Research Article

Bridging National Policy And Local Realities: A Mixed-Methods Analysis Of Early Childhood Literacy And Numeracy Implementation In Indonesia

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ABSTRACT

Background: Early numeracy is important for human capital development and is a national educational priority in Indonesia. This study investigates implementing the early literacy–numeracy policy for 2024 in West Nusa Tenggara/Nusa Tenggara Barat (NTB) and aims to identify barriers to such an implementation, as well as to design a locally contextualized technology-supported learning model. Methods: This study was conducted using a concurrent mixed-methods design, including a policy review, teacher–parent surveys (n = 662), 15 semi-structured interviews, three focus group discussions, and one pilot intervention in urban, rural, and remote ECE centers. The local breadth of policy varied considerably; execution might be restricted in the tropical Sumbawa area by an absence of instructors, inadequacy of resources, and poverty (despite strong local parental responsibility). We piloted the LENTAS model that integrated local wisdom, offline-first edtech parenting techniques, and structured parental engagement with teacher mentoring. At the most deprived site, the percentage of answers meeting 10 established criteria increased from about 50% to 80%. Policy impacts are greatest, and early numeracy results more equitable, if policies acknowledge the importance of ongoing professional development, contextual relevance, adequate learning materials and resources, and strong family–community partnerships.

Keywords: numeracy literacy, early childhood education, education policy, locally contextualised learning model, educational technology.

1. INTRODUCTION

Early Childhood Education: A country's strong human resource base begins with this stage of learning. These foundational skills are most critical early in life, and basic literacy and numeracy underpin other aspects of child development in cognitive, social-emotional, and physical domains. Formal numeracy, or the understanding of patterns and logic around numbers and even some basic math skills, is clearly a key readiness outcome for the next stage of schooling. Aside from preparing them for academic careers, paying special attention to early numeracy will also develop life skills in children that are becoming more useful as the world is changing rapidly. Cross-national evidence shows that some of the gap in basic literacy and numeracy between disadvantaged and advantaged children exists at school entry, and this gap does not close on its own during the early years of schooling (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025). In England, a longitudinal study revealed that disadvantaged pupils enter compulsory school scoring 23.6% lower on standardized number assessments than their peers (with effect sizes (g = 0.51) remaining at least through the first year of formal schooling; Culliney & Robson, 2026). An important body of literature that has summarized evidence for early-numeracy interventions reveals statistically significant impacts, with the strongest effects in low-income populations (Nelson & McMaster, 2018). This body of evidence gives a firm strategic conclusion to policymakers in low- and middle-income countries: investment in foundational learning during the early years is the most effective lever for inclusive human-capital development..

The Early Childhood Education (ECE) sector in Indonesia has been hampered by fragmented governance issues between national and regional governments, uneven provisioning of the ECE subsector, and limited early learning curricular coherence (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025). Indonesia has a strong national commitment to early literacy and numeracy since President Prabowo Subianto's inauguration in October 2024 (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025). On 28 October 2024, the new Minister of Primary and Secondary Education, Abdul Mu'ti, articulated a strategic policy framework for ECE by recognising mathematical understanding as a life skill rather than a formal subject area (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025). The framework highlights: (a) socialisation of foundational mathematical ideas (pattern, sequence, size) within the context of daily activities; (b) systematic use of play-based pedagogies; (c) avoidance of early arithmetic drill;

and (d) embedding literacy, numeracy, and digital awareness as an interrelated learning triangle. This framework is generally aligned with global agreement on developmentally appropriate practice (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025).

However, the national policy articulation at a macro-level falls short of addressing an important question regarding implementation: How does a centrally designed play-based and contextual framework operate as everyday classroom practice within the context of deeply geographically stratified provinces characterized by socio-economic and cultural heterogeneity? Nusa Tenggara Barat is a good example of this problem. NTB is situated in the Lesser Sunda Islands of eastern Indonesia and consists of two major islands (Lombok and Sumbawa) and scattered populations on coastal, highland, and remote archipelagic sub-districts. The Human Development Index has traditionally trended below the national average, and adult literacy and numeracy indicators also remain stubbornly below national targets (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025). In terms of absolute numbers, ECE services have increased rapidly over the last two decades, but quality indicators—teacher qualifications, learning materials, intensity of supervision, and parental engagement—are highly inconsistent, with rural and remote centres consistently faring worse than urban counterparts in provincial monitoring reports (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025).The Mendikdasmen policy framework recognises this complexity and explicitly invokes kearifan lokal (local wisdom) and contextualisation as implementation principles (Habibi, 2025), but the empirical evidence base for how this localisation should occur, and whether it produces measurable learning gains, remains thin. This study addresses that gap by analysing the implementation of the new national literacy-numeracy policy in NTB from three interlocking perspectives: (a) fidelity and adaptation at the point of delivery; (b) barriers and enablers identified by the practitioners and families who enact the policy daily; and (c) the design, pilot, and preliminary effects of a locally contextualised, technology-supported pedagogical model.

Guided by this framework, the study addresses four research questions:

1. Q1: How is the national early literacy-numeracy policy implemented across urban, rural, and remote ECE settings in NTB?
2. Q2: What are the principal barriers to effective implementation at the classroom, school, and household levels?
3. Q3: Which locally adapted strategies—including the integration of cultural practices and educational technology—appear most effective in strengthening early numeracy?
4. Q4: What evidence-based recommendations can be formulated to enhance policy effectiveness, equity, and sustainability in disadvantaged contexts such as NTB?

1.1 Conceptual Framework

The underlying framework of concepts is given below, which indicates the different hierarchical levels in which implementation analysis takes place. Moving from national strategic direction downwards through provincial and district coordination structures to the ECE classroom and household, while feedback from practitioners and families flows upwards, might best support the refinement of policy.

