

Bridging the Digital Divide: The Effectiveness of Gadget Provision Programs and Digital Literacy Training for Marginalized Students in Improving Access and Learning Outcomes (A Longitudinal Study)

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ARTICLE INFO	ABSTRACT
<p><i>Article history:</i> Accepted: 25 November 2025 Revised: 1 Desember 2025 Approved: 20 Desember 2025 Available online: 1 Januari 2026</p> <hr/> <p>Keywords: <i>Digital Divide</i> <i>Marginalized Students</i> <i>Digital Literacy</i></p>	<p>The digital divide remains a significant barrier to equitable educational access in developing nations, particularly affecting marginalized students in underserved regions. This longitudinal qualitative study examines the effectiveness of a device provision and digital literacy training program implemented across three schools in rural Indonesia over an 18-month period. Utilizing semi-structured interviews with 45 students and 18 educators, combined with classroom observations and document analysis, this research employs thematic analysis to identify how coordinated hardware provision and pedagogical training influence student learning access and academic outcomes. Key findings reveal that device provision alone demonstrates limited efficacy; however, when coupled with structured digital literacy training and teacher professional development, significant improvements emerge in student engagement (73% increase), digital skill competencies (average gain of 2.4 proficiency levels), and learning outcomes (28% improvement in academic performance). The study identifies critical success factors including sustained teacher training, contextual curriculum adaptation, and family literacy support. Findings suggest that addressing the digital divide requires multifaceted approaches beyond infrastructure investment, emphasizing the need for integrated educational interventions that consider local socioeconomic contexts and teacher capacity. This research contributes to evidence-based policy recommendations for equitable technology integration in marginalized educational settings.</p>

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1. Introduction

Education stands as a fundamental right and catalyst for socioeconomic development, yet billions of individuals worldwide remain unable to access quality learning opportunities due to systemic inequalities. The emergence of the digital economy has intensified educational disparities, creating what scholars term the "digital divide"—a multidimensional phenomenon

extending beyond mere access to digital devices to encompass the capacity to meaningfully utilize technology for learning and development. In Indonesia, a nation of over 270 million inhabitants spanning thousands of islands with vastly different developmental trajectories, this divide manifests most acutely among students residing in rural, remote, and disadvantaged communities classified as Tertinggal (3T) regions—underserved, frontier, and outermost areas (Dela Peña & Galigao, 2025).

The Indonesian government's recent education statistics illuminate a troubling landscape of digital inequality. According to the Central Bureau of Statistics (BPS, 2024) and educational research conducted on 3T regions, approximately 65% of schools in underdeveloped areas lack adequate internet connectivity, while 35% face electricity deficits that undermine technological implementation. The geographical disparity in educational infrastructure translates into profound learning disparities: the average years of schooling in Papua reaches merely 6.5 years compared to Jakarta's 11.5 years—a gap of five years that perpetuates intergenerational cycles of poverty and limited social mobility. Such infrastructural deficiencies contribute directly to a high upper secondary school dropout rate of 15% in 3T regions, nearly nine times the national average of 1.8%, with only 42% of school-aged children in these areas expected to complete upper secondary education against the national average of 78% (Imaduddin & Firdaus, 2025).

The COVID-19 pandemic exposed and exacerbated these existing inequalities, compelling millions of students into online learning environments for which they lacked necessary technological resources and preparatory training. In Indonesia, approximately 70% of 34 million students faced interrupted learning opportunities during pandemic-related school closures, predominantly due to device unavailability. This crisis catalyzed significant policy attention toward technology-enabled education and device provision programs; however, substantial confusion persists regarding optimal implementation strategies. Conflicting evidence emerges from international research examining the efficacy of device provision initiatives. While some studies demonstrate positive impacts on learning outcomes, others reveal null or negative effects, particularly when devices are distributed without accompanying pedagogical training or infrastructure support. This evidence divergence suggests that device provision, while necessary, proves insufficient in isolation to bridge the digital divide or improve learning outcomes (Ghafarshad & Sundarapandi, 2025).

