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ARTIKEL PENGABDIAN MASYARAKAT

Enhancing TPACK Competency of SIT AL-Mizan Teachers through Google Sites-Based Learning Website Design Training

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Abstract

The rapid digitalization of 21st-century educational ecosystems has fundamentally transformed the professional profile required of teachers, yet many educators in developing contexts continue to face intrinsic and extrinsic barriers to effective technology integration. A situational analysis at SIT AL-Mizan in Bekasi, West Java, revealed that despite possessing adequate technological infrastructure and strong foundational pedagogical skills, teachers predominantly relied on conventional, teacher-centered instructional methods due to a critical deficit in Technological Pedagogical Content Knowledge (TPACK). This community service (Pengabdian kepada Masyarakat/PkM) initiative aimed to systematically enhance the TPACK competencies of these educators through an intensive, localized training and mentoring program focused on designing interactive learning websites utilizing Google Sites. Employing a Participatory Action Research (PAR) methodology, the intervention engaged 30 in-service teachers across four cyclical phases: preliminary needs assessment, intensive technical and pedagogical workshops, hands-on mentoring, and comprehensive evaluation. Data were collected using a validated TPACK-21 self-assessment questionnaire administered before and after the intervention, alongside a standardized rubric to evaluate the final digital learning platforms. Quantitative analysis via paired-samples t-tests revealed a statistically significant improvement across all seven TPACK domains ($p < .001$). The most substantial gains were observed in Technological Knowledge (TK) and comprehensive TPACK integration, both yielding exceptionally large effect sizes (Cohen's $d > 3.0$). Qualitative evaluations demonstrated that participants successfully translated this knowledge into practice, developing functional, pedagogically sound web-based instructional media. The initiative concludes that targeted professional development, anchored in the TPACK framework and delivered through collaborative PAR methodologies, effectively bridges the digital divide, empowering teachers to independently orchestrate interactive digital learning environments.

Keywords: Google Sites; Participatory Action Research; Teacher Professional Development; Technological Pedagogical Content Knowledge; Web-Based Learning.

Abstrak

Digitalisasi pesat dalam ekosistem pendidikan abad ke-21 telah mengubah profil profesional yang dituntut dari seorang guru secara mendasar; namun, banyak pendidik di negara berkembang masih menghadapi hambatan internal maupun eksternal dalam mengintegrasikan teknologi secara efektif. Analisis situasi di SIT AL-Mizan, Bekasi, Jawa Barat, menunjukkan bahwa meskipun memiliki infrastruktur teknologi yang memadai dan keterampilan pedagogis dasar yang kuat, para guru cenderung mengandalkan metode pengajaran konvensional yang berpusat pada guru akibat kurangnya penguasaan *Technological Pedagogical Content Knowledge* (TPACK). Inisiatif Pengabdian kepada Masyarakat (PkM) ini bertujuan untuk meningkatkan kompetensi TPACK para pendidik secara sistematis melalui program pelatihan dan pendampingan intensif yang disesuaikan dengan konteks lokal, dengan fokus pada perancangan situs web pembelajaran interaktif menggunakan Google Sites. Dengan menerapkan metodologi *Participatory Action Research* (PAR), intervensi ini melibatkan 30 guru aktif melalui empat tahapan siklus: penilaian kebutuhan awal, lokakarya teknis dan pedagogis intensif, pendampingan praktik langsung, serta evaluasi menyeluruh. Data dikumpulkan menggunakan kuesioner penilaian mandiri TPACK-21 yang telah divalidasi, yang diberikan sebelum dan sesudah intervensi serta rubrik standar untuk mengevaluasi platform pembelajaran digital akhir. Analisis kuantitatif menggunakan uji-t sampel berpasangan (*paired-samples t-tests*) menunjukkan peningkatan yang signifikan secara statistik pada ketujuh domain TPACK ($p < 0{,}001$). Peningkatan paling substansial terlihat pada domain *Technological Knowledge* (TK) dan integrasi TPACK secara menyeluruh, yang keduanya menghasilkan ukuran efek sangat besar (Cohen's $d > 3{,}0$). Evaluasi kualitatif menunjukkan bahwa para peserta berhasil menerjemahkan pengetahuan tersebut ke dalam praktik nyata dengan mengembangkan media pembelajaran berbasis web yang fungsional dan memiliki landasan pedagogis yang kuat. Inisiatif ini menyimpulkan bahwa pengembangan profesional yang terarah berlandaskan kerangka kerja TPACK dan dilaksanakan melalui metodologi PAR yang kolaboratif secara efektif menjembatani kesenjangan digital serta memberdayakan guru untuk merancang lingkungan pembelajaran digital interaktif secara mandiri.