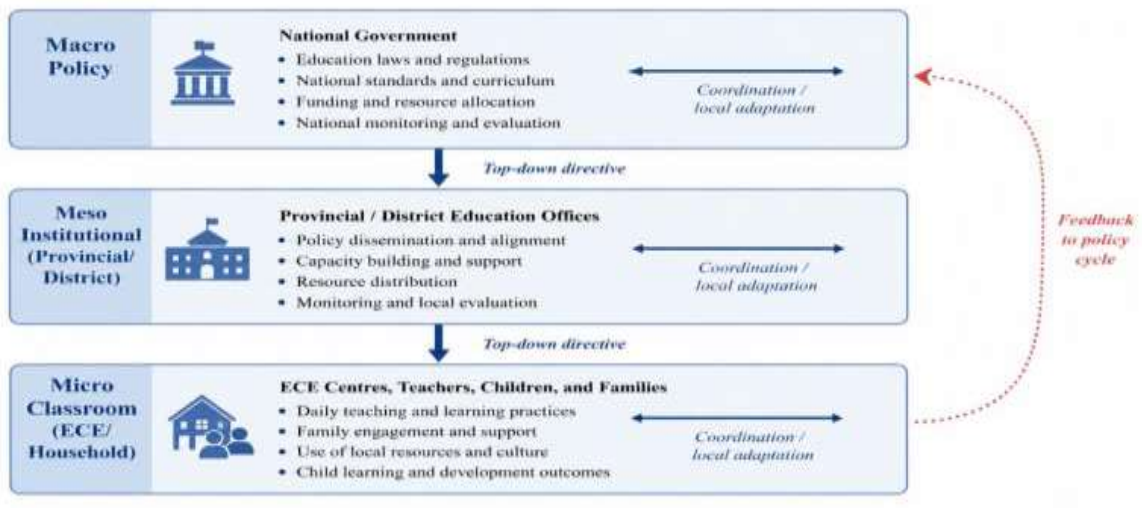

Figure name: Conceptual Implementation Framework for ECE Numeracy-Literacy Policy in NTB

Figure caption: Figure 1. The sociopolitical context and historical processes for the policy implementation framework of early literacy-numeracy policy in disadvantaged sub-national settings, with integration across macro-policy, meso-institutional, and micro-classroom layers. The horizontal arrows within each layer imply coordination and local adaptation; the red-dotted feedback from practitioners to policy represents the friction and conflict encountered in day-to-day matters.

2. LITERATURE REVIEW

2.1 Early literacy and numeracy as a foundation for equity

There is a growing body of empirical evidence demonstrating that investments in early literacy and numeracy provide linear returns throughout the life course (Gillon et al., 2024). Combining evidence from low-, middle-, and high-income countries, the Lancet Series on Advancing Early Childhood Development argued that foundational learning in early childhood is a prerequisite to achieving the global social justice and educational equity commitments of the Sustainable Development Goals (Black et al., 2016). Using historical data, Engle and coauthors estimate that every percentage-point increase in preschool participation reduces the gap in schooling attainment between rich and poor youth cohorts by about 0.026 grades (Engle et al., 2011). There is meta-analytic evidence that structured early numeracy-based interventions in the preschool and early primary years lead to statistically significant effects (Nelson & McMaster, 2018), supported by a follow-up generalisability study on Turkish low-socioeconomic-status children with an effect size of 1.32 (KARAKUŞ et al., 2023).

The implications are straightforward: without deliberate, contextual, and sufficiently resourced intervention, equity in early numeracy is not a "given" outcome of widening access. Commentary on Indonesian early childhood education (ECE) policy has pointed out that while ECE expansion occurred from the late 1960s, this was accompanied by insufficient programme quality assurance, resulting in what scholars have reported as a "quality plateau" and further suggesting that effective strategies for improving ECE quality need to be multi-level, encompassing practitioner preparation, materials, and household engagement (Zakiyah et al., 2026).

2.2 Policy implementation in decentralised and disadvantaged contexts

Implementing national education policy in the classroom is often problematic. Implementation theory differentiates between top-down, bottom-up and hybrid models (Fadhil & Sabic-El-Rayess, 2020), with most contemporary analysts focusing on coordination across levels including central versus local mandates, administrative capacity, and responsiveness of practitioners. This is all the more problematic in decentralised systems (such as Indonesia) where there are large differences at the district level while accountability lines are fragmented, and feedback loops from schools to ministries can be weak. More recently, subsequent analyses have found that even carefully designed reforms (including professional development for teachers) have had difficulty achieving consistent improvements in classroom practice due to the lack of well-developed monitoring and feedback mechanisms. Their bottom-up initiatives run the risk of becoming fragmented and unable to scale up; this often leads to a reliance on purely top-down approaches in an attempt to achieve coherence. If paired with investment in teacher capacity, learning materials and community engagement, hybrid models that blend top-down strategic direction with local adaptation have worked better.

2.3 Local wisdom, ethnomathematics, and culturally responsive pedagogy

Recent developments, driven by international interest and support for indigenous integration and effective local initiatives in ECE, aim to safeguard children's development by incorporating traditional practices. The ethnomathematics tradition represents culturally situated mathematical practices, such as pattern recognition in textiles, geometry in architecture, and counting in marketplaces, establishing these practices as valid gateways toward formal numeracy [5]. Recent empirical work in Indonesian settings shows that integrating classroom activities with local cultural stories, traditional games, and daily practices yields significant effects on mathematical interest and correctness, while at the same time promoting a stronger identity. For instance, studies in East Java document 35% gains in numeracy performance on formative evaluations from incorporating local wisdom into early-grade numeracy through traditional games such as engklek (Simanjuntak et al., 2025); the Tri Hita Karana philosophy has guided ECE pedagogy in Bali with effects on cultural identity formation; and a Make-a-Match approach embedded in Topeng Malangan was found to enhance young children's engagement with numeracy learning tasks (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025). Comparative Indonesian ECE programme studies further confirm that local cultural values are vital for character building and culturally responsive

pedagogy (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025).

