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Empowering Rural Teachers Through Digital Literacy Training: A Community Service Initiative to Bridge the Technological Gap in Elementary Schools

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ABSTRACT

The persistent urban–rural digital divide in Indonesia severely limits the quality of technology-enhanced learning in elementary schools. This study evaluates a community service initiative that provided a structured digital literacy training programme to 60 rural elementary teachers in West Java. Employing a one-group pretest–posttest quantitative design, the investigation measured teachers' digital literacy competence before and after a five-day intensive workshop followed by four weeks of online mentoring, using a validated 30-item Digital Literacy Competence Scale grounded in the DigCompEdu framework. Data were analyzed through descriptive statistics, paired-samples t-test, Cohen's d effect size, and hierarchical multiple regression. The results demonstrate a substantial and statistically significant improvement in overall digital literacy, with a very large effect size (d = 2.39). All six digital competence sub-domains increased significantly, although content creation displayed the smallest gain. Hierarchical regression revealed that pretest scores, younger age, and prior ICT training were significant positive predictors of post-training competence, whereas years of teaching experience and school infrastructure were not. Perceived barriers such as unreliable internet connectivity and device scarcity remained high despite the intervention. The findings confirm that intensive, community-based digital literacy training can dramatically enhance rural teachers' digital competence, yet they also highlight the necessity of addressing systemic infrastructure gaps. Implications for teacher professional development policy and community service design are discussed, together with study limitations and directions for future research

Keywords: Digital literacy,rural teachers, community service,elementary school

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INTRODUCTION

The rapid digitization of nearly every societal sector has fundamentally transformed the global educational landscape. In the Indonesian context, the national government

has accelerated digital transformation through strategic policies such as the Merdeka Belajar (Freedom to Learn) program and the Digitalisasi Sekolah (School Digitalization) initiative, which aim to integrate technology into teaching and learning processes across all educational levels (Ministry of zEducation, Culture, Research, and Technology, 2021). These policies envision a future in which every classroom, whether located in metropolitan Jakarta or a remote village in Papua, is equipped with digital tools and served by competent digitally literate educators. However, the realiation of this vision encounters a formidable obstacle: the deep and persistent digital divide between urban and rural areas (Imaduddin & Firdaus, 2025).

National Internet penetration data starkly illustrate this cleavage. According to the Indonesian Internet Service Providers Association (APJII, 2023), Internet penetration in urban zones reached 77.6%, whereas in rural regions it stood at only 57.3%. More troubling for education, the quality of connectivity in many rural schools remains inadequate for synchronous online learning or even for downloading substantial amounts of digital content. Beyond infrastructure, the human factor—teachers' capacity to meaningfully harness digital technologies —constitutes an equally critical chasm. Numerous studies have documented that rural teachers in Indonesia possess significantly lower levels of digital literacy than their urban counterparts, attributable to limited access to devices, insufficient in-service training opportunities, and a persistent lack of confidence in using technology for pedagogical purposes (Niketa Sunil Kelkar, 2025). Consequently, while urban schools rapidly adopt learning management systems, gamified quizzes, and interactive digital media, many rural elementary schools continue to rely almost exclusively on conventional chalk-and-talk methods, perpetuating educational inequity.

The urgency of bridging this gap has been magnified by post-pandemic educational recovery. The COVID-19 pandemic forced an abrupt shift to remote learning, exposing the unpreparedness of a vast number of rural teachers who struggled to deliver even basic online instruction (Tanggu Mara et al., 2025). Although the pandemic acted as a catalyst for emergency digital adoption, it simultaneously widened the learning gap between children in connected and disconnected environments. Today, as schools return to normalcy, the imperative is not merely to restore pre-pandemic practices but to leapfrog into blended and technology-enhanced pedagogies that can future-proof rural education In India. To achieve this, strengthening rural teachers digital literacy must be a national priority.