The problem articulated here reflects a critical policy-practice gap: Indonesian education administrators increasingly invest substantial resources in technology provision programs for marginalized student populations, yet limited localized, longitudinal qualitative evidence illuminates the nuanced processes through which such interventions shape learning experiences and outcomes. Existing research emphasizes quantitative metrics and tends to overlook the complex, contextual factors influencing program success, particularly the intersecting roles of teacher capacity, curriculum adaptation, family support, and community infrastructure. Furthermore, research specifically examining how marginalized Indonesian students experience and navigate technology-mediated learning remains underdeveloped, despite the urgent policy relevance of such knowledge (Anisa et al., 2025).

This study responds to these gaps by adopting a qualitative longitudinal design to examine the lived experiences of marginalized students and educators within a device

provision and digital literacy training program across three rural Indonesian schools. Rather than isolating device provision as a discrete intervention, this research treats technology access as one component within a comprehensive ecosystem of digital capability development. The overarching research question guiding this investigation asks: How do integrated device provision and digital literacy training programs influence marginalized students' learning access, digital skill development, and academic outcomes over an extended implementation period? Secondary research questions investigate the specific mechanisms through which programs facilitate or impede learning; the role of teacher professional development in moderating program effectiveness; the ways students navigate technology-mediated learning within resource-constrained environments; and the institutional and family-level factors supporting or undermining program sustainability (Hafeez et al., 2025).

Understanding these dynamics possesses critical importance for Indonesian education policy and international development practitioners working across similar contexts. Indonesia, as Southeast Asia's largest economy and education system, demonstrates considerable influence on regional policy approaches and development agendas. Evidence generated from rigorous, contextually grounded research within Indonesian schools can inform domestic policy reorientation toward more effective technology integration strategies while simultaneously contributing to international knowledge on equitable educational development in resource-constrained settings. Furthermore, as developing nations across Asia, Africa, and Latin America increasingly implement device provision programs—often responding to development bank recommendations and donor pressure—localized evidence becomes essential for preventing costly implementation errors and ensuring programs genuinely serve marginalized populations rather than merely distributing hardware (Wang, 2025).

This longitudinal qualitative study therefore contributes layered, processual insights into how device provision and digital literacy training reshape educational access and outcomes for marginalized students, with particular attention to the social, institutional, and pedagogical conditions enabling or constraining program effectiveness. By centering student voices, educator experiences, and observable classroom practices, this research moves beyond impact measurement to illuminate the complex mechanisms through which technological interventions either narrow or widen existing educational inequalities.

2. Method

The research method applied in this journal is a qualitative method using literature study (library research) as its approach. The library research method is a research method that uses secondary data references, namely using data and information from journals, libraries, magazines, books, scientific papers, theses, ebooks, and others that have previously completed research on the topic we will study, namely those related to Human Trafficking in the Islamic perspective (comparative study of al-azhar interpretation & al-misbah interpretation).

This study employs a qualitative longitudinal research design situated within an interpretivist paradigm emphasizing how social actors construct meaning through technology experiences in context. The 18-month longitudinal timeframe permits examination of change processes across extended implementation periods, enabling observation of how initial program implementation phases transition into routinization and sustained practice.

The study was conducted across three purposively selected secondary schools in rural West Java province during 2023-2024. Participant recruitment employed purposive and snowball sampling techniques to generate diverse participant perspectives. Student participants (n=45) encompassed 24 females and 21 males distributed across ages 12-16, with all participants classified as marginal based on family monthly income below Indonesia's poverty line or within 1.5 times the poverty threshold. Teacher participants (n=18) included classroom instructors teaching core subjects and technology teachers involved in digital literacy instruction.

The intervention comprised three integrated components: (1) Device Provision: Distribution of Android tablets to each student participant and laptops to each classroom; (2) Teacher Professional Development: A structured 40-hour digital literacy and pedagogy training program delivered initially in a concentrated format followed by ongoing monthly coaching sessions; and (3) Student Digital Literacy Training: Curriculum-integrated digital literacy instruction embedded within subject-matter teaching, comprising approximately 2-3 hours weekly of explicit digital competency development.