The evidence base is most related to NTB, where locally meaningful cultural assets (e.g., Sasak woven textile motifs [tenun Sasak], the traditional game of congklak (a mancala-style board game), and gasing (a spinning top), as well as the ritualized marketplace economy) serve as rich numeracy materials. Thus, integrating local wisdom is not a romanticization of the past but an evidence-based pedagogical approach consistent with constructivist learning theory (Syahrial et al., 2020).

2.4 Technology integration in early childhood settings

How digital technology fits into ECE has also been a topic of robust discussion. Critics caution against screen-time, the sidelining of play and equity in access; proponents emphasise opportunities to provide feedback tailored for the individual, representation that models many modes of expression and opportunities to decentralise qualified teaching. In the examples from cognitive science, field experiments manipulating gamified numeracy curricula in real-world low-resource preschool settings have shown significant and durable improvements immediately post-experiment in intuitive mathematical skills (largest effects observed in most severe baseline deprivation; Dillon et al., 2017). Nevertheless, the same evidence highlights that any symbolic mathematical gains mechanisms result from technology-mediated interventions are likely to be fleeting unless coupled with high-quality adult scaffolding and sustained pedagogical integration (Benavides-Varela et al., 2020). The studies of the ECE professional development landscape similarly note that sustaining change in technology-rich classrooms relies upon both ongoing coaching and peer-learning communities as well as reflective practice (Caneva et al., 2023), not one-off training events.

The "digital divide" in rural and remote contexts is not just about device accessibility but connectivity, electricity, content language, and teacher digital literacy (Mustafa et al 2024). Appropriate teacher and parent support can enhance the impact of blended technology programmes optimised for low-bandwidth or offline contexts to improve foundational literacy and numeracy (S 2026)(Selson et al, 2023).

2.5 Parental engagement and community partnership

One of the best exogenous predictors for early numeracy development is parental engagement (Ghazali et al., 2021), particularly in low socioeconomic status populations. Research from China indicates that preschool attendance helps to close urban–rural cognitive divides but only when families supplement its impact with learning stimulation via home-based practices (Zheng et al., 2021; Jung & Hasan, 2014). Specific evidence from the Indonesian context also shows that parental stimulation at home in numeracy tasks is an important proximal mid-predictor of young children's outcomes in early numerical learning (Habibi, 2025). This suggests that school-based interventions should be accompanied by more structured home-based parent programmes which reframe common routines—cooking, shopping, counting—as intentional numeracy learning opportunities.

2.6 Research Gap

Despite this rich evidence base, there are still a number of critical gaps. Firstly, there is a scarcity of studies on the sub-national delivery of national ECE policy reforms within decentralised middle-income countries such as Indonesia and hardly any investigations in provinces with high levels of socio-economic disadvantage, such as NTB. Second, existing results for numeracy programs based on local wisdom focus on primary-school interventions, while evidence in pre-primary settings is more limited. Third, combined data on cultural adaptation and technology integration in ECE are rarely examined together. Fourth, comparative studies of urban vs. rural and remote settings within individual provinces are few. This study deals with all four gaps directly.

3. RESEARCH OBJECTIVES

The present study pursues four interconnected objectives:

1. To analyse the implementation of the 2024 national literacy-numeracy policy in ECE settings in NTB and characterise variation across urban, rural, and remote contexts.
2. To identify and analyse the principal multi-level barriers (teacher capacity, infrastructure, household engagement, cultural fit) that condition implementation.
3. To develop, pilot, and preliminarily evaluate a locally contextualised, technology-supported numeracy learning model and specify the elements that appear most effective.
4. To formulate evidence-based, equity-oriented recommendations for policymakers, school leaders, and teacher educators regarding the reinforcement of early literacy-numeracy implementation in disadvantaged Indonesian provinces.

4. METHOD

4.1 Research design

We used a concurrent mixed-methods design involving parallel quantitative and qualitative strands along with an embedded quasi-experimental pilot intervention. This design is suited to research questions that are at once descriptive ("how is the policy being implemented?"), explanatory ("what are the barriers and enablers?"), and interventional ("does the model work?"). The Research Ethics Committee of Universitas Mataram provided ethical approval for this study. Informed consent, in writing, was received from all subjects, and parental/guardian approval was secured for collecting data from children as per Indonesian research ethics regulations.

4.2 Research site and context

We conducted the study in NTB Province, consisting of two main islands, Lombok and Sumbawa, with significant geographical dispersion across coastal, highland, and archipelagic sub-districts. The study was particularly purposive in identifying three distinct types of contexts from NTB, focusing on: (a) a west coast urban ECE centre in Mataram, the provincial capital; (b) a rural village ECE centre based at Janapria Village, East Lombok; and (c) an isolated island setting ECE centre on the island of Sumbawa. This three-way stratification was intended to surface the modal implementation patterns across the urban–rural–remote gradient which characterises much of eastern Indonesia.

4.3 Participants

Participants were recruited from four stakeholder groups. For teachers and ECE practitioners, six lead teachers (two per site) engaged with the pilot intervention, and another cohort of teachers from across the province completed the broader survey. For parents and caregivers, 50 parents and caregivers participated in FGDs and parenting workshops at the three pilot sites, while an additional convenience sample responded to the survey. Sixty children (approximately 20 per pilot site) enrolled in the pilot program, and quantitative numeracy indicators were measured pre- and post-intervention. Other participants included 15 key informants (e.g., senior and experienced ECE teachers, headmasters and coordinators of the ECE unit in the district education office, university faculty members who teach ECE courses, and community leaders). Adolescent girls were also included. Data collection employed mixed methods, including 20 focus group discussions (FGDs). These FGDs involved a combination of teacher–parent groups. Purposive sampling was used to recruit participants, with convenience sampling employed for the survey.

