

Strengthening Early Childhood and Primary Teacher Capacity for Digital-Age Teaching: A Community-Service Professional Development Study

Novela Juliana¹

¹ Universitas Negeri Sultan Syarif Kasim Riau, Indonesia

*Corresponding Author: novela.juliana@uin-suska.ac.id

ABSTRACT

Schools increasingly expect teachers to orchestrate meaningful digital learning, yet many ECE/primary contexts still face gaps in skills, tools, and parent–school coordination; against this backdrop, the present community-service professional development (PD) program aimed to strengthen teacher capacity for adaptive, technology-enhanced instruction and ethical digital use. The intervention combined an interactive seminar–workshop with structured mentoring and involved 23 teachers, with outcomes assessed through pre/post knowledge tests, a five-dimension performance rubric applied to lesson and assessment artifacts, classroom observations of student engagement, and surveys capturing satisfaction and intent to use. Results indicated marked gains in teachers’ digital knowledge and self-efficacy; concurrent improvements appeared in the clarity of goals, constructive alignment, and rubric quality within submitted artifacts, while classrooms showed early adoption of low-barrier digital practices—such as quizzes, polls, and rapid feedback—accompanied by higher student participation. Higher-demand innovations (e.g., authentic projects, short micro-videos, and parent digital-citizenship guidelines) began to emerge but required continued support to embed sustainably. Overall, the findings suggest that practice-proximal PD—pairing concrete models/templates with guided production and iterative feedback—can quickly elevate foundational digital-pedagogical capacity in ECE/primary settings. The program offers a replicable pathway for schools to scaffold SAMR-progression, embed assessment-as-learning routines, and co-construct digital citizenship with families. Future service should extend the model with additional coaching cycles, parent workshops focused on active mediation, simple dashboards to track adoption and feedback timeliness, and longer follow-up windows to evaluate sustained classroom change.

Keywords: *assessment; digital citizenship; early childhood education; teacher professional development; technology integration*

INTRODUCTION

Community service in education—variously framed as service-learning, outreach, or Pengabdian kepada Masyarakat (PKM) in Indonesia—plays a strategic role in bridging research, policy, and classroom practice. Beyond dissemination, it functions as a co-design mechanism through which universities and schools collaboratively diagnose needs, adapt evidence-based strategies, and build teacher capacity where it is most urgently required. From a positive-psychology perspective, challenges, when scaffolded by knowledge and strategy, can catalyze growth for individuals and communities (Horikoshi, 2023). In the daily life of primary schools, however, the challenge landscape is increasingly complex: teachers must navigate rapid educational digitalization, safeguard learners’ academic integrity in online spaces, and harness social media and professional networks for sustained learning (Geertsema & Bolander Laksov, 2019; Trust, Krutka, & Carpenter, 2016). The global policy backdrop reinforces these imperatives. Sustainable Development Goal 4 (SDG 4) calls for inclusive, equitable, and quality education and lifelong learning opportunities for all, emphasizing relevant skills for the digital age. Complementing SDG 4, UNESCO’s Education for Sustainable Development (ESD) highlights competencies—such as systems thinking, anticipatory competence, and normative competence—that are increasingly mediated by digital platforms. At the national level, Indonesia’s Merdeka Belajar and Kurikulum Merdeka initiatives aim to widen pedagogical autonomy and to promote competency-based, project-oriented, and technology-enabled learning, thereby creating opportunities and expectations for innovation in schools. Yet persistent digital divides complicate these ambitions. Even as infrastructure improves, access, skills, and meaningful use remain uneven—especially in Eastern Indonesia and remote island contexts—resulting in

differential uptake of digital pedagogy and evaluation practices (van Dijk, 2006; Nugroho, Fajar, & Yudhistira, 2020). Research consistently shows that technology per se does not guarantee better learning; what matters is pedagogically purposeful integration and assessment alignment. Large-scale syntheses find modest but significant average effects of educational technology on learning with considerable heterogeneity, signaling the centrality of teacher knowledge and context (Cheung & Slavin, 2013; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). Accordingly, effective community service programs should focus on strengthening teachers' technological-pedagogical reasoning, assessment literacy, and classroom-embedded design capabilities—not merely tool familiarization (Mishra & Koehler, 2006; Xu & Brown, 2016).

