request of Knowledge Society". In: *Procedia Social and Behavioral Sciences* 180 (May 2015), pp. 484–488. DOI: 10.1016/J.SBSPRO.2015.02.148.

[4] J. M. Voogt and N. N. Pareja Roblin. "Curriculum and 21st century skills". In: *International Encyclopedia of Education: Fourth Edition*. Jan. 2023, pp. 49–55. DOI: 10.1016/B978-0-12-818630-5.03007-4.

[5] B. Xu, X. Ma, Y. Zhang, and X. Wu. "How does mathematical literacy affect creative thinking? Independent effects and differential impacts across proficiency groups". In: *Acta Psychologica* 260 (Oct. 2025), p. 105509. DOI: 10.1016/J.ACTPSY.2025.105509.

[6] W. Hidayat and U. Aripin. "The improvement of students' mathematical understanding ability influenced from argument-driven inquiry learning". In: *Journal of Physics: Conference Series* 1157.3 (Mar. 2019). DOI: 10.1088/1742-6596/1157/3/032085.

[7] O. Fitzmaurice, N. O'meara, and P. Johnson. "Highlighting the Relevance of Mathematics to Secondary School Students – Why and How". In: *European Journal of STEM Education* 6.1 (2021). DOI: 10.20897/ejsteme/10895.

[8] L. K. Fryer, A. Shum, R. B. King, and P. Lau. "How does interest in a course interact with course learning?" In: *Learning and Instruction* 98 (Aug. 2025). DOI: 10.1016/j.learninstruc.2025.102106.

[9] I. H. Sarah and R. Frank. "Scaffolding of learning activities: Aptitude-treatment-interaction effects in math?" In: *Learning and Instruction* 99 (Oct. 2025), p. 102177. DOI: 10.1016/J.LEARNINSTRUC.2025.102177.

[10] M. A. Shabur and M. R. Siddiki. "Investigating social media's impact on the new era of interactive learning: A case study of Bangladesh". In: *Heliyon* 10.4 (Feb. 2024), e26234. DOI: 10.1016/J.HELIYON.2024.E26234.

[11] R. Ariyanti, E. Rosalina, and T. G. Satria. "Pengembangan Media Smart Board Pada Pembelajaran Matematika Di Kelas III SD". In: *Edu Cendikia: Jurnal Ilmiah Kependidikan* 1.3 (Dec. 2021), pp. 88–94. DOI: 10.47709/educendikia.v1i3.1147.

[12] R. Wahyuni and H. A. Nasution. "Penggunaan Media Papan Pintar Terhadap Hasil Belajar Matematika Peserta Didik SD". In: *ALGORITMA: Journal of Mathematics Education* 6.2 (Dec. 2024), pp. 165–175. DOI: 10.15408/ajme.v6i2.42756.

[13] A. J. Naziyatul, M. Sari Dewi, and I. Ratih Sulistiani. "Pengaruh Media Pembelajaran Papan Pintar Terhadap Hasil Belajar Siswa Pada Mata Pelajaran Matematika Kelas II SD Brawijaya Smart School Malang". In: *JPMI: Jurnal Pendidikan Madrasah Ibtidaiyah* 6.2 (2024). URL: http://riset.unisma.ac.id/index.php/JPMI/index.

[14] A. Miranda Purba, R. Destini, and U. Barus. "Pengembangan Media Pembelajaran Papan Pintar Untuk Meningkatkan Hasil Belajar Siswa Pada Mata Pelajaran Matematika Kelas II Di SD Swasta Bunga Tanjong". In: *Journal Of Humanities and Social Studies* 2.4 (2024). URL: https://humasjournal.my.id/index.php/HJ/index.

[15] F. O. Mumpuni and I. Mulyawati. "Development of Smart Board Media on The Ability To Count Addition and Subtraction Materials in Grade II Elementary School Students". In: *Prima: Jurnal Pendidikan Matematika* 8.2 (2024), pp. 424–435.

[16] M. Amalia and Niken Ayu Pratiwi. "Pengaruh Media Interaktif Terhadap Minat Belajar Siswa Pada Pembelajaran IPA Kelas 4 SD". In: *Jurnal Jendela Pendidikan* 4.1 (2024). DOI: https://doi.org/10.57008/jjp.v4i01.689.

[17] Z. Guo and L. K. Fryer. "Personal relevance and interest: exploring the relationships among three types of perceived personal relevance and middle school students' interest in a math lesson". In: *Learning and Individual Differences* 122 (Aug. 2025), p. 102733. DOI: 10.1016/J.LINDIF.2025.102733.

[18] J. Jiang, G. Goepel, K. Crolla, and L. K. Fryer. "Impact of extended reality on students' interest, self-efficacy and performance in architecture education: A mixed-methods research". In: *Advanced Engineering Informatics* 62 (Oct. 2024), p. 102744. DOI: 10.1016/J.AEI.2024.102744.

[19] H. Pertiwi, A. Aziz, and M. Husni. "Development of Smart Board Visual Media for Autistic Children in Learning Indonesian Language". In: *Special and Inclusive Education Journal* 4.2 (2023).

[20] N. Cahyati, M. A. Desti, and M. Sari. "Smart Board Live Application: Super Complete Online Learning Platform for Effective Online Learning". In: *Pancaran Pendidikan* 10.1 (Mar. 2021). DOI: 10.25037/pancaran.v10i1.284.

[21] Ricardo and I. R. Meilani. "Impak minat dan motivasi belajar terhadap hasil belajar siswa (The impacts of students' learning interest and motivation on their learning outcomes)". In: *Jurnal Pendidikan Manajemen Perkantoran* 1.1 (2017), pp. 79–92. URL: http://ejournal.upi.edu/index.php/jpmanper/article/view/00000.