4.4 Instruments and data collection

The main study protocol had five interrelated instruments: (a) a structured document-analysis protocol for both national policy texts and provincial statistics; (b) a bilingual (Indonesian–Sasak) teacher and parent survey capturing household numeracy activities, perceived barriers, and teaching practices; (c) semi-structured interview guides used with 15 key informants; (d) FGD protocols for three focus groups; and (e) a researcher-administered child numeracy assessment comprising number recognition of the digits one through ten, counting using one-to-one correspondence, simple comparisons such as more/less or equal/comparative weight, and basic pattern recognition that was administered pre- and post-intervention. The items in the survey were based on existing early childhood education (ECE) practice indicators and adapted from international longitudinal frameworks of measurement for early years settings. All instruments were piloted with teachers and parents from a small sample prior to deployment, and scales were adapted for cultural and linguistic context.

4.5 The pilot learning model

Our pilot, called LENTAS ("Locally Contextualised Early Numeracy with Technology Support"), comprised four design principles: (a) culturally based play-based learning (congklak counting, woven patterns, and role-play of market activities); (b) low-bandwidth technology (offline-first tablet apps and local-language content); (c) structured parent engagement via short workshops and home-activity guides; and (d) ongoing teacher support—in-class mentoring by the research team. The model was piloted at each site for two to three months during 2025, using four components per weekly lesson cycle.

4.6 Data analysis

Quantitative strand. Teacher, parent, and child characteristics were summarised through descriptive statistics. We measured paired-sample comparisons for pre–post numeracy in the pilot and conducted a descriptive examination of cross-site differences in baseline and change scores. Inferential generalisation was not attempted due to a small per-site n (c. 20 children) and the absence of a randomised control group; instead, descriptive effect sizes and qualitative triangulation were used.

Qualitative strand. Audio-recordings of interviews and FGDs were transcribed verbatim, de-identified to ensure participant confidentiality, and then analysed using reflexive thematic analysis (Braun & Clarke, 2006; Campbell et al., 2021) following the standard six-phase process: familiarisation with data; initial coding of data (i.e., identifying interesting features relevant to the research question); searching for themes in coded data (grouping

codes into broader categories reflecting similarities); reviewing potential themes against the full dataset (ensuring high-quality themes based on clear evidence from transcripts); defining key issues around reviewed themes as stand-alone entities; and naming reviewed themes. We coded inductively (from the data) and deductively (derived from the conceptual categories of barriers and enablers identified in the literature review). Two researchers independently coded a large subsample and compared their coding to improve the robustness of the analysis.

Integration. The interpretive phase integrated quantitative and qualitative findings through a convergent joint display, which involved cross-checking the magnitude and directionality of statistical patterns against emergent themes..

4.7 Trustworthiness and ethics

Data credibility was ensured through prolonged engagement, member checking (in FGDs), and triangulation across the different data sources, while transferability was supported through a thick description of the three implementation contexts. Dependability in the coding process was ensured by maintaining a formal audit trail, and confirmability was verified through dual coding and team-based data interpretation. The pilot is recognized as being in its early stages. This intervention was designed as an additive pedagogical enrichment, not a replacement for the standard curriculum delivery.

5. FINDINGS

5.1 Policy implementation status across the urban–rural–remote gradient

The document analysis confirmed that indeed the 2024 Kemendikdasmen framework sets out a national strategy coherent with research and best practices literature on early mathematics education, which emphasises: (a) the importance of socialising basic mathematical concepts in daily practice; (b) play-based pedagogy; (c) coordinating non-standardised curriculum materials around play to avoid premature exposure to arithmetic drill; and (d) integration across literacy areas, encompassing literacy practices for numeracy awareness, along with digital literacy practices and tools, to enhance teachers' understanding that each competency area is interlinked (Habibi, 2025). Communication on the new policy regarding NTB travelled quickly from national to provincial and district levels, and the NTB Education Office generated implementing guidance in the first quarter of 2024.

Qualitative and survey data reveal wide variations in implementation by site. In Mataram, urban ECE centres reported fairly high fidelity to the framework: teachers had undergone training; children had access to learning materials; and parental engagement mechanisms were in place. In East Lombok, rural ECE centres described implementation as partial but spirited — albeit poorly resourced and monitored. Remote ECE centres in Sumbawa observed the least stringent practices, with only a fraction of teachers trained in literacy and numeracy, rudimentary resources, and no evident mechanisms to involve parents. The new framework is being described as, in one urban teacher's words: "how we have always worked"; another went even further, describing it as "a great idea we only just heard about" from her remote area.

The schematic below shows the LENTAS pilot design: the four-pillar model that was instantiated at the three comparative case sites..