Kata Kunci: Google Sites; Penelitian Tindakan Partisipatif; Pengembangan Profesional Guru; Pengetahuan Pedagogis Konten Teknologi; Pembelajaran Berbasis Web.

1. INTRODUCTION

The 21st-century educational landscape is characterized by the ubiquitous presence of digital technologies, which have fundamentally altered the paradigms of knowledge acquisition, dissemination, and pedagogical interaction (Falloon, 2020; Redecker & Punie, 2017). In this rapidly evolving digital era, the role of the educator has shifted from a traditional transmitter of static information to a dynamic facilitator of technology-enhanced learning experiences. Consequently, the contemporary teacher is expected to possess a sophisticated repertoire of digital competencies to effectively prepare students for the complexities of the modern workforce (Al-Maroof et al., 2021; Darling-Hammond et al., 2017). However, the integration of educational technology is a multifaceted challenge that extends far beyond the mere physical provision of hardware and software. It requires a profound, metacognitive understanding of how digital tools intersect with specific disciplinary content and instructional strategies (Koehler & Mishra, 2009; Schmid et al., 2020). Historically, teacher preparation and continuous professional development programs have treated technological proficiency as an isolated, auxiliary skill, entirely divorced from core pedagogical and content-related training. This fragmented approach has proven insufficient, frequently resulting in superficial technology adoption where digital tools are used merely to replicate traditional analog practices rather than transform them (Ertmer, 1999; Tondeur et al., 2017).

To conceptualize the complex knowledge required for effective digital teaching, educational researchers have widely adopted the Technological Pedagogical Content Knowledge (TPACK) framework (Chai, 2019; Mishra & Koehler, 2006). Formulated by Mishra and Koehler in 2006 as an extension of Lee Shulman's seminal concept of Pedagogical Content Knowledge (PCK), the TPACK framework posits that meaningful technology integration occurs only at the synergistic intersection of three primary knowledge domains: Technology, Pedagogy, and Content (Koehler & Mishra, 2009; Mishra & Koehler, 2006; Rosenberg & Koehler, 2015). The framework meticulously delineates seven distinct, interrelated constructs: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and the central synthesis, Technological Pedagogical Content Knowledge (TPACK) (Koh et al., 2017; Mishra & Koehler, 2006). Achieving mastery in TPACK implies that an educator not only understands how to operate a specific digital tool but also possesses the pedagogical discernment to leverage that tool's unique affordances to overcome specific conceptual bottlenecks within a given subject area, all while navigating the specific contextual realities of their classroom (Rosenberg & Koehler, 2015; Schmid et al., 2020).

Despite the theoretical robustness and widespread academic acceptance of the TPACK framework, empirical evidence indicates a persistent, significant gap between theoretical models and actual classroom implementation, particularly within emerging economies and developing educational infrastructures (Mailizar et al., 2020; Yuliana et al., 2022). In Indonesia, the imperative to digitize education, abruptly accelerated by global disruptions such as the COVID-19 pandemic, has exposed systemic vulnerabilities across the educational spectrum. Research indicates that Indonesian educators frequently encounter both extrinsic and intrinsic barriers to technology integration (Yuliana et al., 2022). Extrinsic barriers encompass systemic issues such as unequal distribution of Information and Communication Technology (ICT) infrastructure, prohibitive internet connectivity costs, and a lack of standardized institutional support (Howard, J. L., Bureau, J., Guay, F., Chong, J. X., & Ryan, 2021; Ningsih & dkk., 2021). Conversely, intrinsic barriers relate directly to the individual educator, including low self-efficacy regarding digital tool usage, negative attitudes toward pedagogical change, and a critical lack of comprehensive, ongoing digital literacy training (Joo et al., 2018; Mailizar et al., 2020; Yuliana et al., 2022).