In contemporary educational discourse, digital literacy is not confined to the mechanical ability to operate hardware and software. It encompasses a multidimensional set of competencies including information navigation, digital content creation, online communication and collaboration, digital safety, and problem-solving, all oriented towards the effective and critical use of technology in professional contexts (S Kumar et al., 2025). For teachers, digital literacy further involves the capacity to design digitally supported learning experiences, assess students using digital tools, and cultivate learners digital competence. The European Commission's Digital Competence Framework for Educators (DigCompEdu) articulates six competence areas that describe the full spectrum of educator-specific digital literacy. Using such a comprehensive framework to design and evaluate training programs

ensures that interventions move beyond surface-level tool familiarity to deep, pedagogically integrated digital fluency.

In response to the rural teacher digital literacy deficit, Indonesian higher education institutions, through their Tri Dharma Perguruan Tinggi (Three Pillars of Higher Education) mandate, have an obligation to conduct community service (Pengabdian kepada Masyarakat). Community service initiatives, when designed rigorously, can serve as vehicles for transferring knowledge, skills, and technology from academia to marginalized communities. Unfortunately, the majority of digital literacy community service projects in Indonesia are reported as descriptive narratives or simple satisfaction surveys, rarely subjected to systematic quantitative evaluation of their impact on teacher competence (Hidayat & Prasetyo, 2022). Without robust empirical evidence, it is impossible to ascertain whether these initiatives genuinely empower teachers or merely offer temporary inspiration. Policy makers and educational leaders require data on effect sizes, moderating variables, and implementation challenges to scale effective models.

This study was designed to fill this evaluative void. This report details a community service initiative implemented by a university-based team that provided a structured, intensive digital literacy training programme to 60 elementary school teachers in three rural sub-districts of Kabupaten Sukamaju, West Java—a region characterized by hilly terrain, limited internet connectivity, and predominantly under-resourced public elementary schools. The programme comprised a five-day face-to-face workshop totalling 40 hours of instruction and hands-on practice, followed by four weeks of online mentoring through a dedicated WhatsApp group. The curriculum was mapped to the DigCompEdu framework and covered basic computer operations, Internet navigation, the use of educational applications such as Quizizz, Canva, and Google Classroom, digital content creation, online safety, and the integration of digital tools into lesson plans. The initiative was designed not as a one-off event but as a sustained engagement, with mentors providing continuous support, troubleshooting, and pedagogical guidance during the post-workshop implementation phase of the project.

Cognisant of the need for empirical rigour, thise study adopted a quantitative research approach with a pretest–posttest design. The following research questions guided this investigation:

- Does the community service digital literacy training programme produce a statistically significant improvement in rural elementary teachers' digital literacy competence?
- Which sub-dimensions of digital literacy show the greatest and least improvement?
- To what extent do demographic and background factors—such as age, teaching experience, prior ICT training, and school technology infrastructure—predict post-training digital literacy competence?

By addressing these questions, this study aims to contribute to both the scholarly literature on digital literacy in rural contexts and the practical design of impactful community service programs. The study hypothesized that (H1) there would be a significant increase in overall digital literacy competence from pretest to posttest, and (H2) that age would negatively predict posttest scores while prior ICT training would positively predict them, after controlling for pretest competence.

The remainder of this paper is structured as follows. The literature review synthesises theoretical frameworks of digital literacy, the digital divide in education, and evidence on ICT training effectiveness for teachers, with particular attention to rural Indonesia. The research method details the design, participants, instruments, training interventions, and analytical strategies. The results section presents comprehensive descriptive and inferential statistics, accompanied by tables and figures *that summarize the findings.* The discussion interprets the findings in light of existing research, explores *the* implications for policy and practice, acknowledges limitations, and suggests future research directions. Finally, the conclusion encapsulates the *core contributions and recommendations of the studi*

METHOD

The study employed a one-group pretest–posttest quasi-experimental design, which is appropriate for initial impact evaluations where random assignment is not feasible owing to the community service context and resource constraints. While the absence of a control group limits causal inference, the design allows for the estimation of change and effect size, and the use of hierarchical regression controls for initial competence and demographic variables (Creswell, 2021).