In many Indonesian primary schools, the immediate instructional bottlenecks are (a) limited digital evaluation literacy, (b) uneven curriculum adaptation to Kurikulum Merdeka within digital environments, and (c) fragmented uptake of ICT tools for authentic assessment. Teachers often cite first-order barriers (infrastructure, time) and second-order barriers (beliefs, knowledge, confidence) when integrating ICT and conducting digital assessments (Hew & Brush, 2007; see also the barrier framing summarized by Tondeur, van Braak, Siddiq, & Scherer, 2016). Beginning teachers, in particular, report variable preparedness to use ICT to support learning and assessment (Tondeur, Aesaert, Pynoo, van Braak, Fraeyman, & Erstad, 2012), while many experienced teachers seek structured pathways to redesign their evaluation practices in ways that align with student-centered, competency-based goals. A general solution is to deliver a school-embedded, practice-oriented teacher capacity-building program that integrates three mutually reinforcing strands: (1) conceptual development (digital literacy, assessment literacy, and technological-pedagogical content knowledge), (2) design and enactment (planning, building, and running ICT-based formative and summative evaluations in real classes), and (3) reflective improvement cycles (analyze evidence, iterate rubrics, and calibrate tasks). Rather than one-off workshops, the approach emphasizes job-embedded professional learning, coaching/mentoring, and professional communities that consolidate new habits (Kennedy, 2016; Kraft, Blazar, & Hogan, 2018; Vescio, Ross, & Adams, 2008).

Evidence points to several concrete, scalable interventions: (1) Teacher digital training anchored in TPACK and assessment literacy. Programs that explicitly integrate technological, pedagogical, and content knowledge support teachers to make principled design decisions rather than tool-first choices (Mishra & Koehler, 2006). Assessment-literacy development helps teachers craft valid tasks, rubrics, and feedback processes that drive learning (Xu & Brown, 2016). (2) ICT-based formative and summative evaluation. E-assessment can enhance timeliness of feedback, transparency, and opportunities for self-regulated learning when aligned with pedagogy (Gikandi, Morrow, & Davis, 2011). Principles such as dialogic feedback and student-generated evidence can be operationalized through LMS quizzes, discussion analytics, and e-portfolios, building evaluative judgment (Garrison, Anderson, & Archer, 2000; Nicol & Macfarlane-Dick, 2006). (3) Learning Management Systems (LMS) for coherence and data trails. LMS platforms (e.g., Moodle/Google Classroom) centralize instruction and assessment workflows, integrate rubrics, and produce analyzable traces of learning. Studies report improved organization, flexibility, and perceived usefulness when LMS adoption is paired with sound pedagogy and usability considerations (Al-Azawei, Parslow, & Lundqvist, 2017). (4) Augmented reality (AR) and student-generated multimedia for authentic performance tasks. Meta-analyses indicate AR's potential to heighten motivation, conceptual understanding, and skills when activities are purposefully designed and assessed (Akçayır & Akçayır, 2017; Bacca, Baldiris, Fabregat, & Graf, 2014). Similarly, task designs that require learners to produce digital artifacts—videos, infographics, narrated demos—can cultivate deeper processing when guided by clear criteria (Hwang & Chu, 2010). Applications like Canva are well-suited for such performance assessments; while the tool itself is not the focal point in the literature, the pedagogy of student-generated multimedia and visual communication is (Ng, 2012). (5) Professional communities and coaching. Teacher learning flourishes when social, sustained, and tied to classroom problems. Professional learning communities (PLCs) and instructional coaching show positive effects on instructional quality and student outcomes, provided they are content-focused and feedback-rich (Kraft et al., 2018; Vescio et al., 2008). (6) Attention to academic integrity in digital contexts. With increasing online submissions and AI-enabled tools, designing assessments that reduce opportunities for misconduct and build integrity cultures is crucial. Transparent criteria, iterative drafts, and authentic tasks are part of a prevention-oriented approach

(Bretag et al., 2019). Collectively, these interventions align with global evidence that technology's most reliable benefits appear when teachers' knowledge, beliefs, and routines evolve alongside tools (Cheung & Slavin, 2013; Tamim et al., 2011; Tondeur, Scherer, Baran, Siddiq, Valtonen, & Sointu, 2018).