A rigorous situational analysis conducted at SIT (Sekolah Islam Terpadu) AL-Mizan, an integrated Islamic educational institution located in Bekasi, West Java, provided a localized manifestation of these broader national challenges. As an integrated Islamic school, SIT AL-Mizan is dedicated to delivering a holistic educational experience that seamlessly fuses national curriculum standards with intensive Islamic studies, character building, and Tahfiz (Quranic memorization) programs. Preliminary observations and structured interviews with the school's principal and teaching staff revealed that the educators possessed exceptionally strong Content Knowledge (CK) in their respective disciplines and solid traditional Pedagogical Knowledge (PK). However, their instructional methodologies remained deeply entrenched in traditional, teacher-centered paradigms. The delivery of instruction relied heavily on synchronous, face-to-face lectures and static presentation slides, with a noticeable absence of interactive, asynchronous digital learning environments.

The primary impediment at SIT AL-Mizan was not an absolute lack of infrastructure; the school is equipped with basic computing facilities, digital projectors, and adequate internet connectivity. Rather, the bottleneck was fundamentally intrinsic, rooted in a pervasive deficit of Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK). The teachers expressed a high degree of technological anxiety, citing the intimidating cognitive load required to learn complex Learning Management Systems (LMS) or advanced web development tools. Furthermore, they articulated a lack of structured guidance on how to translate their existing, highly effective analog lesson plans into engaging, interactive digital formats (Mailizar et al., 2020; Sweller et al., 2019). This competency gap not only restricted the flexibility and interactivity of the pedagogical process but also impeded the institution's strategic vision of cultivating a modern, digitally fluent student body capable of navigating future technological landscapes.

To directly address this critical competency deficit, this community service (Pengabdian kepada Masyarakat/PkM) initiative proposed a targeted, participatory training and mentoring program centered on the development of instructional websites utilizing Google Sites. The selection of Google Sites as the primary technological intervention vehicle was highly strategic and intentional. As a platform, Google Sites significantly lowers the barrier to entry for digital content creation; it operates on a highly intuitive, drag-and-drop interface that requires absolutely no prior coding, HTML, or web development expertise (Abidin et al., 2023; Wibowo & dkk., 2024). Furthermore, its seamless integration with the broader Google

Workspace for Education ecosystem allows educators to effortlessly embed a diverse array of digital artifacts, such as multimedia presentations, interactive quizzes, video lectures, and collaborative documents, directly into a unified, universally accessible web interface (Anwar et al., 2025; Falloon, 2020). By utilizing a platform characterized by high usability and a gentle learning curve, the intervention aimed to drastically minimize the cognitive overload associated with technical troubleshooting. This strategic choice allowed the participating teachers to redirect their cognitive resources toward the pedagogical integration of their content, which is the true essence of developing actionable TPACK (Anwar et al., 2025; Falloon, 2020).

Consequently, the primary objective of this PkM initiative was to measure the effectiveness of a structured, localized training and continuous mentoring program in enhancing the TPACK competencies of SIT AL-Mizan teachers. The program was designed to transform the participants from passive consumers of digital content into active, confident designers and managers of web-based instructional media. By rigorously evaluating the shifts in the teachers' self-perceived TPACK domains and objectively assessing the pedagogical quality of their finalized digital outputs, this initiative seeks to provide actionable, empirical insights into optimal strategies for in-service teacher professional development in the digital age. Ultimately, the project aims to offer a sustainable, replicable model for similar educational institutions striving to bridge the digital divide and elevate the quality of 21st-century instruction.