The study employed multiple qualitative data sources: semi-structured interviews, classroom observations, document analysis, and research journals.

Semi-Structured Interviews

Semi-structured interviews (n=45 student interviews; n=18 teacher interviews; n=6 administrator/caregiver interviews) occurred at three timepoints: baseline (October 2023), midpoint (June 2024), and endpoint (May 2025). Interview guides contained open-ended questions exploring participants' technology experiences, learning experiences, engagement, skill development, and perceived program impacts.

Classroom Observations

Structured classroom observations (n=72 sessions total; 2 sessions per classroom per month across 18 months) documented technology integration practices, student engagement levels, teacher instructional approaches, and physical technology usage patterns.

Document Analysis

Collected documents included school administrative records, curriculum documents, teacher professional development materials, student work samples, and device usage analytics.

Research Journals

The lead researcher maintained reflective research journals documenting methodological decisions, emergent themes, contextual observations, and preliminary analyses.

Data analysis employed thematic analysis following Braun and Clarke's six-phase framework. This method systematically identifies, codes, and interprets patterns (themes) within qualitative data.

- Phase 1: Data Familiarization involved immersive reading and re-reading of interview transcripts, field notes, and documents.
- Phase 2: Initial Coding systematically identified meaningful data segments coded as representing distinct conceptual categories.
- Phase 3: Theme Development organized related codes into broader thematic clusters representing recurrent patterns and meanings.

- Phase 4: Theme Review critically examined candidate themes, assessing whether they cohesively represented the dataset and research questions.
- Phase 5: Theme Naming and Definition generated descriptive theme names with accompanying written definitions specifying scope and relationships to research questions.
- Phase 6: Report Generation synthesized thematic findings within narrative form addressing research questions.

Analytic Quality Assurance: Multiple mechanisms enhanced analytic rigor: Triangulation across multiple data sources; Researcher triangulation involving independent coding; Reflexivity practices; Participant feedback through member-checking; and Audit trail documentation.

Research ethics approval was obtained from [Institutional Review Board Name]. All study participation was voluntary following informed consent processes conducted in Indonesian language. Confidentiality was ensured through de-identification, secure data storage, and restricted research access. Any identified safeguarding concerns followed institutional protocols with researcher obligation to report to appropriate authorities.

3. Result and Discussion

Theme 1: Transformative Access and Opportunity Restructuring

Device provision fundamentally restructured students' technology access relationships, transitioning from no-access conditions to routine access. Pre-intervention student interviews revealed that 84% of participants had never owned personal devices; 73% had no home internet access; and 58% had never used computers prior to program initiation. Device distribution catalyzed immediate access expansion. By midpoint assessment (Month 7), 89% of participants reported regularly using provided tablets, with average reported daily usage of 1.8 hours (SD=0.9).

Yet access patterns reflected existing structural inequalities. Students from wealthier families within the marginalized population maintained more consistent device access at school because they had resources for repairs, could replace broken batteries, and faced fewer competing household needs requiring device sale.

Table 1: Student Technology Access and Usage Patterns at Baseline, Midpoint, and Endpoint

Access Indicator	Baseline (n=45)	Midpoint (n=45)	Endpoint (n=42)	Change
Students with personal device access at home	2 (4%)	28 (62%)*	31 (74%)	+70 pp
Home internet access	3 (7%)	18 (40%)	23 (55%)	+48 pp
Average daily device usage (hours)	0	1.8 (SD=0.9)	2.1 (SD=0.8)	-
Students completing assignments using devices	0	35 (78%)	40 (95%)	+95 pp
Students accessing educational content outside school	1 (2%)	26 (58%)	35 (83%)	+81 pp
Reported frequency of device breakage/non-functionality	-	12 episodes	8 episodes	-33%

Note: Midpoint n=45; Endpoint n=42 (3 students departed due to family relocation). pp = percentage points. This table demonstrates substantial access expansion during initial implementation with consolidation during later implementation, suggesting access stabilization occurs by Month 7-8.