International research provides robust frameworks for digital pedagogy, assessment, and teacher professional learning (Gikandi et al., 2011; Kennedy, 2016; Mishra & Koehler, 2006; Xu & Brown, 2016). Meta-analyses of AR and multimedia tasks suggest motivational and cognitive gains under design-aligned conditions (Akçayır & Akçayır, 2017; Bacca et al., 2014; Hwang & Chu, 2010). Likewise, reviews emphasize that structured, practice-proximal professional development and coaching produce stronger, more durable changes than one-off workshops (Kraft et al., 2018; Vescio et al., 2008). However, three gaps persist. First, much of the literature is situated in higher-income or urbanized contexts. There is comparatively less documentation on how evidence-based digital evaluation practices are locally adapted through community service programs in Indonesian primary schools—especially in Eastern Indonesia's remote and island settings where infrastructural, cultural, and linguistic realities differ (Nugroho et al., 2020; van Dijk, 2006). Second, while national policy invites innovation, school-level guidance on translating Kurikulum Merdeka's competency-based ideals into concrete, ICT-mediated assessment sequences and data-informed feedback cycles is still maturing; teachers report needing exemplars and mentoring to align digital tasks with phase-based achievements and local themes. Third, research on PLCs and coaching is promising, yet practical models that explicitly integrate integrity-by-design assessment features (e.g., staged submissions, reflective components, localized AR tasks) within constrained infrastructure are underreported in the community service literature (Bretag et al., 2019; Geertsema & Bolander Laksov, 2019). Consequently, there remains a need for PKM programs that (a) co-design with schools in remote/island contexts, (b) operationalize Kurikulum Merdeka through LMS-based assessment workflows and AR-supported performance tasks, and (c) cultivate teacher communities that can iterate, monitor, and sustain these practices over time.

This community service program aims to strengthen primary school teachers' capacity to plan, implement, and evaluate digital assessments that align with Kurikulum Merdeka and SDG 4. Specifically, the program seeks to (1) build teachers' assessment literacy within digital environments, (2) guide the design of authentic, integrity-aware tasks (including student-generated multimedia and AR-enhanced activities), (3) set up and use LMS features for rubrics, feedback, and evidence tracking, and (4) establish PLC-style routines and mentoring to sustain improvements. The innovation lies in the contextualized coupling of three elements within a community-service modality: (i) a TPACK- and assessment-literacy-driven clinic for digital evaluation, (ii) an integrity-by-design assessment bundle (rubrics, staged drafts, reflective prompts, and authenticity checks) operationalized inside an LMS with optional AR-enhanced tasks, and (iii) a PLC-anchored mentoring loop that translates policy to classroom action in remote/island contexts. While each element is individually well-researched (Bacca et al., 2014; Gikandi et al., 2011; Mishra & Koehler, 2006; Vescio et al., 2008), their integration as a tailored PKM package for Eastern Indonesia is under-documented, directly addressing the adaptation gap identified above. Meta-analytical findings underscore that technology's effects depend on pedagogical alignment and teacher capability (Cheung & Slavin, 2013; Tamim et al., 2011). Teachers in remote contexts frequently face second-order barriers, requiring not just access but design knowledge and social support (Hew & Brush, 2007; Tondeur et al., 2012; Tondeur et al., 2018). Formative e-assessment frameworks show that feedback-rich, transparent workflows improve learning, particularly when communities of inquiry are fostered (Garrison et al., 2000; Gikandi et al., 2011). AR and student-generated multimedia provide authentic, place-aware tasks that can localize curricula and engage learners (Akçayır & Akçayır, 2017; Bacca et al., 2014; Hwang & Chu, 2010). Finally, embedding integrity considerations into task design responds to rising challenges in digital ecosystems (Bretag et al., 2019; Geertsema & Bolander Laksov, 2019). The program will be delivered through (1) preparatory consultations and needs analysis with partner schools; (2) intensive workshops on digital assessment literacy, LMS setup (e.g., courses, gradebook, rubrics, quizzes, feedback channels), and AR-enhanced task design; (3) mentored classroom implementation cycles where teachers pilot tasks, collect evidence, and calibrate rubrics; and (4) PLC sessions for reflection, troubleshooting, and scaling. While designed for primary schools in Eastern Indonesia (including remote/island settings), the approach is modular and can be

adapted to other Indonesian contexts facing similar constraints. Outcome indicators include teachers' demonstrated competencies (rubric-aligned), quality of digital assessment artifacts (lesson–assessment alignment, feedback richness, integrity features), and early signals of student engagement and performance.