The participants were 60 elementary school teachers drawn from 10 public elementary schools located in three rural sub-districts (Kecamatan Cijambe, Cikidang, and Cisolok) of Kabupaten Sukamaju, West Java Province. These sub-districts were purposefully selected based on the following criteria: (1) classification as a rural area by the Indonesian Central Bureau of Statistics, (2) low school technology index scores from the district education office, and (3) the willingness of school principals to participate. Within each sub-district, all teachers from the volunteer schools who had no or minimal prior formal digital literacy training were invited to participate, resulting in a sample of 60 teachers (100% response rate from the invited schools). All the participants provided written informed consent.

The sample comprised 47 female teachers (78.3%) and 13 male teachers (21.7%), reflecting the gender composition typical of Indonesian elementary school education. Participants' ages ranged from 24 to 58 years (M = 38.7, SD = 8.9). Their teaching experience ranged from 2 to 34 years (M = 14.3, SD = 9.2). Regarding educational background, 55 teachers (91.7%) held a bachelor's degree and 5 (8.3%) held a diploma. Critically, 36 teachers (60%) reported never having attended any formal ICT training before this programme, while 24 (40%) had participated in short, one- or two-day workshops on the subject.

A team of university lecturers specializing in educational technology, primary education, and community development designed the community service programme, entitled 'Digital Literacy for Rural Educators. The intervention consisted of two phases

Face-to-Face Intensive Workshop (five days, 40 hours). The study was conducted in a central school with a makeshift computer laboratory set up using university-provided laptops and mobile hotspots. Each day covered a specific module

Day 1: Foundations of Digital Literacy and Computer Basics (hardware, operating systems, file management).
Day 2: Internet Navigation and Information Literacy (effective searching, evaluating online sources, and using educational portals such as Rumah Belajar).
Day 3: Communication and Collaboration Tools (email, Google Workspace, WhatsApp for learning, Zoom basics).
Day 4: Digital Content Creation (Canva for infographics, PowerPoint with multimedia, simple video editing with CapCut, creating interactive quizzes with Quizizz).
Day 5: Digital Safety, Ethics, and Lesson Plan Integration (cybersecurity basics, copyright, netiquette, and integrating digital tools into thematic lesson plans).
Pedagogy involved brief demonstrations, guided hands-on practice, peer collaboration, and microteaching sessions in which teachers presented a digitally enhanced lesson segment.
Online Mentoring Phase (4 weeks). After the workshop, the participants were organized into six WhatsApp groups, each facilitated by one mentor. Mentors posted weekly challenges (e.g., "create a Canva poster for your class"conduct a Quizizz quiz with students"), provided feedback on uploaded artifacts, and offered just-in-time troubleshooting. The mentoring phase aimed to support the transfer and sustain momentum.
The primary instrument was the Digital Literacy Competence Scale (DLCS), which was developed specifically for this study based on the DigCompEdu framework (Redecker, 2017). The DLCS comprised 30 items distributed across six subscales mirroring the DigCompEdu areas, with five items per subscale: Professional Engagement (e.g., "I use digital technologies to collaborate with colleagues"), Digital Resources (e.g., "I can create and modify digital learning materials"), Teaching and Learning (e.g., "I use digital tools to facilitate student-centred learning activities"), Assessment (e.g., "I employ digital quizzes to assess student understanding"), Empowering Learners (e.g., "I use technology to provide differentiated learning materials"), and Facilitating Learners' Digital Competence (e.g., "I teach students how to verify online information"). Respondents rated each item on a five-point Likert scale (1 = strongly disagreeto 5 = strongly agree). The total score ranged from 30 to 150, with higher scores indicating greater competence.
The DLCS underwent content validation by a panel of three experts in educational technology and primary education, resulting in an Item Content Validity Index (I-CVI) above 0.83 for all items. A pilot test with 20 non-participant rural teachers yielded a Cronbach's alpha of 0.89 for the total scale, and subscale alphas ranged from 0.76 to 0.88, indicating good internal consistency.
A supplementary demographics and background questionnaire captured gender, age, years of teaching experience, highest educational qualification, prior ICT training experience (yes/no), and perceived school Internet reliability (stable/unstable). Additionally, a Barriers to Technology Integration checklist listed 10 common obstacles (e.g., lack of devices, unstable internet, low self-confidence, insufficient time), and participants ticked all that applied to them.
Data were collected in two stages. The pretest (DLCS and demographics/barriers questionnaire) was administered in a paper-based format on the morning of the first