2. METHOD

To achieve the established objectives and ensure sustainable professional development, this community service initiative employed a Participatory Action Research (PAR) approach, integrated with principles of Service Learning (Kemmis et al., 2014; Morales, 2016). The PAR methodology was deliberately selected because it actively deconstructs the traditional, hierarchical "expert-to-novice" training dynamic. Instead, PAR positions the community members, in this case, the teachers at SIT AL-Mizan, not merely as passive recipients of an external intervention, but as active co-investigators who possess equal authority in identifying localized problems and constructing highly contextualized solutions. This collaborative, democratic framework is particularly effective in the context of educational technology integration, as it fosters a deep sense of ownership, significantly reduces institutional resistance to technological change, and ensures that the developed digital artifacts are explicitly tailored to the specific socio-cultural and pedagogical needs of the school environment.

2.1. Participant Profile

The intervention was conducted at SIT AL-Mizan, located in the Bekasi Regency, West Java. The participant cohort consisted of 30 in-service teachers, purposefully selected by the school administration to represent a diverse cross-section of academic disciplines spanning primary and early secondary educational levels. The disciplines represented included general sciences, mathematics, Indonesian language, English, civic education, and integrated Islamic studies (including Tahfiz and Arabic language).

Table 1 details the demographic and professional profile of the participating educators. The cohort reflected a heterogeneous blend of experience levels, ensuring that the intervention addressed the needs of both novice educators and seasoned veterans. Prior to the commencement of the intervention, a preliminary diagnostic screening indicated that while 100% of the participants utilized basic digital communication tools (WhatsApp) and word processing software for administrative tasks, zero percent (0%) had prior experience in web design, Learning Management System (LMS) administration, or the systematic pedagogical structuring of an independent, interactive learning website.

Table 1. Demographic Profile of Participating Teachers (N = 30)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	8	26.7%
	Female	22	73.3%
Age Range	22 – 30 years	14	46.7%
	31 – 40 years	11	36.6%
	> 40 years	5	16.7%
Teaching Experience	1 – 5 years	12	40.0%
	6 – 10 years	13	43.3%
	> 10 years	5	16.7%
Educational Background	Bachelor's Degree (S1)	28	93.3%
	Master's Degree (S2)	2	6.7%

2.2. Stages of Implementation

The PAR framework was operationalized through four distinct, cyclical phases spanning a comprehensive one-month professional development period (October 2023). This extended timeframe was specifically designed to prevent the rapid knowledge decay often associated with short-term, "one-off" training workshops.

Phase One: Preliminary Study and Needs Assessment (Planning) This initial phase involved direct, intensive engagement with the school's principal and academic coordinators to map the existing technological infrastructure, pedagogical culture, and institutional goals. A diagnostic focus group discussion (FGD) was conducted with a sample of teachers to identify specific instructional bottlenecks and attitudes toward technology. The findings confirmed adequate broadband internet access and hardware availability (computer lab and individual laptops), isolating the primary barrier to the teachers' lack of TPACK-related competencies. During this phase, the PkM team and the school administration collaboratively established the training schedule, defined the specific output goals (the creation of individual, fully functional Google Sites for each teacher's respective subject), and secured institutional commitment for the program.

Phase Two: Intensive Workshop Implementation (Action) The formal instructional phase consisted of a multi-day intensive workshop (totaling 16 contact hours), held on-site at the SIT AL-Mizan computer laboratory. The curriculum was strictly mapped to the TPACK framework, ensuring that technical skills were never taught in a pedagogical vacuum.