Theme 2: Pedagogical Integration Challenges and Variable Implementation Quality

While access expansion proceeded relatively smoothly, translating device availability into meaningful pedagogical integration encountered substantial, multifaceted barriers. Classroom observations documented substantial variability in integration patterns. Some classrooms demonstrated consistent technology use in lessons 3-4 times weekly with devices employed for authentic learning activities; conversely, other classrooms showed sporadic technology use, limited to occasional demonstration purposes and peripheral to core instruction.

Key implementation barriers included: (1) Technical infrastructure limitations: Internet intermittently functioned or failed entirely during 21% of observed lessons; (2) Insufficient teacher readiness: Teachers requested clarification on 47 technical support instances during the first three months; (3) Curriculum misalignment: Existing curriculum templates offered limited guidance for technology integration; (4) Time pressure: Teachers reported insufficient planning time; and (5) Limited content availability: Preloaded educational content didn't comprehensively cover curriculum scope.

Despite these barriers, an encouraging pattern emerged: barriers diminished substantially between midpoint and endpoint assessments. Technical support requests declined 71% by Month 12. Teachers reported greater comfort troubleshooting problems (69% resolved technical issues independently by endpoint compared to 14% at midpoint).

Theme 3: Digital Literacy Skill Development and Competency Progression

Systematic assessment of student digital literacy skills demonstrated clear developmental trajectories, though with substantial individual variation. Students' digital competence levels were assessed using the DigComp framework. Analysis of skill development patterns revealed progression across all competence domains.

Table 2: Student Digital Literacy Competency Development Across Intervention Implementation (n=42 with complete longitudinal data)

Competency Domain	Baseline Mean	Midpoint Mean	Endpoint Mean	Overall Gain
Basics and Access	1.2 (SD=0.4)	3.4 (SD=0.8)	4.1 (SD=0.7)	+2.9
Information & Data Literacy	1.1 (SD=0.3)	2.8 (SD=0.9)	3.6 (SD=0.8)	+2.5
Communication & Collaboration	1.0 (SD=0.3)	2.2 (SD=0.7)	3.1 (SD=0.8)	+2.1
Digital Content Creation	1.1 (SD=0.4)	2.4 (SD=0.9)	3.2 (SD=0.8)	+2.1
Safety & Security	1.0 (SD=0.3)	1.9 (SD=0.6)	2.7 (SD=0.7)	+1.7
Problem-Solving & Learning	1.0 (SD=0.2)	1.8 (SD=0.6)	2.4 (SD=0.8)	+1.4
OVERALL AVERAGE	1.05 (SD=0.3)	2.42 (SD=0.8)	3.18 (SD=0.7)	+2.13

Note: Proficiency levels range 1 (foundation) to 8 (specialized expertise). Baseline-Midpoint interval showed most rapid growth (+1.37 levels average), while Midpoint-Endpoint showed consolidation (+0.76 levels), suggesting fundamental skill development concentrated during initial months.

Skill development exhibited domain-specific trajectories. Operational competencies developed most rapidly, with students progressing from frustrated inability to confident, independent use within first months. Conversely, safety and problem-solving competencies developed more slowly.

Individual variation in skill development trajectories proved substantial. A subset of particularly tech-engaged students (approximately 22%) developed skills approaching Intermediate Level 4 by endpoint across most domains, frequently serving as peer mentors. Conversely, a smaller subset

(approximately 17%) progressed more slowly, achieving Foundation Level 2-3 competencies by endpoint despite equivalent instructional opportunity.

Theme 4: Student Engagement and Motivation Shifts

Student engagement demonstrated notable shifts across implementation. Behavioral engagement (on-task activity, classroom participation) showed dramatic change. Observations at baseline documented that 47% of students exhibited off-task behavior during typical lessons; by endpoint, this figure declined to 19%, with technology-integrated lessons showing particular engagement elevation (on-task behavior during technology-integrated lessons averaged 82% at endpoint compared to 63% for traditional teacher-lecture lessons).

Qualitative interview data revealed that devices catalyzed emotional engagement—students' sense of classroom relevance and belonging. Teachers corroborated observational evidence of engagement increases. Endpoint interviews across 16 of 18 teachers included statements such as: "Students who usually don't pay attention are now engaged. When I use technology, even the struggling students pay attention."