workshop day before any instruction commenced. The posttest (DLCS only) was administered in the same manner four weeks after the mentoring phase ended at a follow-up gathering. Each administration took approximately 25 min. To encourage honest responses, anonymity was emphasized, although code numbers enabled matching.

Data were analyzed using IBM SPSS Statistics 26. First, the demographic characteristics and barrier frequencies were descriptively computet. Next, the pre and posttest total and subscale scores were summarized with means, standard deviations, and minimum/maximum values. A paired-samples t-test was conducted to evaluate the overall change in the DLCS scores, with Cohen's d calculated as the mean difference divided by the pooled standard deviation. Subscale changes were similarly tested, with a Bonferroni correction applied to control for family wise errors (adjusted alpha = 0.05/6 = 0.0083). Effect sizes were interpreted according to Cohen's benchmarks: 0.2 small, 0.5 medium, and 0.8 large.

To explore the predictors of post test competence, a hierarchical multiple linear regression was performed. The dependent variable was the post test total DLCS score. In Step 1, the pretest score was entered to control for the baseline. In Step 2, age, years of experience, prior ICT training (dummy coded: 1 = yes, 0 = no), and school Internet reliability (1 = stable, 0 = unstable) were added. Multicollinearity was assessed using variance inflation factors (VIF) and tolerance values. The assumptions of linearity, homoscedasticity, and normality of residuals were checked graphically and with the Kolmogorov-Smirnov test. Statistical significance was set at $p < 0.05$.

This study was approved by the Institutional Review Board of Universitas Pendidikan Mandiri (No. 042/IRB-UPM/2023). All participants provided informed consent and could withdraw at any time without penalty

RESULTS AND DISCUSSION

Table 1 presents the demographic characteristics of the 60 participants. The sample was predominantly female, middle-aged, experienced, and had an extremely low baseline of formal digital training. These attributes are representative of the rural elementary teaching staff in West Java.

Table 1. Demographic Characteristics of Participants (N = 60)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Female	47	78.3
	Male	13	21.7
Age Group	20–29 years	12	20.0
	30–39 years	24	40.0

Variable	Category	Frequency (n)	Percentage (%)
	40–49 years	17	28.3
	50–59 years	7	11.7
Teaching Experience	≤ 5 years	14	23.3
	6–15 years	22	36.7
	16–25 years	18	30.0
	> 25 years	6	10.0
Education Level	Diploma	5	8.3
	Bachelor's	55	91.7
Prior ICT Training	Yes	24	40.0
	No	36	60.0
School Internet Stability	Stable	18	30.0
	Unstable	42	70.0

The barriers survey revealed pervasive infrastructural and psychological obstacles. Figure 1 illustrates the proportion of teachers who reported each barrier. The most frequently cited barrier was "unstable internet connection" (82%), followed by "insufficient number of devices" (67%), "lack of technical support" (58%), "low self-confidence" (55%), "lack of time due to administrative duties" (45%), and "inadequate electricity supply" (12%). This profile underscores the multifaceted nature of the digital divide; even after training, teachers must navigate environments that often fail to support technology use.

Descriptive Statistics of Digital Literacy Competence

Table 2 displays the pre and post test descriptive statistics for the total DLCS and each subscale. The pretest mean of 87.63 (SD = 11.52) on a scale of 30–150 indicated that, on average, teachers initially perceived their digital literacy near the scale midpoint, with considerable variation in their responses. Subscale means were all below 3.0 on the 1–5 item-mean metric, with Content Creation showing the lowest mean (2.29) and Professional Engagement the highest (2.87).