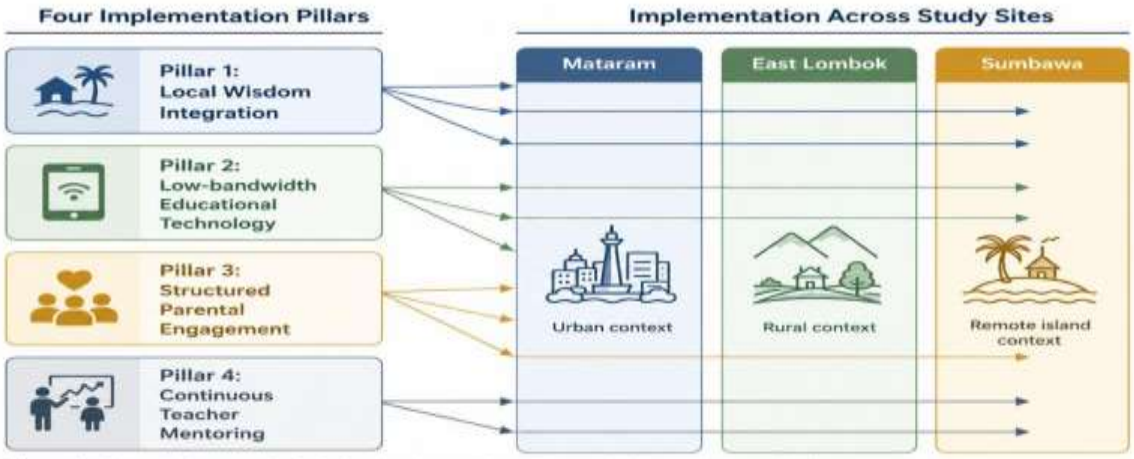

Figure 1. Schematic framework of the four implementation pillars applied across three study sites.

Note. The pillars are implemented in Mataram (urban), East Lombok (rural), and Sumbawa (remote island) contexts.

Figure 2: LENTAS Four-Pillar Implementation Framework Across Three Pilot Sites

Figure 2. The LENTAS implementation framework illustrating four interconnected intervention pillars—Local Wisdom Integration, Low-bandwidth Educational Technology, Structured Parental Engagement, and Continuous Teacher Mentoring—implemented across three contrasting Early Childhood Education (ECE) settings: Mataram (urban), East Lombok (rural), and Sumbawa (remote island). Each pillar contributes complementary mechanisms to strengthen early literacy-numeracy implementation across diverse local contexts.

5.2 Barriers to implementation

Four interrelated barrier categories frequently emerged from the interview, FGD, and survey data.

Teacher capacity. In rural and remote sites, teachers commented on limited availability of pre-service and in-service preparation to meet the challenges of teaching play-based numeracy. A number talked about returning to paper-based, teacher-oriented activities even though the training emphasised interactive approaches. Delivery of numeracy activities was far less likely to take place at remote sites, with self-reported confidence in this area significantly lower. A recurrent issue raised in the FGDs was the discrepancy between teachers' theoretical knowledge and their actual practical repertoires: "We know what we're supposed to do, but we don't know how"

Infrastructure and materials. Even where teachers were willing, the actual infrastructure to enable play-based and technology-supported learning was patchy. Responses from the survey showed that physical resources (counting games, number cards, and calibrated measuring tools) were in significant short supply, with remote sites reporting the least availability. Electricity reliability and internet connectivity were sporadic in all locations, but Sumbawa was the worst affected across all sites.

Parental interaction and home numeracy context. Summary: Parents at all sites reported valuing education but identified significant barriers (both practical and material). Parents in urban locations had higher education; more flexible employment; also provided more numeracy stimulation at home (e.g., counting during shopping, board games). In rural and especially remote sites, parents more commonly reported low levels of education completion, demanding jobs, and a lack of understanding of how to assist numeracy learning at home. Similar evidence at an international level confirms the structural importance of these factors within low-SES populations.

Cultural-linguistic fit. Teachers and parents also remarked that widely-used standard national textbooks imported from urban Java contexts were sometimes culturally "distant" to the lived experiences of children in NTB. On Lombok and Sumbawa islands, some teachers said that illustrations, vocabulary, and examples made no sense to local children without translation.

5.3 Enablers identified across sites

Four enabling strategies were consistently identified across the interviews and FGDs.

Integration of local wisdom. Teachers using local Sasak and Samawa elements, including traditional games (congklak, gasing), woven-textile motif recognition, and market role-play, reported significantly higher child engagement and faster uptake of concepts compared with teachers utilizing imported materials.

Low-bandwidth educational technology. Where the tablet-based LENTAS application was used, teachers noted that it improved interactivity, engaged children, and provided visual representations of numerals and patterns otherwise absent from classrooms. The offline-only mode retained the main advantages in the site with the lowest bandwidth availability, corroborating recent evidence on technology-supported ECE programs operating at scale in low-resource settings (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia, 2025).

Structured parental engagement. Second, the home practice reinforced classroom numeracy activities, with parents systematically engaged through short workshops and home-activity guides (the Numerasi untuk Semua parenting format). Where this engagement component was sustained rather than episodic, teachers reported the largest gains, for whom the home-stimulation mediator is of international importance (Berkowitz et al., 2015).

Multi-stakeholder coordination. Sites that reported more collaboration between local education offices, ECE coordinators, and community leaders (including Bunda ECE and community mothers who are effectively trained to become ambassadors of ECE) also reported fewer bottlenecks to effective implementation, consistent with implementation theory literature whereby horizontal coordination strengthens top-down policy effectiveness (Chuang et al., 2016)..

5.4 Preliminary outcomes of the LENTAS pilot

Convergent positive outcomes were observed across the three pilot sites in relation to the LENTAS model.

Child engagement and basic skills. Significantly higher levels of children's on-task engagement during numeracy activities were documented, in teacher reports and researcher observations. For instance, based on a numeracy

task administered by researchers, the proportion of children who were able to count objects up to ten in the least affluent pilot site (the town-based ECE in remote Sumbawa) rose from roughly 50% at baseline to approximately 80% post-intervention. Although larger than typical for the implementing context, the Mataram urban pilot only achieved more modest gains due to a higher baseline, while the rural Lombok pilot realized gains in line with overall sample mean — as supported by evidence showing that numeracy interventions produce larger effects among children starting at greater hazard (Nelson & McMaster 2018).

