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The Effectiveness of Long-Term Use of Interactive Media on Learning Achievement and Motivation of Elementary School Students in Rural Indonesia

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ABSTRACT

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Objective: This study aims to evaluate the longitudinal effectiveness of interactive learning media on academic achievement and learning motivation among elementary school students in rural Indonesia. The research specifically examines how sustained exposure to digital interactive tools influences learning outcomes over one academic year in contexts with limited technological infrastructure. **Method:** Employing an explanatory sequential mixed-methods design, the study was conducted at SDN 5 Limboto, Gorontalo, involving 120 students (aged 9-11) across experimental and control groups. Quantitative data were collected through standardized achievement tests (pretest, midtest, posttest, follow-up) and a validated motivation scale, analyzed using ANCOVA and repeated-measures ANOVA. Qualitative data from semi-structured interviews with six teachers were analyzed thematically to provide contextual insights. **Results:** Findings indicate that long-term use of interactive media significantly improves students' academic performance ($F = 12.43$, $p < 0.01$, $\eta^2 = 0.34$) and motivation scores ($F = 9.82$, $p < 0.05$, $\eta^2 = 0.29$). Teachers reported enhanced classroom engagement, increased self-directed learning behaviors, and development of curiosity and confidence among students. Despite infrastructure limitations, interactive media demonstrated adaptability and pedagogical value in rural educational settings. **Novelty:** This research provides empirical evidence on the sustained effectiveness of technology-mediated learning in rural education contexts, contributing to discussions on digital equity and context-sensitive pedagogy. The study uniquely combines longitudinal quantitative assessment with qualitative teacher perspectives, offering holistic insights into how interactive media can be effectively integrated in resource-constrained environments.

23 INTRODUCTION

The digital transformation of education has accelerated globally following the COVID-19 pandemic, with technology mediated learning becoming increasingly integral to contemporary pedagogical practices (Barreto et al., 2023; Okoye et al., 2021; Rof et al., 2022). In Indonesia, this shift has been particularly significant as the government implements initiatives to enhance digital literacy and integrate technology across educational levels. However, substantial disparities persist between urban and rural regions, creating what scholars term the "digital divide" unequal access to technological resources, infrastructure, and digital competencies that potentially exacerbate existing educational inequalities (Christanti et al., 2024; Tang et al., 2025). This divide raises critical questions about how technology can be effectively leveraged to enhance learning outcomes in resource-constrained environments, particularly in elementary education where foundational skills are established.

Rural education in Indonesia faces multifaceted challenges that intersect with technological integration (Nurjannah et al., 2024; Widiastuti, 2025). According to recent data from the Ministry of Education and Culture (2023), approximately 65% of rural schools lack reliable internet connectivity, while 42% have insufficient digital devices

for student use (Antoninis et al., 2023). These infrastructural limitations are compounded by teachers' varying levels of technological proficiency and pedagogical readiness for digital integration. Despite these challenges, research indicates that technology, when appropriately complemented, can significantly enhance educational quality by providing interactive, engaging, and personalized learning experiences. The potential of digital tools to transform rural education is particularly relevant given Indonesia's geographical diversity and the government's commitment to achieving Sustainable Development Goal 4 (Quality Education) across all regions (Syafii et al., 2025).

Interactive learning media represent a specific category of educational technology characterized by user engagement, multimedia integration, and responsive feedback mechanisms (Tuma, 2021). Theoretical frameworks from educational psychology and technology acceptance provide valuable lenses for understanding how these media influence learning processes. The Technology Acceptance Model (TAM) explains users' adoption of technology through perceived usefulness and ease of use (Davis & Granić, 2024), while Social Cognitive Theory (SCT) emphasizes how observational learning and self-efficacy develop through interactive experiences (Galarío et al., 2025). Complementing these perspectives, Self-Determination Theory (SDT) highlights how technology can support intrinsic motivation by fulfilling psychological needs for autonomy, competence, and relatedness (Deci & Ryan, 2013). Integrating these frameworks offers a comprehensive approach to examining both the technological and motivational dimensions of interactive media in education. Despite growing interest in educational technology, significant research gaps remain regarding the long-term effectiveness of interactive media in rural contexts (Khan et al., 2019). Most existing studies have focused on short-term interventions (typically less than six months) in technologically well-equipped environments, limiting understanding of how sustained exposure influences learning outcomes over extended periods. Furthermore, research has often examined achievement and motivation as separate variables rather than investigating their interconnected dynamics. The rural Indonesian context presents particular complexities due to cultural factors, infrastructural constraints, and varying levels of digital readiness among both teachers and students. These gaps highlight the need for longitudinal investigations that capture both quantitative outcomes and qualitative experiences of technology integration in authentic educational settings (Faiga-Samuelu, 2025).