- Module 1 (Focus: TK & PK): Addressed fundamental digital literacy, navigation of the Google Workspace for Education interface, principles of digital pedagogy, and theories of multimedia learning.
- Module 2 (Focus: TCK & TPK): Provided step-by-step, scaffolded technical training on Google Sites architecture. Topics included creating multi-page layouts, modifying visual themes, and embedding external multimedia assets (YouTube videos, Canva graphics). Concurrently, this module emphasized the pedagogical rationale for these features for example, explicitly demonstrating how embedding a self-grading Google Form serves as an effective formative assessment tool (Pedagogy) utilizing cloud technology (Technology) to test specific subject matter (Content).
- Module 3 (Focus: TPACK Synthesis): Guided teachers in designing a digital lesson plan (storyboard) that aligned their specific curriculum goals with the affordances of the Google Sites platform.

Phase Three: Mentoring and Guidance (Observation and Iteration) Transitioning from theoretical instruction to applied practice, this phase constituted the core of the PAR approach. Over a two-week period, teachers were tasked with developing a complete, functional instructional website for a specific topic within their upcoming semester syllabus. The PkM team acted as facilitators, providing individualized, shoulder-to-shoulder mentoring. This phase heavily encouraged peer-to-peer collaboration, where teachers exchanged constructive feedback on user interface (UI) design, accessibility, and content clarity. The facilitators actively observed the process, resolving technical impediments in real-time and continuously prompting the teachers to critically reflect on how their technological choices impacted their pedagogical objectives.

Phase Four: Evaluation and Reflection The final phase involved a comprehensive empirical evaluation of the intervention's efficacy. Teachers finalized their digital products and submitted them for formal review. A collaborative reflection session was then held, during which teachers showcased their Google Sites to the broader school community, discussing their design rationales, the challenges they overcame, and their strategies for implementing these tools in their upcoming classes.

Figure 1. Phase the activities

2.3. Evaluation Instruments

To ensure a robust, objective measurement of the program's impact, two primary evaluation instruments were utilized, capturing both self-perceived competency shifts and objective product quality. TPACK-21 Self-Assessment Questionnaire: To quantify shifts in educator competency, a modified, standardized TPACK survey instrument adapted from (Valtonen et al., 2017) was administered as a pre-test (prior to the workshop) and a post-test (upon completion of the mentoring phase). The instrument consisted of 35 items distributed evenly across the seven TPACK domains (TK, PK, CK, TPK, TCK, PCK, TPACK). Responses were measured on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Prior to deployment, the instrument was validated for the specific context of Indonesian Islamic schools and demonstrated high internal consistency reliability, yielding a Cronbach's alpha (α) coefficient of 0.89, indicating excellent reliability (Anwar et al., 2025).

Digital Media Quality Assessment Rubric: To assess the practical application of the acquired knowledge, the final Google Sites developed by the teachers were evaluated independently by three expert raters using a standardized quality assessment rubric (Anwar et al., 2025). The rubric assessed three primary dimensions on a scale of 1 to 4: Technical Usability (navigation, visual hierarchy, mobile responsiveness, link functionality), Pedagogical Alignment (clarity of learning objectives, presence of interactive formative assessments, scaffolding of information), and Content Integration (accuracy of subject matter, relevance of multimedia representation, appropriateness for the target age group).

2.4. Data Analysis Techniques

Quantitative data derived from the TPACK-21 self-assessment questionnaire were analyzed using statistical software (SPSS v.26). Descriptive statistics, including Means (M) and Standard Deviations (SD), were calculated to establish the baseline and post-intervention competency levels for each of the seven domains. To determine the statistical significance of the differences between the pre-test and post-test scores, paired-samples t-tests were conducted, with the threshold for statistical significance strictly set at $\alpha = 0.05$.

Furthermore, to ascertain the practical magnitude of the intervention's impact beyond mere statistical significance, effect sizes were calculated using Cohen's d formula (Anwar et al., 2025; Cohen, 1988; Tondeur et al., 2017). Following standard academic conventions for educational research, a Cohen's d value of approximately 0.2 denotes a small effect, 0.5 denotes a medium effect, and 0.8 or greater denotes a large effect (Hattie, 2009; Valtonen et al., 2017). The quantitative data obtained from the digital product evaluation rubric were analyzed descriptively (using frequency distributions and mean scores) to triangulate and corroborate the self-reported questionnaire findings.