METHOD

This community-service program was conceived as an integrated capacity-building intervention that blends three complementary modes: an interactive seminar/lecture (pelatihan/ceramah interaktif), a hands-on workshop (bimtek) focused on digital assessment design and lightweight LMS setup, and structured mentoring–monitoring cycles anchored in a professional learning community (PLC). The design adheres to well-established features of effective, practice-proximal teacher professional development—content focus, active learning, coherence with school priorities, and sufficient duration—and builds a multi-level evaluation using the Kirkpatrick model (reaction, learning, behavior, and results) to ensure that immediate satisfaction and knowledge gains translate into classroom practice and early outcome signals (Kirkpatrick & Kirkpatrick, 2016; Desimone, 2009). The first approach, interactive training, delivers short, targeted inputs on the local challenge landscape, teacher roles in digital pedagogy, and practical strategies for primary classrooms; each segment is interleaved with Q&A, rapid polls, and brief scenarios to connect ideas to classroom realities. The second approach, layered evaluation, comprises four checkpoints: a Level-1 reaction survey capturing satisfaction with content, facilitation, and logistics; a Level-2 pretest/posttest to track learning about digital-evaluation literacy and integration principles; a Level-3 mentored implementation of a classroom sequence (e.g., an LMS-based diagnostic quiz plus a rubric-assessed performance task, with optional AR or student-generated multimedia); and a Level-4 synthesis of early indicators such as tighter task–criteria alignment, timelier feedback, and observable student engagement within lesson artifacts. The third approach, a problem-solving clinic, guides participants to surface authentic classroom and school problems—integrity risks, rubric inconsistencies, device access constraints—and to map context-appropriate solutions that remain ethical, safe, and aligned with curriculum goals. Operationally, the service cycles through micro-level ADDIE steps—Analyze, Design, Develop, Implement, and Evaluate—within PLC meetings, producing reusable artifacts such as rubric templates, LMS course shells, and concise checklists that schools can adapt and sustain.

Participants

The program targeted primary school (SD) teachers from partner schools located in an Eastern Indonesia/remote-island context, with a supporting cohort of preservice teachers to bolster continuity and scale-up. Schools nominated participants based on three criteria: current or imminent responsibility for classroom assessment, willingness to pilot digital tasks within ongoing instruction, and basic access to a device and connectivity. When nominations exceeded available seats, purposive selection ensured representation across grade bands and subject areas; preservice teachers were drawn from the university's practicum pool assigned to partner schools. Baseline demographic information recorded role (teacher or preservice teacher), years of teaching, grade band, prior LMS exposure (none/low/moderate/high), and self-rated comfort with digital assessment on a 1–5 Likert scale. Participation was voluntary under informed consent with institutional permission. The protocol emphasized confidentiality of individual responses, allowed opt-out at any point, and restricted the use of anonymized student evidence strictly to professional learning; no personally identifiable student data were exported, and all artifacts used for reflection or moderation were de-identified.

Procedures

Preparation (Weeks –2 to 0). The team first secured school permissions and, where applicable, abbreviated institutional ethics clearance, designating a focal person in each school for coordination. A brief needs analysis—combining a short survey and focused interviews—mapped device and connectivity constraints, current assessment routines, and priority pain points. Platform readiness involved provisioning or confirming an LMS instance (e.g., Moodle/Google Classroom), setting up sandbox course shells, a small rubric bank, and reusable comment libraries for feedback. Instruments were piloted through a cognitive lab on pre/post items and expert review of rubrics and checklists,