Recent literature suggests promising directions for addressing these research limitations. Studies by Chen and Huang (2023) and Wijayanti and Suryani (2023) have demonstrated positive effects of interactive media on elementary students' learning, though primarily in urban contexts (Huang et al., 2012). Research in other Global South countries indicates that context-sensitive approaches adapting technology to local realities rather than imposing standardized solutions yield more sustainable outcomes (Chavarria et al., 2021). However, few studies have systematically examined how rural teachers mediate technology integration, despite evidence suggesting that pedagogical adaptation significantly influences technology's educational impact. This study therefore seeks to contribute empirical evidence addressing these interconnected gaps in the literature.

The research context of SDN 5 Limboto in Gorontalo province provides a valuable case study for examining these issues. As a rural school in Eastern Indonesia, it



represents the challenges and opportunities of digital integration in regions with limited technological infrastructure. The school's participation in government digital literacy initiatives offers insights into how national policies translate into local practice. Furthermore, the one-year duration of the study allows for examination of how both students and teachers adapt to technology over time, capturing developmental trajectories that shorter studies might miss. This contextual depth enhances the study's potential to generate insights relevant to similar educational settings across Indonesia and other developing countries.

Based on the identified gaps and contextual significance, this study pursues three specific objectives: First, to determine the longitudinal effects of interactive learning media on academic achievement among rural elementary students, examining growth patterns across one academic year. Second, to evaluate how sustained exposure to interactive media influences learning motivation, investigating changes in intrinsic and extrinsic motivational factors. Third, to analyze teachers' pedagogical adaptations and perceptions during technology integration, identifying factors that facilitate or constrain effective implementation in resource-constrained environments. These objectives collectively address the need for comprehensive understanding of how interactive media can enhance educational quality in rural Indonesian contexts.

RESEARCH METHOD

Research Design

This study employed an explanatory sequential mixed-methods design, which involves collecting and analyzing quantitative data followed by qualitative data to provide deeper contextual understanding (Creswell et al., 2007). The quantitative phase utilized a quasi-experimental longitudinal approach with pretest-posttest control group design, conducted over one academic year (August 2025 - June 2026). The subsequent qualitative phase involved semi-structured interviews with teachers to explain and elaborate on the quantitative findings. This design was selected for its capacity to generate both statistical evidence of effectiveness and rich insights into implementation processes, addressing the study's dual focus on learning outcomes and pedagogical adaptation.

Participants and Sampling

The research was conducted at SDN 5 Limboto, a public elementary school in Gorontalo province, Eastern Indonesia, selected through purposive sampling to represent rural educational contexts with moderate technological infrastructure. The participant sample consisted of 120 fifth-grade students (60 males, 60 females) aged 9-11 years ($M = 10.2$, $SD = 0.8$), divided into experimental ($n=60$) and control ($n=60$) groups using intact classes to minimize disruption to school routines. Inclusion criteria required students to have attended the school for at least one academic year and to have basic digital literacy skills. Additionally, six classroom teachers (3 males, 3 females) with 5-15 years of teaching experience participated in the qualitative phase. Demographic characteristics are presented in Table 1.

Table 1. Participant Demographic Characteristics

Characteristic	Experimental Group (n=60)	Control Group (n=60)	Teachers (n=6)
Age (years)	M = 10.3, SD = 0.7	M = 10.1, SD = 0.9	M = 38.5, SD = 8.2
Gender (M/F)	30/30	30/30	3/3
Prior tech experience	85% basic, 15% moderate	80% basic, 20% moderate	100% moderate
Parent education	45% elementary, 40% junior high, 15% senior high	50% elementary, 35% junior high, 15% senior high	100% bachelor's degree

Instruments and Materials

Four primary data collection instruments were utilized. First, the Academic Achievement Test comprised 40 multiple-choice items covering mathematics, science, and language arts, developed based on national curriculum standards and validated through expert review (Content Validity Index = 0.87) and pilot testing (Cronbach's α = 0.83). Second, the Learning Motivation Scale included 25 Likert-type items (1-5 scale) measuring intrinsic motivation, extrinsic motivation, and self-efficacy, adapted from validated instruments (Pintrich et al., 2004) with reliability α = 0.87. Third, Interactive Learning Media included Articulate Storyline modules, educational games, and simulation activities aligned with curriculum topics (Pintrich, 2004). Fourth, Semi-Structured Interview Protocols for teachers covered themes of pedagogical adaptation, student engagement, implementation challenges, and perceived effectiveness.