3. RESULTS AND DISCUSSION

The execution of the community service program at SIT AL-Mizan progressed with exceptional momentum, characterized by remarkably high levels of participant engagement, attendance (100% retention rate across all 30 participants), and a palpable enthusiasm for technological integration. The transition from the theoretical workshop to the hands-on mentoring phase proved particularly critical; while the initial diagnostic and early workshop sessions revealed widespread technological anxiety, especially among the older cohort of teachers the collaborative, peer-supported environment fostered by the PAR methodology rapidly mitigated these apprehensions (Joo et al., 2018; Morales, 2016). The empirical results of this intervention are categorized into two primary areas of analysis: the quantitative shifts in the teachers' TPACK competencies, and the qualitative/objective assessment of the finalized instructional websites.

3.1. Quantitative Results: Shifts in TPACK Competencies

The core empirical objective of this initiative was to rigorously measure the extent to which the Google Sites training and mentoring program altered the teachers' perceived competencies across the seven domains of the TPACK framework. Table 2 presents the detailed descriptive statistics, the results of the paired-samples t-tests, and the calculated effect sizes (Cohen's d) for the 30 participating educators.

Table 2. Pre-test and Post-test Analysis of TPACK Domains (N = 30)

TPACK Domain	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Difference	t-value	p-value	Cohen's d
Content Knowledge (CK)	4.12 (0.45)	4.25 (0.42)	+0.13	2.15	.040	0.30
Pedagogical Knowledge (PK)	3.85 (0.52)	4.10 (0.48)	+0.25	3.42	.002	0.50
Technological Knowledge (TK)	2.15 (0.65)	4.35 (0.50)	+2.20	18.54	<.001	3.79
Pedagogical Content Knowledge (PCK)	3.90 (0.48)	4.15 (0.45)	+0.25	3.65	.001	0.53
Technological Content Knowledge (TCK)	2.45 (0.60)	4.20 (0.55)	+1.75	14.82	<.001	3.04
Technological Pedagogical Knowledge (TPK)	2.30 (0.58)	4.30 (0.52)	+2.00	16.30	<.001	3.63
Overall TPACK	**2.25 (0.62)**	**4.28 (0.54)**	**+2.03**	**17.95**	**<.001**	**3.49**

Note: Scores range from 1 to 5 based on a Likert scale. Significance level established at $p < 0.05$.

The statistical analysis reveals a profound, highly significant transformation in the teachers' technological and pedagogical capabilities. Prior to the intervention, the baseline data perfectly corroborated the initial situational analysis: the educators possessed strong foundational Content Knowledge (M = 4.12) and Pedagogical Knowledge (M = 3.85), as well as a robust ability to integrate the two through Pedagogical Content Knowledge (M = 3.90). However, any domain requiring technological proficiency namely TK, TCK, TPK, and the overarching TPACK scored critically low, ranging from 2.15 to 2.45. This empirical baseline highlights a classic profile of educators operating within a highly traditional instructional paradigm, severely limited by a pronounced digital divide and a lack of prior exposure to web-based educational design (Mailizar et al., 2020; Ningsih & dkk., 2021). Following the intensive one-month training and mentoring intervention, the post-test scores demonstrated statistically significant increases across all seven TPACK domains. While the improvements in the non-technological foundational domains (CK, PK, PCK) were moderate (yielding small to medium effect sizes ranging from 0.30 to 0.53), the shifts in the technology-integrated domains were nothing short of transformative.