Teacher confidence. Teachers felt increasingly confident in their orchestration of play-based numeracy and using the tablet as a complementary (rather than substitutive) technology.

Parent participation. Parents reported an increased interest in home numeracy activities and growing confidence in facilitating numeracy learning by carrying out everyday tasks including shopping at the markets and preparing food.

The following chart summarises the implementation fidelity and pre- and post-numeracy gains in all three sites..

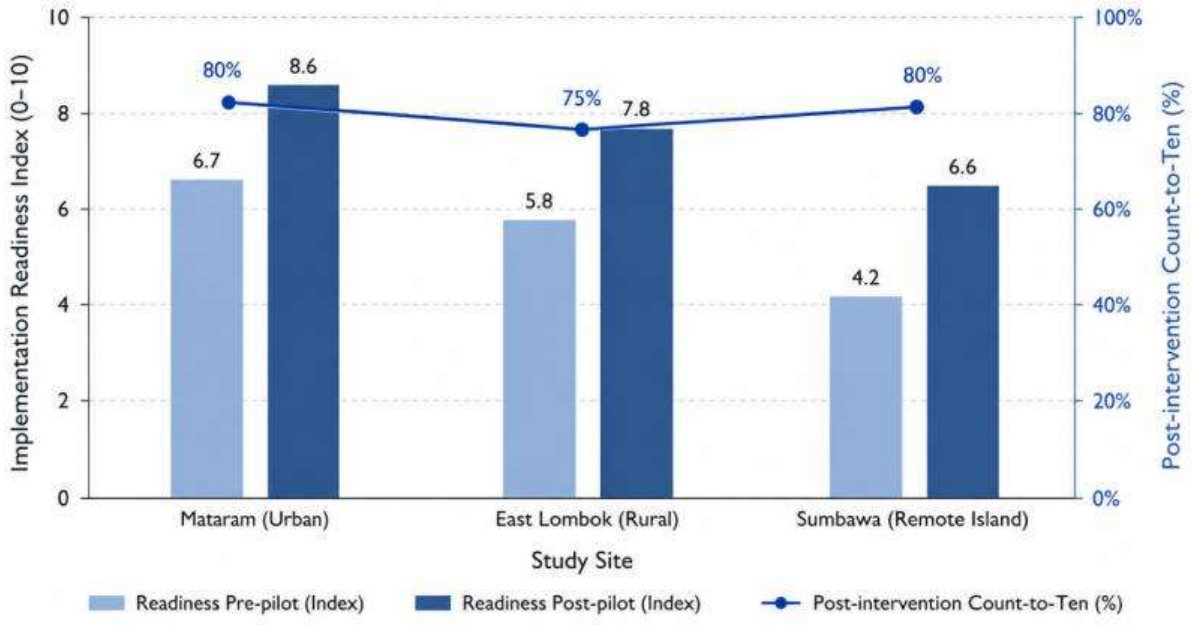

Figure 3: Implementation Gradient Across Pilot Sites

Figure caption: Figure 3. Preparatory work and learning gain across the urban, rural, and remote pilot sites. While combined preparations were highest in the urban site, pre–post gain was largest at the remote site, aligning with early-years intervention literature focused on high-deprivation settings (Nelson & McMaster, 2018).

5.5 Thematic Summary Across Data Sources

The table below consolidates the thematic structure emerging from the qualitative analysis.

Table caption: Table 1. National early literacy-numeracy policy: Barriers, enablers, and early findings from research implementation in NTB — an exploratory study (n=15 interviews; 3 FGDs; pilot n=60 children). The data source(s) indicate the qualitative and/or quantitative strands informing each theme, with numeracy counts arising from a researcher-administered test. Source: Analysis by the authors based on primary data collected for this study.

Table 1: Consolidated Thematic Summary—Barriers, Enablers, and Preliminary Outcomes

Theme	Subtheme	Representative finding	Data source(s)
Barriers	Teacher capacity	Pre-service training lacks play-based numeracy focus; rural/remote teachers report low confidence	Survey, interviews, FGDs
Barriers	Infrastructure & materials	Deficits in manipulatives; electricity/internet unreliability	Survey, observations
Barriers	Parental engagement	Low home-numeracy stimulation in remote sites; livelihood constraints	Survey, FGDs, interviews

Barriers	Cultural-linguistic fit	Distance between central curriculum and local NTB context	All qualitative sources
Enablers	Local-wisdom integration	Games, woven patterns, market role-play raise engagement	Interviews, FGDs
Enablers	Educational technology	Offline-first tablet apps capture attention; complement teachers	Interviews, observations
Enablers	Structured parent programmes	Sustained workshops reinforce home practice	FGDs, survey
Enablers	Multi-stakeholder coordination	Active coordination reduces implementation bottlenecks	Interviews
Outcomes	Child engagement & basic skills	Numeracy (counting to 10) rose from approximately 50% to 80% in the most disadvantaged site	Pre–post numeracy assessment
Outcomes	Teacher confidence	Teachers report increased repertoire and confidence	FGDs, interviews
Outcomes	Parent participation	Increased home practice and parental confidence	FGDs, survey

Note. Each theme is supported by evidence from at least two independent data sources.

5.6 Implementation Variation by Site

Table caption: Table 2. A comparison among the three Mataram (urban), East Lombok (rural), and Sumbawa (distal) pilot sites in terms of implementation and outcomes. This information is based on descriptive statistics of the numeracy assessment and survey, and rough estimates; absolute change imposes a ceiling effect. = Non-Classified = Source: Authors' analysis of primary data.