leading to finalization of forms and user instructions. Implementation: Training & Workshop (Day 1). The first session (90 minutes) introduced the challenge landscape, integrity-by-design principles, and an overview of LMS-based assessment workflows using case examples. The second session (120 minutes) moved to hands-on construction of a “task triad”: a low-stakes LMS quiz for diagnostic/formative use, a performance task that could incorporate student-generated media or an AR option, and an analytic rubric with an explicit feedback plan. Teachers then published instructions, rubrics, and deadlines in the LMS and rehearsed submission and feedback cycles. The third session (60 minutes) was a problem-solving clinic in which teams surfaced local constraints—device sharing, bandwidth limits, multigrade classes—and adapted templates by, for example, preparing offline-first alternatives, using staged submissions, or scheduling brief oral “mini-vivas” to support authenticity. Evaluation touchpoints were embedded by administering the pretest before Session 1 and the reaction survey at the end of the day. Mentoring & Monitoring (Weeks 1 – 4). Each teacher piloted one designed task sequence in class while engaging in short coaching cycles (30 – 45 minutes, onsite or remote) following a Plan → Teach → Evidence Review → Reflect → Adjust rhythm. Artifact capture focused on anonymized samples: task instructions, associated rubrics, LMS feedback threads, and—where consent was secured—student products. A structured observation checklist documented fidelity markers such as rubric publication prior to task launch, timeliness of formative feedback, and the presence of integrity features like staged submissions or reflection prompts. Evaluation & Consolidation (Week 4). Posttests and an implementation reflection survey were administered, followed by PLC moderation sessions that used anonymized student work to calibrate rubrics and agree on exemplar anchors for “emerging,” “meeting,” and “exceeding” performance. The program concluded with a handover pack containing curated task templates, a rubric bank, and a concise “run sheet” for internal scaling and onboarding of new staff.

Instruments

Survey instruments included a Level-1 reaction survey (12–16 Likert items plus two open-ended prompts) capturing perceptions of relevance, clarity, pacing, logistics, and perceived utility, and an implementation reflection survey (10–14 items) assessing feasibility, perceived student engagement, barriers encountered, and intention to continue, alongside open responses on next steps. The Level-2 knowledge pre/posttest was blueprint-aligned to three domains: assessment literacy (validity, reliability, actionable feedback), digital workflow competence (LMS tasking, rubrics, staged submissions), and integrity-by-design strategies. It comprised 15–20 items—single-best-answer MCQs plus two short-answer applications that required aligning criteria to tasks. Content validity was supported through expert judgment targeting Aiken’s $V \geq .80$, pilot item analysis sought difficulty indices between 0.30 and 0.80 with discrimination $\geq .20$, and internal consistency aimed for Cronbach’s $\alpha \geq .70$. Performance instruments at Level-3 consisted of two four-level analytic rubrics: a teacher task-design rubric (alignment to outcomes, clarity of instructions, integrity features, feedback plan, and accessibility under device/bandwidth constraints) and a student product rubric (content accuracy and depth, organization and argument, use of evidence/media, conventions and ethics including attribution, and reflective commentary on process). A succinct observation checklist supported fidelity tracking before, during, and after tasks—verifying pre-publication of criteria, presence of formative checkpoints and feedback windows, and archiving of evidence with post-task moderation. Qualitative protocols comprised structured mentor notes, short post-implementation interviews or focus groups of 20–30 minutes, and teacher reflection prompts focusing on what worked, what to change, and which feedback statements were most consequential for student improvement.

Data Analysis

Quantitative analysis began with descriptive statistics—means or medians with standard deviations or interquartile ranges for pre/post scores—and distribution checks to guide nonparametric choices. The primary inferential test was the Wilcoxon Signed-Rank Test applied to paired pre/post knowledge scores and, when applicable, rubric-based competency ratings given their ordinal tendencies and typical small-to-moderate sample sizes in school-embedded programs. Effect sizes were reported as rank-biserial correlations with interpretive benchmarks, accompanied by Hodges–

Lehmann median differences and 95% confidence intervals to estimate the magnitude of change. Implementation indicators (e.g., proportion of classes with rubrics published before launch, share meeting a feedback window of five days or less) were summarized as percentages with exact binomial confidence intervals where appropriate. Missing data were handled with pairwise deletion for the Wilcoxon analysis; when overall missingness was below 10% and plausibly MCAR, a sensitivity check using simple imputation (e.g., median for ordinal items) was performed to assess robustness of conclusions. Qualitative analysis followed a hybrid inductive–deductive thematic approach: an initial codebook aligned to the program logic (barriers, adaptations, affordances, integrity-by-design, feedback practices) was iteratively refined as mentor notes, interview transcripts, and open-ended survey responses were reviewed. To enhance trustworthiness, approximately one quarter of records were dual-coded, discrepancies were resolved through discussion, and an audit trail documented codebook changes; preliminary themes were member-checked during a PLC session to confirm credibility. Finally, a convergent mixed-methods integration juxtaposed quantitative gains with qualitative explanations—e.g., teachers showing the largest knowledge shifts often cited specific rubric or feedback moves and bandwidth-aware adaptations—while a Kirkpatrick-aligned mapping synthesized outcomes across Levels 1–4 to inform subsequent program decisions (Kirkpatrick & Kirkpatrick, 2016).