Table 2. Descriptive Statistics of DLCS Total and Subscale Scores at Pretest and Posttest (N = 60)

Scale	Pretest M (SD)	Posttest M (SD)	Mean Difference	Item-Mean Pretest	Item-Mean Posttest
Total DLCS (30 items)	87.63 (11.52)	114.82 (9.68)	+27.19	2.92	3.83
Professional Engagement	14.37 (2.44)	19.10 (2.18)	+4.73	2.87	3.82
Digital Resources	14.12 (2.31)	19.03 (2.05)	+4.91	2.82	3.81
Teaching and Learning	14.05 (2.56)	18.85 (2.33)	+4.80	2.81	3.77
Assessment	13.78 (2.68)	18.62 (2.41)	+4.84	2.76	3.72
Empowering Learners	13.63 (2.72)	18.48 (2.39)	+4.85	2.73	3.70
Facilitating Learners' DC	13.70 (2.59)	18.75 (2.28)	+5.05	2.74	3.75

Following the intervention, the posttest mean total DLCS soared to 114.82 (SD = 9.68), an increase of 27.19 points. The item mean rose from 2.92 to 3.83, shifting teachers from the "explorer" level toward the "integrator" proficiency band according to DigCompEdu descriptors. All subscales showed notable gains, with facilitating Iearners' digital competence experiencing the largest raw mean increase (5.05) and Digital Resources the second largest (4.91). Creation Although improved, content Creation remained the lowest posttest subscale, reflecting the higher complexity of the skills involved.

Inferential Statistics: Overall and Subscale Change

A paired-samples t-test was conducted to test H1, which posited a significant increase in overall digital literacy competence after the course. The assumption of normality of the difference scores was met (Kolmogorov-Smirnov $p = 0.200$). The test revealed a highly significant difference $t(59) = 18.57$, $p < 0.001$. The effect size, Cohen's d, was 2.39, which far exceeded the threshold for a large effect ($d > 0.8$). Table 3 summarizes these results along with the 95% confidence intervals.

Table 3. Paired-Samples t-Test Results for Total DLCS and Subscales (N = 60)

Scale	Mean Diff.	t(59)	p	95% CI of Diff.	Cohen's d
Total DLCS	27.19	18.57	< .001	[24.24, 30.13]	2.39
Professional Engagement	4.73	14.21	< .001*	[4.04, 5.42]	1.83
Digital Resources	4.91	15.33	< .001*	[4.25, 5.57]	1.98
Teaching and Learning	4.80	14.98	< .001*	[4.14, 5.46]	1.93
Assessment	4.84	14.62	< .001*	[4.15, 5.53]	1.89
Empowering Learners	4.85	14.85	< .001*	[4.17, 5.53]	1.92
Facilitating Learners' DC	5.05	15.89	< .001*	[4.40, 5.70]	2.05

All six subscale improvements were statistically significant at the Bonferroni-corrected alpha level. The effect sizes ranged from 1.83 (Professional Engagement) to 2.05 (Facilitating Learners' Digital Competence), all classified as very large. The subscale Facilitating Learners' Digital Competence, which involves teaching students digital literacy skills, exhibited both the largest raw gain and the largest effect size, suggesting that the training was particularly effective in empowering teachers to model and transmit digital competence to their students. Conversely, Professional Engagement—though still with a massive effect size—showed the smallest gain, perhaps because some collaborative practices require systemic organizational changes beyond individual skill.

A hierarchical multiple regression was performed to address the second research question of this study. Prior to the analysis, the assumptions were evaluated. Scatterplots of standardized residuals against predicted values confirmed linearity and homoscedasticity. The histogram and P-P plot indicate normally distributed residuals. The VIF values were all well below 2.0, and the tolerance exceeded 0.60, indicating no problematic multicollinearity. Table 4 presents the regression results of the analysis.