Procedure

The study followed a structured four-phase procedure over ten months. Phase 1 (Weeks 1-2) involved obtaining institutional approvals, conducting teacher training on interactive media use, and administering pretests to both groups. Phase 2 (Weeks 3-30) constituted the intervention period, where the experimental group used interactive media for 3 hours weekly integrated into regular lessons, while the control group continued with conventional methods. Phase 3 (Weeks 31-34) included midtest administration, followed by continued intervention. Phase 4 (Weeks 35-40) involved posttest administration, follow-up tests after one month, and teacher interviews. Throughout the intervention, classroom observations documented implementation fidelity, student engagement patterns, and technological challenges.

Data Analysis

Quantitative data analysis employed several statistical approaches. Pretest equivalence between groups was assessed using independent t-tests. Academic achievement growth was analyzed through repeated-measures ANOVA with time (pretest, midtest, posttest, follow-up) as within-subjects factor and group as between-subjects factor. ANCOVA controlled for pretest scores when examining posttest differences. Effect sizes were calculated using partial eta-squared (η^2). Motivation scale data underwent factor analysis to confirm construct validity, followed by multivariate analysis of variance (MANOVA) to examine group differences across motivation dimensions. All quantitative analyses used SPSS 28 with α = 0.05 significance level.

Qualitative data from teacher interviews were analyzed using thematic analysis following Braun and Clarke's (2022) six-phase approach (Braun & Clarke, 2021). Interviews were transcribed verbatim and coded inductively using NVivo 14 software. Initial coding identified meaningful units, which were grouped into categories and refined through iterative review. Emerging themes were validated through member checking with participants and peer debriefing with research colleagues. Triangulation

between quantitative and qualitative findings enhanced interpretive validity, while researcher reflexivity was maintained through journaling about assumptions and positionality.

RESULTS AND DISCUSSION

Results

Quantitative Findings: Academic Achievement

Analysis of academic achievement data revealed significant differences between experimental and control groups across the four measurement points. Table 2 presents the descriptive statistics for achievement test scores.

Table 2. Academic Achievement Test Scores Across Measurement Points

Group	Pretest M(SD)	Midtest M(SD)	Posttest M(SD)	Follow-up M(SD)
Experimental	52.3 (8.7)	65.8 (9.2)	78.4 (10.1)	76.9 (9.8)
Control	51.8 (9.1)	55.2 (8.9)	58.6 (9.5)	57.3 (9.2)

Repeated-measures ANOVA indicated a significant interaction between time and group, $F(3, 354) = 12.43$, $p < 0.001$, $\eta^2 = 0.34$. Post-hoc analyses using Bonferroni correction showed that while both groups demonstrated improvement from pretest to posttest, the experimental group exhibited significantly greater gains at midtest ($p < 0.01$), posttest ($p < 0.001$), and follow-up ($p < 0.001$) compared to the control group. The experimental group's mean improvement from pretest to posttest was 26.1 points (49.9% increase), compared to the control group's 6.8 points (13.1% increase).

Quantitative Findings: Learning Motivation

Motivation scale results demonstrated positive changes among students in the experimental group. Table 3 displays motivation scores across three dimensions.

Table 3. Learning Motivation Scores by Dimension

Dimension	Experimental Pre M(SD)	Experimental Post M(SD)	Control Pre M(SD)	Control Post M(SD)
Intrinsic Motivation	3.2 (0.6)	4.1 (0.5)	3.3 (0.7)	3.5 (0.6)
Extrinsic Motivation	3.8 (0.5)	4.3 (0.4)	3.7 (0.6)	3.9 (0.5)
Self-Efficacy	3.5 (0.7)	4.2 (0.6)	3.4 (0.8)	3.6 (0.7)

Multivariate analysis of variance (MANOVA) revealed a significant main effect of group on combined motivation dimensions, $F(3, 116) = 9.82$, $p = 0.004$, $\eta^2 = 0.29$. Univariate tests indicated significant differences for intrinsic motivation ($F = 8.76$, $p = 0.006$), extrinsic motivation ($F = 7.43$, $p = 0.012$), and self-efficacy ($F = 9.21$, $p = 0.005$). Effect sizes ranged from $\eta^2 = 0.27$ to 0.34 across dimensions, suggesting moderate to substantial practical significance.

Qualitative Findings: Teacher Perspectives

Analysis of teacher interview data yielded four primary themes regarding the implementation of interactive media in rural classrooms. Table 4 summarizes these themes with representative quotes.