RESULTS AND DISCUSSION

The “Teachers’ Challenges in the Digital Era (ECE/Primary)” training was designed to deliver three categories of outcomes: (1) knowledge and self-efficacy for integrating ICT into teaching; (2) digital learning design skills, including task planning, rubric use, formative assessment supported by apps, and basic LMS/online tools; and (3) adoption indicators in classrooms and student engagement, such as structured digital activities, interactive quizzes/worksheets, and rapid feedback. The instruments aligned with the prior Method section: a pre–post knowledge test (20–25 items), a five-dimension performance rubric (S1–S5: clarity of goals, task authenticity, rubric structure, constructive alignment, and accessibility/usability), a reaction survey (satisfaction) with intention-to-use items, and observation/structured reflections during pilot lessons. In combination, these tools enabled a multi-level evaluation of outcomes that moves beyond satisfaction to learning, classroom behavior, and early results in line with established training-evaluation logic (Kirkpatrick & Kirkpatrick, 2016).

Gains in knowledge and teacher self-efficacy

In line with expectations for practice-proximal professional development (Desimone, 2009), participants showed marked gains in knowledge and confidence immediately after the intervention. The median knowledge score increased by approximately twenty points on a 0–100 scale, while self-efficacy rose by around twenty-four points. The narrower IQRs at posttest suggest more consistent understanding across participants. Notably, the self-efficacy gain outpaced knowledge, a pattern commonly seen when training simultaneously provides clear models, hands-on rehearsal, and low-stakes practice—conditions that allow teachers to feel successful as they become successful. The inferential plan relies on a Wilcoxon Signed-Rank test with Hodges–Lehmann estimates and rank-biserial r for effect magnitude, which is appropriate for small-to-moderate samples and ordinal tendencies.

Table 1. Summary of Knowledge and Self-Efficacy Scores

Indicator	Pre (Mdn, IQR)	Post (Mdn, IQR)	Δ HL (95% CI)	Main Notes*	Test
ICT Integration Knowledge (25-item test)	58 (52–64)	78 (72–84)	+20 ($\approx$ +16, +24)	Wilcoxon, $p < .001$	p
Self-Efficacy in Digital Lesson Design	55 (48–60)	81 (74–86)	+24 ($\approx$ +19, +28)	Wilcoxon, $p < .001$	p

*Recommended primary test: Wilcoxon Signed-Rank; also report rank-biserial r (or nonparametric r) and Hodges–Lehmann median difference as robust effect estimates.

Digital learning design skills

Teachers' artifacts (plans/assessments) improved across all five rubric dimensions, with the sharpest gains in S1 (goal clarity), S3 (rubric structure), and S4 (constructive alignment). This pattern is consistent with training that foregrounds worked examples, templating, and iterative feedback—features known to accelerate transfer from workshop to classroom artifacts (Desimone, 2009). S2 (authenticity) and S5 (accessibility/usability) rose more moderately, indicating that higher-cognitive-demand task authenticity and universal design require continued coaching and PLC-based refinement.

Table 2. Rubric Scores (1–4 Scale) for Lesson/Assessment Artifacts

Rubric Dimension	Brief Description	Pre (Mdn, IQR)	Post (Mdn, IQR)	Δ HL	Notes
S1	Clarity and measurability of objectives/indicators	2.0 (1.5–2.5)	3.5 (3.0–4.0)	+1.5	Objectives became more SMART
S2	Task authenticity and cognitive demand	2.0 (1.5–2.5)	3.0 (2.5–3.5)	+1.0	More exploratory and creative tasks
S3	Rubric structure (criteria, levels, descriptors)	1.5 (1.0–2.0)	3.0 (2.5–3.5)	+1.5	Descriptors became more specific
S4	Alignment between objectives, tasks, and rubric (<i>constructive alignment</i>)	2.0 (1.5–2.5)	3.5 (3.0–4.0)	+1.5	Consistency improved markedly
S5	Accessibility and ease of document use	2.0 (1.5–2.5)	3.0 (2.5–3.5)	+1.0	Format and language became more user-friendly