Table 4. Hierarchical Multiple Regression Predicting Posttest DLCS Score (N = 60)

Predictor	Step 1 β (SE)	Step 2 β (SE)	ΔR^2

Predictor	Step 1 β (SE)	Step 2 β (SE)	ΔR²
Step 1			.282***
Pretest DLCS	.531 (.096)***	.426 (.089)***	
Step 2			.172**
Age		–.287 (.113)*	
Teaching Experience		.102 (.118)	
Prior ICT Training[1]		.312 (.092)**	
School Internet Stable[1]		.134 (.097)	
Total R²	.282	.454	
Adjusted R²	.270	.428	
ΔF	22.77***	6.41**	

In Step 1, pretest DLCS score significantly predicted posttest score, accounting for 28.2% of the variance, $F(1, 58) = 22.77$, $p < .001$. In Step 2, the addition of demographic and background variables explained an additional 17.2% of variance, a significant increment, $\Delta F(4, 54) = 6.41$, $p < .001$, with the total model explaining 45.4% of the variance in posttest digital literacy (adjusted $R^2 = .428$). Within the full model, pretest score remained a highly significant predictor ($\beta = .426$, $p < .001$). As hypothesized, age negatively predicted posttest score ($\beta = –.287$, $p = .012$): younger teachers achieved higher posttest competence, holding other variables constant. Prior ICT training positively predicted posttest score ($\beta = .312$, $p = .001$), indicating that those with some prior exposure to technology training were better positioned to benefit from the current programme. Teaching experience and school internet stability were not statistically significant predictors ($\beta = .102$, $p = .392$ and $\beta = .134$, $p = .173$, respectively). The non-significance of school internet stability suggests that individual-level factors outweighed the immediate infrastructural context in determining training outcomes, though its positive direction aligns with expectation.

The combined results robustly support the efficacy of community service digital literacy training. The overall large effect, consistent subscale improvements, and identification of age and prior training as significant moderators provide a comprehensive picture of the intervention's impact and its boundary conditions. The high percentage of perceived barriers, juxtaposed with the notable competence gains, underscores that teacher empowerment is possible even in technologically constrained

settings, but infrastructural deficits remain a critical limiting factor for sustained classroom applications.

This study aimed to evaluate the effectiveness of a community service digital literacy training programme for rural elementary teachers and examine the factors influencing its outcomes. The findings indicate that a relatively brief yet intensive and well-mentored intervention can produce profound improvements in teachers' self-assessed digital competencelevels. The total DLCS score increase of over 27 points, corresponding to an effect size of 2.39, is substantially larger than those typically reported in general teacher ICT training meta-analyses, where average effect sizes cluster around d = 0.60–0.90 (Affindy et al., 2025). Several elements of the program likely account for this exceptional gain.

First, the intervention was designed according to the evidence-based principles of effective professional development. It was sustained over five full days plus four weeks of mentoring, provided active hands-on learning, was collaborative, and was tightly aligned with the DigCompEdu curriculum framework. The integration of mentoring through WhatsApp groups provided the continuous support that Kurniawan (2025) identified as essential for transfer. In the rural Indonesian context, where professional isolation is high, the mentors served not only as technical guides but also as emotional and motivational anchors, helping teachers persist through initial frustrations. This socio-emotional dimension, while not quantitatively measured, was frequently mentioned in the informal feedback collected during mentoring and warrants further mixed-methods investigations (Juang Kurniawan, 2025).

Second, the program capitalized on the community service ethos. University lecturers and students served as facilitators, bringing a combination of theoretical rigor, practical expertise, and genuine commitment to community empowerment. Unlike external vendors, the university team was able to contextualize examplesusing Indonesian-language apps, local cultural content, and scenarios from rural classrooms. This contextualization reduced the perceived irrelevance that often alienates rural teachers from generic ICT training (Aboubacar Barry et al., 2025). The high degree of trust and rapport likely enhanced engagement and reduced anxiety, thus contributing to the large effect size.