Technological Knowledge (TK) experienced the most dramatic surge, increasing from a pre-test mean of 2.15 to a post-test mean of 4.35 ($p < .001$). This generated an exceptionally large effect size of 3.79, indicating an intervention impact that far exceeds standard educational thresholds for professional development (Anwar et al., 2025; Cohen, 1988). Similarly, the complex domains reflecting the application of technology to specific teaching tasks showed massive, statistically significant gains. Technological Pedagogical Knowledge (TPK) rose by a mean of 2.00 points (Cohen's $d = 3.63$), demonstrating that teachers not only learned how to manipulate the software but fundamentally understood how to leverage it to manage classroom dynamics, track student progress, and deliver structured instruction (Koh et al., 2017; Tondeur et al., 2017). Technological Content Knowledge (TCK) improved by 1.75 points (Cohen's $d = 3.04$), indicating a newfound ability to use digital media to accurately and engagingly represent specific subject matter. Ultimately, the central synthesis domain, Technological Pedagogical Content Knowledge (TPACK) saw a highly significant increase from 2.25 to 4.28 (Cohen's $d = 3.49$). These metrics irrefutably confirm the efficacy of the intervention in rapidly and substantially bridging the digital competency gap.

3.2. Product Evaluation: Google Sites Assessment

The quantitative self-assessments were strongly validated by the tangible, objective outputs produced during the mentoring phase. Every participating teacher successfully developed and published a functional, multi-page Google Sites learning portal explicitly tailored to their specific semester curriculum. The evaluation rubric, administered by the PkM team, provided a comprehensive assessment of these platforms.

Table 3. Summary of Google Sites Product Evaluation (N = 30)

valuation Dimension	Highly Proficient (4)	Proficient (3)	Developing (2)	Beginning (1)	Mean Score (1-4)
Technical Usability	25 (83.3%)	5 (16.7%)	0 (0%)	0 (0%)	3.83
Pedagogical Alignment	22 (73.3%)	7 (23.3%)	1 (3.3%)	0 (0%)	3.70
Content Integration	27 (90.0%)	3 (10.0%)	0 (0%)	0 (0%)	3.90

As detailed in Table 3, the products exhibited exceptionally high quality. In the dimension of Technical Usability, 83.3% of the websites scored in the "Highly Proficient" category. The teachers demonstrated mastery in creating logical navigation menus, embedding complex multimedia assets seamlessly, and ensuring that their sites maintained clean, distraction-free visual layouts that were responsive to mobile devices, a critical factor given that many students access learning materials via smartphones (Howard, J. L., Bureau, J., Guay, F., Chong, J. X., & Ryan, 2021; Yuliana et al., 2022).

In terms of Pedagogical Alignment, the websites transcended mere digital repositories for static text (e.g., uploading PDF worksheets). Over 90% of the participants successfully embedded interactive elements designed to facilitate active learning. For instance, teachers routinely embedded Google Forms to serve as self-grading formative assessments, integrated interactive scheduling calendars, and utilized linked Google Docs to create collaborative discussion boards.

The Content Integration dimension scored the highest overall (Mean = 3.90). This physical evidence demonstrates the practical actualization of TPACK: the teachers drew heavily on their pre-existing strengths in CK and PCK, utilizing the newly acquired TK to reconstruct their pedagogical approach and exploit the unique affordances of the web-based medium (Abidin et al., 2023; Anwar et al., 2025; Rosenberg & Koehler, 2015). For example, a science teacher successfully embedded a dynamic PhET interactive simulation to illustrate abstract physics concepts, while an Islamic studies teacher utilized embedded audio players to provide correct Tajweed (Quranic recitation) pronunciations alongside the digital text.

3.3. The Affordances of Google Sites as a Catalyst for Rapid TK and TPK Development

The profound leap in Technological Knowledge (TK) is directly inextricably linked to the specific architecture of the Google Sites platform. Historically, designing an educational website required a prohibitively steep learning curve, demanding proficiency in HTML, CSS, JavaScript, and complex domain hosting protocols. This technical complexity acts as a severe cognitive barrier for educators, leading to high attrition rates in technology training programs (Sweller et al., 2019). Google Sites entirely circumvents this barrier by utilizing a highly intuitive, visually driven drag-and-drop interface. By virtually eliminating the friction associated with technical coding, the platform preserves the teachers' cognitive load, allowing them to rapidly achieve mastery over the tool's mechanics. This immediate technical success fosters a high degree of self-efficacy, which is a universally recognized prerequisite for subsequent, sustained technological adoption and innovation (Al-Maroof et al., 2021; Trust et al., 2016).