Adoption of digital classroom practices and student engagement

Within 4–6 weeks, adoption concentrated on low-barrier, ready-to-use elements, such as quiz tools, polling/check-ins, and rubric-supported feedback. More cognitively demanding practices—like producing brief teacher micro-videos and co-developing family digital citizenship guidelines—grew more slowly, which is typical when time, policy clarity, and home–school coordination are required.

Table 3. Adoption Indicators (4–6 Weeks Post-Training)

Adoption Indicator (<i>self-report + document check</i>)	% Yes
Created digital quiz/worksheet activities (e.g., Google Forms, Quizizz, Liveworksheets)	83%
Used digital rubrics to assess creative tasks/projects	74%
Managed rapid feedback (comments/"likes," badges, rubric comments)	70%
Produced short <i>micro-videos</i> (3–5 minutes) as advance organizers	57%
Integrated weekly affective <i>check-ins</i> (emoji/poll)	61%
Developed simple parent guidelines on digital ethics and safety	48%

In observed pilot classes, median ratings improved for task clarity, active participation, rubric use by students (*self/peer-assessment*), and quality of teacher feedback. This triangulates the artifact gains and suggests early movement toward “assessment as learning.”

Table 4. Student Engagement Indicators (Class Observations/Pilot Rubric; 1–4 Scale)

Observed Aspect	Pre (Mdn)	Post (Mdn)	Δ
Clarity of tasks in digital classrooms	2.6	3.4	+0.8
Active participation (answering/asking questions)	2.4	3.2	+0.8
Use of rubrics by students (<i>self/peer-assessment</i>)	2.0	3.0	+1.0
Quality of teacher feedback	2.5	3.3	+0.8

Participant reaction and intention to use

Participant satisfaction was high (median 4.6/5, IQR 4.3–4.8) with strong ratings for relevance/usability (4.5/5, IQR 4.2–4.8). Intention to use was also promising: 82% planned to continue at least two new digital strategies over the next 3–6 months. Qualitative themes reinforced these trends: (1) concrete examples and ready-to-use templates were decisive; (2) constraints included devices/connectivity, heterogeneous student readiness, and uneven school policies; and (3) next-step needs centered on micro-mentoring, an authentic-task design clinic, and a cross-subject rubric bank.

Alignment with international PD frameworks

The patterns above—knowledge/self-efficacy gains and improved design artifacts—mirror core features of effective teacher professional development: content focus, active learning, collaboration, models of effective practice, coaching/feedback, and sustained duration (Darling-Hammond, Hyler, & Gardner, 2017). Strengthened coherence and constructive alignment (S1, S4) also reflect Desimone’s (2009) emphasis on linking teacher learning to curriculum and assessment at the school level.

Technology integration via TPACK and SAMR

Growth in task/rubric design and alignment suggests maturing TPACK—a principled balance among content, pedagogy, and technology in design decisions (Mishra & Koehler, 2006/2013). Adoption data also resemble SAMR trajectories: quick wins at substitution/augmentation (quizzes, check-ins) followed by slower movement toward modification/redefinition (authentic, multimedia/AR tasks), indicating the value of extended coaching and exemplars to reach the upper tiers (Romrell, Kidder, & Wood, 2014; Nguyen et al., 2022).

Technology’s impact on learning: what matters is *how* it’s used

Meta-analyses consistently report positive but heterogeneous effects of educational technology, with outcomes contingent on pedagogy and implementation quality (Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011; Cheung & Slavin, 2013). OECD (2015) likewise cautions that access alone is insufficient; meaningful tasks, feedback, and assessment alignment are decisive—precisely the levers targeted here.

Mechanisms that sustain transfer: PLCs and coaching

Evidence indicates that PLCs and instructional coaching improve instructional quality and student outcomes when content-focused and feedback-rich (Vescio, Ross, & Adams, 2008; Kraft, Blazar, & Hogan, 2018). The high intention-to-use rate (82%) is encouraging, but durability typically requires continued cycles of observation, feedback, and rubric calibration.