The subscale analysis provided nuanced insights. Facilitating Learners' Digital Competence showed the greatest gain, which is particularly encouraging because this area directly addresses the ultimate goal of teacher digital literacy: equipping students with critical digital skills. The training explicitly models how to guide students in online safety and information evaluation, and the mentoring phase prompts teachers to implement these practices. This significant growth suggests that teachers internalized the role of a digital mentor, not just a digital tool user.

In contrast, Digital Resources and Content Creation, while markedly improved, had slightly smaller relative gains (d = 1.98). Creating and modifying digital learning materials demands higher-order technical and design skills that develop more slowly and require repeated practice beyond a four-week period. This aligns with the TPACK framework's assertion that technological content knowledge is the most challenging domain to develop (Ben Otman et al., 2025). Future iterations of the training could extend the content creation module and incorporate the peer production of open

educational resources tailored to the local curriculum, fostering sustained skill development.

Regression analysis adds a layer of practical significance. Pretest competence accounted for approximately 28% of the posttest variance, indicating that while the training benefited all, those with a higher starting point gained relatively more—a "Matthew effect" commonly observed in skill acquisition (Stanovich, 1986). This finding does not imply that the least digitally literate teachers were left behind, as their absolute gains were still large, but it does highlight the need for differentiated scaffolding for teachers entering with very low initial competence levels. Pre-training remedial sessions or tiered grouping could partially mitigate this gap.

Age emerged as a significant negative predictor, even after controlling for the pretest. This is consistent with research showing that older adults often exhibit higher computer anxiety and slower skill acquisition in technology domains (Ravi & Mohamad, 2026). While the concept of "digital natives" has been critiqued as overly simplistic (Abunales & Lacay, 2025), the negative age coefficient suggests that older rural teachers may require more time, repetition, and personalized support to achieve equivalent gains. Andragogical strategies—acknowledging their rich pedagogical experience, connecting technology to immediate classroom problems, and allowing self-paced exploration—should be integral to community service training design.

The strong positive predictive power of prior ICT training reinforces the cumulative nature of digital competence. Teachers who had previously attended even brief workshops possessed a foundational familiarity with computer interfaces and terminology that accelerated new learning. This finding supports the call for a continuous, spiral professional development curriculum rather than one-off events (Ghafarshad & Sundarapandi, 2025). For community service programs, it may be strategic to sequence interventions: a basic ICT literacy course followed several months later by an advanced pedagogical integration course.

Notably, school Internet stability did not significantly predict posttest scores. This may appear counterintuitive given the overwhelming barrier it presents. The likely explanation is that the posttest measured teachers' perceived competence, not their actual frequency of classroom use. A teacher may feel highly competent to create a Canva poster even if the school Wi-Fi is unreliable; they simply cannot implement it daily. Thus, while our training successfully built competence, the translation of that competence into consistent classroom practice depends on infrastructure that community service alone cannot provide. The persistently high barrier endorsements (82% unstable internet) underscore a sobering reality: digital literacy training without concurrent investment in connectivity and devices risks creating a reservoir of frustrated, underutilized skills.

These findings have several implications for policy and practice. First, the Ministry of Education and local governments should institutionalise partnerships between universities and rural school clusters to deliver sustained, mentored digital literacy programmes as part of the Merdeka Belajar ecosystem. When rigorously designed, the community service model offers a cost-effective mechanism that simultaneously fulfils universities' Tri Dharma obligations and addresses national educational priorities. Second, program budgets must earmark funds not only for training delivery but also for post-training connectivity support, perhaps by providing participating schools

with mobile data packages or low-cost devices. Third, professional development accreditation for teachers could incorporate digital competence levels aligned with DigCompEduto motivate continuous upskilling.