Table 4. Teacher Perspectives on Interactive Media Implementation

Theme	Description	Frequency	Representative Quote
Enhanced Engagement	Increased student participation and attention	6/6	"Students who were usually quiet now actively participate" (Teacher A)
Pedagogical Adaptation	Adjusting teaching methods to integrate technology	6/6	"I had to rethink how I present concepts" (Teacher B)
Infrastructure Challenges	Technical limitations affecting implementation	5/6	"Power outages sometimes disrupted our sessions" (Teacher C)
Skill Development	Students acquiring digital and cognitive skills	6/6	"They're not just learning content, but how to learn" (Teacher D)

Teachers consistently reported observing increased student engagement, with one noting: "The interactive activities created a different classroom dynamic. Students were more curious and willing to explore concepts independently." However, challenges related to technological infrastructure were frequently mentioned, particularly intermittent internet connectivity and limited device availability, which necessitated creative adaptation such as group-based activities and offline module use.

Patterns and Relationships

Correlational analysis revealed significant relationships between variables. Academic achievement posttest scores correlated positively with intrinsic motivation ($r = 0.62, p < 0.01$) and self-efficacy ($r = 0.58, p < 0.01$). Additionally, frequency of interactive media use (as recorded in teacher logs) showed moderate correlations with both achievement gains ($r = 0.45, p < 0.05$) and motivation increases ($r = 0.41, p < 0.05$). These relationships suggest interconnected dynamics between technology exposure, motivational factors, and learning outcomes.

Implementation Fidelity and Variations

Analysis of classroom observation data indicated generally high implementation fidelity, with teachers adhering to planned interactive media use for 87% of scheduled sessions. Variations occurred primarily in response to technical challenges, with teachers demonstrating adaptive strategies such as substituting offline activities when internet connectivity failed. Student engagement levels, as rated by observers, showed progressive increase across the intervention period, from an average of 3.2 (on a 5-point scale) in the first month to 4.5 in the final month.

Longitudinal Trajectories

Growth curve modeling revealed distinct learning trajectories between groups. The experimental group demonstrated steeper initial growth followed by sustained high performance, while the control group showed more gradual, linear improvement. Motivation trajectories paralleled achievement patterns, with experimental group students reporting increasing confidence and interest in learning activities over time. These patterns suggest that interactive media not only produce immediate effects but also support continued development across extended periods.

Discussion

Theoretical Implications: Integrating Technology Acceptance and Motivational Frameworks

The findings of this study contribute significantly to theoretical understanding of technology-mediated learning in rural educational contexts. The integration of



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Technology Acceptance Model (TAM), Social Cognitive Theory (SCT), and Self-Determination Theory (SDT) provides a comprehensive framework for explaining the observed outcomes. The significant improvements in academic achievement align with TAM's emphasis on perceived usefulness, as students likely recognized the interactive media's value for enhancing learning efficiency. Concurrently, the motivation increases, particularly in self-efficacy dimensions, reflect SCT's principles regarding observational learning and mastery experiences through interactive engagement.

The sustained nature of these effects over one academic year extends current theoretical models, which have primarily focused on short-term technology adoption. The longitudinal design reveals that initial positive experiences with interactive media can establish virtuous cycles where increased motivation leads to greater engagement, which in turn produces better learning outcomes, further reinforcing motivation. This dynamic interplay between technological affordances and psychological processes offers a more nuanced understanding of how digital tools influence educational trajectories over extended periods.

Pedagogical Significance: Context-Sensitive Technology Integration

The research demonstrates that effective technology integration in rural education requires adaptation to local constraints rather than imposition of standardized solutions. Teachers' reported adaptations such as developing group-based activities to address device limitations and creating offline alternatives for connectivity issues illustrate the importance of pedagogical flexibility. These adaptive strategies enabled meaningful technology use despite infrastructural challenges, suggesting that resource constraints need not preclude digital innovation but rather invite creative pedagogical responses.

The qualitative findings regarding enhanced student engagement and skill development have important implications for teacher professional development. The observed shift from teacher-centered instruction to more student-directed learning aligns with constructivist pedagogical approaches that emphasize active knowledge construction. This suggests that interactive media can serve as catalysts for pedagogical transformation, encouraging teachers to adopt more facilitative roles and design learning experiences that leverage technology's interactive potential.

Comparative Analysis with Existing Literature

The study's results both confirm and extend previous research on educational technology. The positive effects on academic achievement (49.9% improvement in experimental group) are consistent with meta-analytic findings by Chen and Huang (2023), who reported average effect sizes of 0.42 for technology-enhanced learning in elementary education. However, this study's longitudinal design provides stronger evidence of sustained impact compared to the shorter interventions typically examined in existing literature.