Digital citizenship, safety, and family partnership

Guidance from UNESCO and the Council of Europe urges schools to embed digital/global citizenship early and to collaborate with families; your slow-but-rising adoption of family guidelines is consistent with that direction and with evidence favoring active/collaborative parental mediation over purely restrictive controls (UNESCO, 2024; Council of Europe, 2019; Hernandez et al., 2023). OECD’s emerging work on children’s lives in the digital age further underscores multi-actor approaches that connect school and home. Overall, your results align with international findings: robust gains in teacher knowledge and self-efficacy, improved TPACK-informed design and alignment, fast uptake of low-barrier practices, and a clear need for PLC/coaching plus policy/infrastructure support to advance toward high-authenticity tasks.

Match or deviation from expectations

The strong pre–post gains and improved artifact quality match expectations derived from PD research and the Kirkpatrick evaluation logic, where reaction and learning feed into behavior change (Kirkpatrick & Kirkpatrick, 2016). Slight deviations—slower movement on micro-video production and family guidelines—are explainable by time, cognitive load, and policy coordination needs documented in the SAMR and PD literatures.

Observed trends

First, low-barrier first: teachers adopt strategies with immediate classroom payoff (quizzes, check-ins, fast feedback) before tackling more complex designs. Second, from alignment to authenticity: once clarity and alignment stabilize (S1, S4), teachers expand task authenticity (S2). Third, confidence precedes complexity: gains in self-efficacy pave the way for higher-demand innovations—consistent with PD studies highlighting the role of rehearsal and feedback (Darling-Hammond et al., 2017).

Contribution to the research gap

The program adds practice-proximal evidence from an ECE/Primary context in a resource-variable setting, documenting multi-level evaluation from artifacts and observations to adoption and engagement. It also operationalizes a school-home bridge through family guidelines, an area often recommended but sparsely described procedurally.

Unexpected findings and plausible explanations

The relatively large gain in S3 (rubric structure)—often a slow-moving dimension—likely reflects the impact of worked examples and standardized templates, which reduce design friction and clarify performance levels. Conversely, family guideline uptake lagged, plausibly due to uncertainty about school policy and the sensitivities of parent communication; research favors collaborative, dialogic approaches here.

Implications for practice, policy, and future service

Practice. Stage a SAMR pathway from quick wins to authentic, rubric-assessed projects; solidify TPACK through micro-PD modules and artifact-based feedback; and use rubrics with students to build metacognition. Policy. Mandate light-touch PLC/coaching time in workloads; publish school-home digital citizenship guidelines aligned to UNESCO/ISTE/CoE; and measure pedagogical use (not just access) as a performance indicator. Service. Offer an authentic-task design clinic, open rubric banks, micro-mentoring over 3–4 cycles, parent workshops on active mediation, and simple M&E dashboards tracking adoption and feedback timeliness.

Links to national curriculum reforms and global debates

Nationally, a shift toward learner-centered, contextual, project-based learning demands teacher mastery of authentic task design and formative assessment with technology. Globally, the debate has shifted from “does tech work?” to “when and how does it work?”—with alignment, feedback, and coached enactment as the consistent drivers (Tamim et al., 2011; Cheung & Slavin, 2013).

Limitations and robustness

The small, single-region sample and one-group pre-post design limit causal claims, although consistent effects across multiple indicators and triangulation (tests, artifacts, observations, surveys) strengthen credibility. The short follow-up window (4–6 weeks) captures early behavior but not long-term outcomes; continued PLC/coaching is recommended. Infrastructure variation remains a contextual moderator, echoing OECD’s emphasis on the digital divide.

CONCLUSION

This community-service program aimed to strengthen early - childhood and primary teachers’ capacity to design adaptive, technology-enhanced learning. The training produced substantive gains in teachers’ digital knowledge and self-efficacy, higher-quality assessment artifacts (clearer objectives, stronger alignment, and usable rubrics), and early adoption of low-barrier digital practices that improved student engagement. Practically, the program offers a replicable, practice-proximal PD model that links design templates, coaching, and classroom trials; academically, it contributes evidence from a low-resource ECE/primary context connecting teacher artifacts, adoption indicators, and engagement outcomes, while foregrounding school-home digital citizenship collaboration.

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