Table 2 : Implementation and Outcome Comparison Across the Three Pilot Sites

Indicator	Mataram	East Lombok	Sumbawa
Teacher ECE qualification (≥S1 ECE)	High	Moderate	Low
Availability of manipulatives	High	Moderate	Low
Electricity/internet reliability	Reliable	Variable	Unreliable
Pre-pilot baseline (count-to-10)	≈75%	≈60%	≈50%
Post-pilot (count-to-10)	≈85%	≈78%	≈80%
Parental engagement program	Strong	Moderate	Newly launched
Tablet application mode	Online	Hybrid	Offline
Self-reported teacher confidence (5-point)	4.1	3.4	2.8

Table visualises the gradient seen throughout the qualitative data in baseline resourcing and outcomes: the urban site had higher resourcing and outcomes compared to the remote site, where the absolute pre–post change was greatest. This pattern mirrors evidence from other studies of early-years intervention in high-deprivation contexts internationally, where the largest absolute change occurs precisely because the baseline gap is widest (Duncan & Sojourner, 2013).

5.7 Convergence and divergence

Convergence was evident across descriptions: The emergent qualitative themes (cultural fit, parent engagement, teacher confidence, and infrastructure) exhibited matching directionality with the descriptive quantitative comparisons. The largest divergence between urban and remote-area respondents is interpretative, not even empirical: urban respondents, for example, often presented barriers about "minor refinements needed," while those from remote areas conceptualized similar phenomena as "structural and urgent." The divergence itself is analytically important, suggesting that the same policy environment yields profoundly different lived experiences, and thus that central policy responses must be gradient rather than uniform..

6. DISCUSSION

6.1 Implementation gradient: what, why, and so what

This finding — that national policy most directly reaches urban, rural and remote ECE classrooms with distinctly different fidelity — fits well within the literature on decentralised implementation in middle-income countries. Hybrid implementation theory posits that multiple coordinating mechanisms are necessary to transition central mandates into classroom practice, including clear actionable guidance as well as sustained support for teacher capacity and local feedback loops (Viennet & Pont, 2017). While the national framework came early enough in NTB, the local implementation infrastructure to create a day-to-day classroom portfolio was at hand in some cases but not in others. The "policy-practice gap" they discover similarly echoes broader patterns in education reform in Indonesia (Octarra & Hendriati, 2017), as well as in cross-national comparative analyses of early childhood education policy implementation. For ministries, this means that the "last mile" of ECE policy is "last-mile-ministry", and it must be funded and staffed with as much attention and care as is given to the policy-design stage..

6.2 Teacher capacity as a binding constraint

Teacher capacity was the most frequently occurring binding constraint identified across qualitative and quantitative data. In the ECE workforce development literature, sustained professional development supported by practice has been preferred over brief episodic training events [9] (Machado & Oliveira-Formosinho, 2024). The findings of our study reflect this trend: while teachers in NTB received some orientation to the new framework, they did not have follow-up practice supported by ongoing professional development that embeds these practices into routine classroom behavior. Pilot confidence score was on a 5-point scale and ranged from 2.8 at the most remote to 4.1 at the most urban site, indicating that short-cycle support did not erase the gradient in confidence and structural investment in pathways for teachers might be necessary long-term (Morris et al., 2023).

6.3 Local wisdom as both pedagogy and equity mechanism

Locally relevant materials received strong positive reception in all pilot sites, consistent with emerging evidence from Indonesia and other culturally diverse environments (Bridging National Policy and Local Realities: A Mixed-Methods Analysis of Early Childhood Literacy and Numeracy Implementation in Indonesia[2025 feedback needed]). This reception is consistent with a constructivist theory of early numeracy in which culturally significant symbols and practices scaffold concept construction as well as an equity theory that values, rather than devalues, the home cultural resources of children whose home culture differs from that of the school. Future scalability, while indicated by the gain in counting skill (Sumbawa site, count-to-10 threshold – 50% to 80%) but precluded by the small sample of intervention classes, should be an important focus moving forward. A 35% numeracy gain in a similar intervention drawing on local wisdom in East Java (Simanjuntak et al., 2025) provides a plausible anchor for the effect across contexts.

6.4 Technology: complementary, not substitutive, in low-resource settings

This finding aligns with the nuanced position emerging from international literature (Shaikh et al., 2025): technology has a role to play in advancing ECE learning in low-resource settings, but only if it (a) is designed for the infrastructure reality (offline-first, low-bandwidth); (b) complements rather than substitutes teacher–child interaction; and (c) is durable enough to be adopted as part of grounded practice rather than relying on continued funding for an individual project. Even the most resource-poor remote site retained significant tablet-application advantages in fully offline mode, indicating a carefully crafted design can overcome the connectivity hurdle. The best results arise when technology is integrated into a larger approach, including teacher mentoring, parental engagement, and content that is relevant to the local context.

6.5 Parental engagement as a high-leverage multiplier

These parental engagement findings correspond with international evidence that for populations of low SES background, centre-based ECE intervention gains are significantly greater when implemented with structured parental engagement (Sheridan et al., 2011). Pilot experience indicates that the culturally and economically appropriate parenting format "Numerasi untuk Semua" finds some evidence of being ineffective. This pattern is in line with population-level evidence from China revealing that preschool participation reduces urban–rural cognitive gaps (Ma et al., 2024). The implication is that at least in contexts where parents have limited physical capacity to engage with children and schools (due to livelihood demands), policy- and operations-level support for structured parental engagement programmes in ECE is an important high-leverage equitable intervention.