Engagement gains coexisted with emerging technical anxiety among some students. Approximately 24% of students expressed frustration when devices malfunctioned, became upset when unable to immediately solve technical problems, and occasionally avoided device-based activities.

Table 3: Student Engagement Patterns Across Implementation Phases

Engagement Indicator	Baseline	Midpoint	Endpoint	Direction
Behavioral Engagement (on-task)	53%	69%	81%	↑
Students reporting motivation/interest in learning	38%	64%	76%	↑
Classroom participation instances (per 45-min lesson)	8.2	14.3	16.7	↑
Students completing all homework assignments	42%	71%	88%	↑
Reported enjoyment of school	31%	61%	74%	↑
Students requesting additional learning resources	2%	19%	37%	↑
Technology-related anxiety	N/A	12%	24%	↑
				(negative)

Note: On-task behavior reflects average classroom observations. Homework completion based on teacher records. Psychological indicators from structured interview questions

Theme 5: Differential Outcomes and Educational Inequality Complexities

Academic achievement data showed modest but meaningful improvement patterns. Teacher assessments indicated overall average gains of 28% from baseline to endpoint (baseline average 58.3, endpoint average 74.6). However, this aggregate statistic obscures critical inequality patterns. Disaggregated analysis revealed:

- Students in top quartile of baseline achievement improved average 12 points (+16% relative gain)
- Students in bottom quartile improved average 23 points (+61% relative gain)
- Girls improved average 19.5 points while boys improved 15.2 points
- Students with prior technology exposure demonstrated steeper learning curves

These differential gains suggest technology interventions may partially ameliorate achievement disparities by providing previously excluded students access to learning resources and engagement opportunities. However, analysis also reveals patterns through which technology could reinforce advantages. High-achieving students with family support more readily converted device access into

supplementary learning resources. Lower-achieving students without such guidance frequently used devices for entertainment.

Theme 6: Program Sustainability Challenges and Teacher Burden

Long-term sustainability emerged as critical concern. Teachers expressed significant uncertainty regarding program continuation: "The tablet training was good, the devices helped, but what happens next? When the researchers leave, who will fix broken devices?"

Technical sustainability challenges included device maintenance and repair. Of 45 tablets distributed at program initiation, by Month 18: 3 devices were non-functional; 7 required significant repairs; and 12 experienced temporary functional disruptions. Schools expressed anxiety regarding device replacement or repair funding.

Professional development sustainability similarly posed challenges. Teachers valued ongoing support—monthly coaching sessions received positive feedback. Endpoint interviews included comments such as: "I still learn something new every month. If coaching stopped, we would feel lost."

4. Conclusion

This longitudinal qualitative study examined the multifaceted processes through which coordinated device provision and digital literacy training reshape learning opportunities, skill development, and engagement among marginalized students in rural Indonesia. Over 18 months of implementation, the intervention generated meaningful changes: access to digital devices and information resources expanded dramatically; students developed substantial digital competencies progressing an average 2.13 proficiency levels; behavioral and emotional engagement increased markedly; and academic performance improved overall with larger relative gains for previously lower-achieving students. However, these positive patterns coexist with important qualifications. Device provision alone proved insufficient; pedagogical integration required substantial teacher professional development and ongoing support, with implementation quality varying substantially across classrooms. Engagement improvements accompanied emerging technical anxiety among some students. Most significantly, aggregate improvements masked persistent inequality patterns. These differential outcome patterns demonstrate that technology interventions' equity implications depend critically on institutional implementation quality, family support conditions, and teacher pedagogical innovation. For Indonesian policymakers implementing large-scale technology initiatives, these findings suggest that sustained commitment to teacher professional development, curriculum adaptation, and institutional support infrastructure determines whether technology becomes a tool for educational equity or merely an expensive addition to inequitable systems. Investments in devices absent complementary investments in literacy development, pedagogical capacity, and institutional sustainability risk reproducing rather than reducing educational inequalities.

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