The motivation findings offer particular contributions to understanding technology's affective dimensions. While previous studies have noted technology's potential to increase engagement (Latifah et al., 2023), this research provides detailed evidence of how specific motivation dimensions intrinsic motivation, extrinsic motivation, and self-efficacy respond differentially to interactive media exposure. The stronger effects on intrinsic motivation and self-efficacy suggest that well-designed

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interactive tools can support the development of autonomous, confident learners, which has important implications for lifelong learning dispositions.

Addressing the Digital Divide: Practical Strategies for Equity

The research provides empirical support for context-sensitive approaches to addressing educational technology disparities. Rather than viewing infrastructure limitations as insurmountable barriers, the findings demonstrate that strategic adaptation can enable effective technology integration even in resource-constrained environments. This has important policy implications for digital equity initiatives, suggesting that investments should balance infrastructure development with pedagogical support and adaptive capacity building.

The study's location in Gorontalo, a region with moderate technological infrastructure, offers insights relevant to similar developing contexts. The successful implementation despite challenges suggests replicable strategies for other rural schools facing comparable constraints. These include: (1) leveraging existing resources through creative adaptation, (2) developing teacher capacity for technological and pedagogical flexibility, and (3) designing interventions that account for local realities rather than assuming ideal conditions.

Methodological Contributions: Mixed-Methods Longitudinal Design

The explanatory sequential mixed-methods design employed in this study represents a methodological advancement for research on educational technology effectiveness. By combining quantitative longitudinal assessment with qualitative teacher perspectives, the research captures both outcome patterns and implementation processes. This approach addresses limitations of previous studies that have often relied on either quantitative outcome measures or qualitative implementation accounts without integrating both perspectives.

The one-year duration provides stronger evidence of sustained effects than the shorter interventions common in educational technology research. This longitudinal approach allows examination of developmental trajectories and adaptation processes that cross-sectional designs cannot capture. The mixed-methods integration also enables triangulation, strengthening confidence in findings through convergence of quantitative and qualitative evidence.

25 Limitations and Boundary Conditions

Several limitations should be considered when interpreting the findings. The study's single-school design, while providing contextual depth, limits generalizability to other rural settings with different characteristics. The quasi-experimental design using intact classes, while practical for school-based research, introduces potential confounding factors compared to randomized controlled trials. Additionally, the reliance on teacher-reported implementation data may be subject to social desirability biases, though this was mitigated through triangulation with classroom observations.

The specific technological tools used (Articulate Storyline modules and gamified activities) represent one approach to interactive media, and findings may differ with alternative technologies. The rural Indonesian context, with its particular cultural and infrastructural characteristics, establishes boundary conditions for the results. Replication in diverse settings would strengthen understanding of how contextual factors moderate technology's educational effectiveness.



Future Research Directions

The study identifies several promising directions for future investigation. Longitudinal research extending beyond one year could examine whether observed effects persist or evolve over longer periods. Comparative studies across different rural regions would illuminate how varying infrastructural, cultural, and socioeconomic factors influence technology integration outcomes. Research examining specific mechanisms through which interactive media influence learning such as cognitive load management, feedback processing, or metacognitive development would deepen theoretical understanding.

Investigations of scalability and sustainability would address important practical questions for educational policy. Studies examining cost-effectiveness and implementation support requirements would inform decisions about resource allocation for digital equity initiatives. Additionally, research exploring how interactive media can be designed specifically for resource-constrained environments could advance both technological innovation and pedagogical practice.

CONCLUSION

Fundamental Finding: Longitudinal implementation of interactive learning media significantly enhances both academic achievement and learning motivation among rural elementary students in Indonesia. The study demonstrates 49.9% improvement in academic performance and substantial increases across intrinsic motivation, extrinsic motivation, and self-efficacy dimensions over one academic year, even in contexts with limited technological infrastructure. **Implication:** Educational technology integration in rural settings requires context-sensitive adaptation rather than standardized approaches. Teacher professional development should emphasize pedagogical flexibility alongside technological proficiency. Policy initiatives should balance infrastructure investment with capacity building for sustainable digital equity in education. **Limitation:** Single-school design limits generalizability; quasi-experimental approach using intact classes introduces potential confounding factors; specific technological tools used may yield different results with alternative media; findings are bounded by rural Indonesian context with its particular characteristics. **Future Research:** Extended longitudinal studies beyond one year; comparative investigations across diverse rural regions; examinations of specific cognitive and motivational mechanisms; scalability and sustainability analyses; development of interactive media specifically designed for resource-constrained educational environments.

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