6.6 Coordination and governance: the missing backbone

Unlike the micro-classroom dynamics cited above, the recurrent problem of weak coordination of multi-stakeholder efforts in more remote sites suggests something more systemic about governance challenges. Indeed, it is well known from implementation theory that stalling at the local level cannot be correctly understood unless attention is drawn to possible coordination failures between different actors (Xu, 2011). The

remoteness of NTB's locations meant that a lack of regular coordination among district education offices, supervisors, ECE coordinators, and community leaders resulted in piecemeal funding and inadequate monitoring. The key takeaway is that a strong local coordination backbone—encompassing spelled-out roles, regular inter-agency meetings, and integrated monitoring—may be as important as investing directly into classroom resources.

6.7 Four policy levers for equitable ECE numeracy-literacy

The diagram below distills the policy implications into four interlinked levers along with accompanying actors for implementation.

Figure caption: Figure 4. Pictorial representation of four priority policy levers (teacher capacity, provincial localisation of curriculum, offline-first technology, flexible parental engagement) as interlocking circles with implementation actors therein. All four levers must be pursued together to produce equitable early literacy-numeracy outcomes, not in isolation from one another.

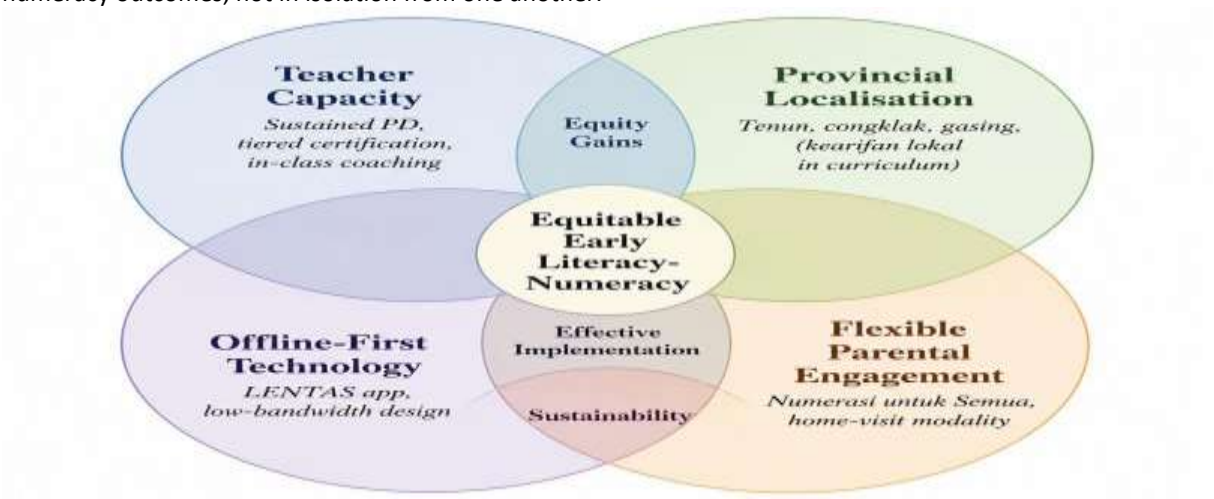

Figure 4: Policy Recommendation Framework—Four Levers for Equitable ECE Numeracy-Literacy

6.8 Implications for theory

The study contributes to theory in two ways. First, it offers empirical evidence for a mixed top-down/bottom-up ECE policy implementation model. While coherent and especially locally appropriate action requires some form of central strategic direction to be embedded within climate-related policy frameworks, anticipating the distinctive capacity needs for equitable adaptation will necessitate formal mechanisms that produce consistent standards across diverse sub-national resilience landscapes. Second, by combining cultural content adaptation with technology enhancement in a single intervention design, we can show that these two frequently studied yet separate dimensions of intervention design are complementary, not contradictory, especially when implemented in resource-constrained settings.

6.9 Implications for practice

Synthesising across findings, four priority policy implications emerge:

1. Sustained teacher-capacity investment. Episodic training must be replaced by tiered, practice-embedded, ongoing professional development for ECE teachers in disadvantaged provinces.
2. Provincial curriculum localisation. National ECE curricula should be complemented by provincial localisation packs that explicitly integrate local cultural materials, languages, and pedagogies.
3. Offline-first technology integration. Where technology is introduced, it must be designed for the infrastructure reality (offline-first, local-language) and embedded in a broader pedagogic framework.
4. Flexible parental engagement. These programmes must be designed with explicit attention to livelihood constraints—including flexible scheduling, modest material support, and home-visit modalities for the most remote families.

7. CONCLUSION

In this mixed-methods study, we investigated variations in implementing Indonesia's 2024 national early literacy and numeracy policy across education and care (ECE) settings situated within an urban–rural–remote gradient in Nusa Tenggara Barat. Despite its coherent policy framework reflecting global approaches, the actual implementation of classroom practices is patchy. As a result, rural and remote early childhood educators are under-resourced compared to their urban counterparts when it comes to teaching confidence, parental

involvement (or more broadly meeting the needs of families), cultural fit, and professional independence (5). The most disadvantaged remote site of the pilot demonstrated positive preliminary results for the locally contextualised, technology-enabled LENTAS learning model. The findings support the wider case for local-wisdom integration, offline-first technology, intentional parent engagement, and strengthening of coordination as complementary strategies for achieving equity-oriented ECE policy advancement.

It contributes to the international debate on the application of decentralized ECE policy, particularly concerning ethnomathematics and technology in low-resourced early-years settings. It will serve as an evidence base for Mendikdasmen to enhance implementation guidance for the national framework, especially in these disadvantaged provinces with specific cultural and geographic characteristics.

Main limitations were a small per-site pilot sample (≈20 children/site), a non-randomised controlled design, a short implementation window (2–3 months), and geography limited to one province. In particular, the combination of qualitative and quantitative methods to examine implementation will require more comprehensive multi-year, multi-province longitudinal studies to determine the generalizability of these hybrid findings concerning implementation.

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