[22] A. Koçoğlu and S. Kanadlı. "The effect of problem-based learning approach on learning outcomes: A second-order meta-analysis study". In: *Educational Research Review* (May 2025), p. 100690. DOI: 10.1016/J.EDUREV.2025.100690.

[23] A. Tusaadia, A. Abdillah, M. Mahsup, V. Mandailina, and S. Syaharuddin. "Learning Independence Towards Mathematics Learning Outcomes Based on Education Level". In: *Indonesian Journal Of Educational Research and Review* 5.3 (Dec. 2022), pp. 577–587. DOI: 10.23887/ijerr.v5i3.52312.

[24] O. M. A. Aldalalah. "The Effectiveness of Infographic via Interactive Smart Board on enhancing Creative Thinking: A Cognitive Load Perspective". In: *International Journal of Instruction* 14.1 (Jan. 2020), pp. 345–364. DOI: 10.29333/IJI.2021.14120A.

[25] K. Michael et al. "Understanding and practice of active learning among upper primary school science and mathematics teachers". In: *Heliyon* 9.6 (June 2023), e16854. DOI: 10.1016/J.HELIYON.2023.E16854.

[26] F. Dwi Lestari and A. T. Sultan. "Studi Literatur: Pengaruh Media Digital Pembelajaran Terhadap Hasil Belajar Matematika". In: *SCIENCE: Jurnal Inovasi Pendidikan Matematika dan IPA* 5.2 (2025). URL: https://jurnalp4i.com/index.php/science.

[27] O. Annisa, F. Auliya, E. Fitriasari, M. Nurunnisa, and A. Marini. "Pengaruh Penggunaan Media Pembelajaran Interaktif Terhadap Hasil Belajar Siswa Di Sekolah Dasar". In: *JPDSH Jurnal Pendidikan Dasar Dan Sosial Humaniora* 2.8 (2023). DOI: https://doi.org/10.53625/jpdsh.v2i8.5765.

[28] Nursella. "Pengaruh Penggunaan Media Pembelajaran Interaktif Terhadap Hasil Belajar Siswa SD". In: *EDUCARE: Jurnal Pendidikan dan Kesehatan* 2 (2024). DOI: https://doi.org/10.70437/jedu.v2i1.14.

[29] T. W. Apoko and B. Waluyo. "Social media for English language acquisition in Indonesian higher education: Constructivism and connectivism frameworks". In: *Social Sciences & Humanities Open* 11 (Jan. 2025), p. 101382. DOI: 10.1016/J.SSAHO.2025.101382.

[30] H. N. Do, B. N. Do, and M. H. Nguyen. "How do constructivism learning environments generate better motivation and learning strategies? The Design Science Approach". In: *Heliyon* 9.12 (Dec. 2023), e22862. DOI: 10.1016/J.HELIYON.2023.E22862.

[31] X. Zhang, Y. Ding, X. Huang, W. Li, L. Long, and S. Ding. "Smart Classrooms: How Sensors and AI Are Shaping Educational Paradigms". In: *Sensors* 24.17 (Sept. 2024). DOI: 10.3390/s24175487.

[32] K. P. Ndwandwe, M. S. Ramaligela, and T. I. Mtshali. "Smartboard enhanced creativity in the technology classroom: lessons on mechanical systems and control". In: *Jurnal Pendidikan Teknologi dan Kejuruan* 30.1 (May 2024). DOI: 10.21831/jptk.v30i1.72289.

[33] A. Tanır. "German Language Teaching Academicians' Contentment on the Usage of Smart Board". In: *Procedia Social and Behavioral Sciences* 182 (May 2015), pp. 259–265. DOI: 10.1016/J.SBSPRO.2015.04.764.

[34] M. Furkan and U. Kurt. "The Effect of Using Smart Boards in Science Lessons on Middle School Students' Attitudes Towards Smartboards and Reflective Thinking Skills". In: *Educational Policy Analysis and Strategic Research* 16 (2021), p. 2021. DOI: 10.29329/epasr.2020.373.2.

[35] J. Engelbrecht and M. C. Borba. "Recent developments in using digital technology in mathematics education". In: *ZDM - Mathematics Education* 56.2 (May 2024), pp. 281–292. DOI: 10.1007/s11858-023-01530-2.

[36] M. De Vita, L. Verschaffel, and J. Elen. "Towards a better understanding of the potential of interactive whiteboards in stimulating mathematics learning". In: *Learning Environments Research* 21.1 (Apr. 2018), pp. 81–107. DOI: 10.1007/s10984-017-9241-1.

[37] Y. T. Lin and C. Te Cheng. "Effects of Technology-Enhanced Board Game in Primary Mathematics Education on Students' Learning Performance". In: *Applied Sciences (Switzerland)* 12.22 (Nov. 2022). DOI: 10.3390/app122211356.

[38] L. Jaramillo-Mediavilla, A. Basantes-Andrade, M. Cabezas-González, and S. Casillas-Martín. "Impact of Gamification on Motivation and Academic Performance: A Systematic Review". In: *Education Sciences* 14.6 (June 2024). DOI: 10.3390/educsci14060639.

[39] Y. K. Türel and T. E. Johnson. "Teachers' Belief and Use of Interactive Whiteboards for Teaching and Learning". In: *Educational Technology & Society* 15.1 (2022), pp. 1176–3647.

[40] A. Semerci and M. K. Aydın. "Examining High School Teachers' Attitudes towards ICT Use in Education". In: *International Journal of Progressive Education* 14.2 (Apr. 2018), pp. 93–105. DOI: 10.29329/ijpe.2018.139.7.