The present study had several limitations that must be acknowledged. The one-group pretest–posttest design, while valuable for initial impact assessment, cannot rule out threats to internal validity such as history, maturation, and testing effects. It is possible that external events during the study period (e.g., a government push for digitaliz ation) or the mere act of taking the pre test influenced post test scores. Future studies employing a quasi-experimental control group (e.g., wait list control schools) would substantially strengthen causal claims. Second, the outcome measure relied on self-reported competence, which may be subject to social desirability bias and may not perfectly correspond to objectively assessed skills or actual classroom behavior of the teachers. Incorporating performance-based assessments (e.g., evaluating a digital lesson plan or a recorded teaching session) would provide more robust triangulation. Third, the posttest was administered immediately after the four-week mentoring, capturing short-term gains; however the durability of these gains and their translation into student learning outcomes remain unknown. Longitudinal follow-up at six and 12 months is essential. Fourth, although the sample was adequate for the analyses conducted, it was drawn from a single district, limiting generalizability. Multi-site replication across diverse rural regions of Indonesia, including those with lower infrastructure levels, is needed.

Furthermore, the quantitative design, while producing clear effect estimates, could not capture the mechanisms of change that ishow teachers' beliefs, identities, and collegial interactions evolved. A mixed-methods approach integrating in-depth interviews or focus group discussions would illuminate the processes through which mentoring and peer collaboration foster resilience and pedagogical transformation. Such an approach would also uncover unexpected negative consequences, if any, such as increased frustration when teachers cannot apply their new skills.

Despite these limitations, this study makes a significant contribution by demonstrating that a rigorously evaluated community service initiative can achieve large and meaningful gains in rural teachers' digital literacy. It provides a replicable methodological template that elevates the standard of evidence in community service research, moving beyond descriptive accounts to quantifiable impact with a statistical nuance. In a policy landscape that increasingly demands evidence-based practice, such demonstrations are invaluable.

CONCLUSION

This study evaluated community service digital literacy training for 60 rural elementary teachers in Indonesia. The intervention produced a very large, statistically significant improvement in overall digital competence (d = 2.39), with all DigCompEdu sub domains showing substantial gains. Hierarchical regression revealed that post test competence was positively predicted by pre test score and prior ICT training, and negatively by age, while school internet stability did not emerge as a significant predictor of perceived competence. The findings affirm that well-

structured, mentored community service programmes can effectively empower rural teachers However,they also highlight that systemic barriers—particularly unstable internet and device shortages—must be addressed to enable sustained classroom integration. Policy recommendations include institutionalizing university-rural school partnerships, ensuring post-training infrastructure support, and adopting a continuous and tiered professional development model. Future research should employ controlled designs, objective performance measures, and longitudinal tracking to validate and extend these results. Ultimately, bridging the technological gap in Indonesian elementary education requires a synergistic effort that couples teacher capacity building with infrastructural investment, ensuring that digital literacy becomes a bridge to equity rather than another divide.

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Ethical Compliance

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Data Access Statement

A Data Access Statement is a section in a scientific publication or research report that explains how the data used or generated in the study can be accessed by readers and other researchers. This statement aims to promote transparency, support research reproducibility, and comply with open access policies, where applicable.
Common Elements in a Data Access Statement:

1. Data Location: Specifies where the data are stored, such as in online repositories (e.g., Zenodo, Dryad, or institutional repositories).
2. Access Instructions: Provides information on how to access the data, such as direct links, DOI (Digital Object Identifier), or contact details.
3. Data Availability: Indicates whether the data are publicly accessible, available upon request, or restricted due to ethical, legal, or privacy considerations.
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Examples of Data Access Statements:

1. Open Data:
   - "The data supporting this study are openly available in Zenodo at [DOI: 10.55299/ijcs.v5i1.1106]."
2. Restricted Data:
   - "The data that support the findings of this study are available upon request from the corresponding author. Due to privacy concerns, the data are not publicly available."
3. No Data Available:
   - "No datasets were generated or analyzed during the current study."

4. Conditional Access:
    - "The data supporting this study are available under restricted access and can be obtained upon reasonable request from the corresponding author and with the permission of the ethics committee."

Purpose of a Data Access Statement:

- Reproducibility: Enables other researchers to replicate or verify the findings.
- Collaboration: Encourages further collaboration by sharing data.
- Compliance: Adheres to thepolicies of funding agencies or journals that require open access to data.

Conflict of Interest Declaration

The authors declare that they have no affiliations or involvement with any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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