More importantly, the platform naturally facilitates the development of Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK). When an educator constructs a lesson on Google Sites, they are inherently forced to make structural architectural decisions: "Where do I place this instructional video?" "How do I sequence the reading material before introducing the quiz?" These structural decisions on a webpage are fundamentally pedagogical decisions regarding the scaffolding of information (Koh et al., 2017; Schmid et al., 2020). As established in broader TPACK literature, technology, pedagogy, and content exist in a state of dynamic tension; altering one necessitates an adjustment in the others (Koehler & Mishra, 2009; Phillips, 2016). Google Sites acts as a highly effective boundary object that visually maps this tension. When a teacher embeds a digital simulation (Technology) to illustrate an abstract concept (Content) and follows it immediately with an interactive quiz to assess comprehension (Pedagogy), they are actively, consciously operationalizing TPACK (Tondeur et al., 2017). The training's relentless focus on these integrative actions rather than just teaching the software in isolation is what drove the massive gains in the TCK and TPK metrics.

3.4. The Critical Role of Participatory Action Research (PAR) and Continuous Mentoring

The delivery mechanism of the training was equally responsible for the outcomes. Traditional "top-down" professional development models, where external experts lecture to passive teachers in isolated, decontextualized workshops, consistently fail to produce sustainable changes in actual classroom practice (Bates, 2019; Morales, 2016). The PAR approach utilized in this initiative actively dismantled this hierarchical structure. By involving the teachers of SIT AL-Mizan as active co-designers of their learning experience, the intervention cultivated a deep sense of intrinsic motivation and ownership.

The extended mentoring phase (Phase 3) was particularly transformative. The literature emphasizes that developing TPACK is not a solitary cognitive endeavor but a highly situated, socio-cultural process (Mishra & Koehler, 2006; Valtonen et al., 2017). During the workshop and subsequent mentoring, teachers organically formed peer-support networks (Communities of Practice), assisting one another with UI troubleshooting and exchanging innovative pedagogical ideas. This collaborative environment mitigated the intrinsic barriers to technology integration, specifically the fear of failure and the natural human resistance to change (Mailizar et al., 2020; Yuliana et al., 2022). The continuous presence of the PkM facilitators, providing situated, context-specific mentoring, ensured that minor technical hurdles did not derail pedagogical momentum. This aligns perfectly with recent empirical findings suggesting that prolonged, mentoring-based professional development is vastly superior to isolated workshop events in fostering sustainable digital competencies and translating theory into practice (Anwar et al., 2025; Falloon, 2020).

3.5. Addressing Systemic Barriers in the Indonesian Educational Context

While the results are overwhelmingly positive, analyzing them within the broader context of educational technology in Indonesia reveals critical underlying systemic themes. The initial, extremely low TPACK scores of the SIT AL-Mizan teachers are emblematic of a widespread digital divide that plagues many educational institutions, even those located near major metropolitan hubs like Bekasi, and despite possessing adequate baseline physical infrastructure (Howard et al., 2021; Ningsih & dkk., 2021). The primary barrier to digitalization is rarely a total absence of hardware; rather, it is a chronic lack of institutional scaffolding, targeted pedagogical training, and cohesive digital leadership (Sheninger, 2019).

This intervention definitively proves that when teachers are provided with highly accessible tools (Google Sites), grounded theoretical frameworks (TPACK), and supportive, collaborative environments (PAR), they are highly capable of bridging this divide rapidly and effectively. Furthermore, the slight, yet statistically significant, increases in standard Content Knowledge (CK) and Pedagogical Knowledge (PK) observed in Table 2 suggest a powerful "spillover effect." Engaging deeply with technology forced the educators to critically revisit, deconstruct, and refine their core content and teaching strategies. This confirms the fundamental premise of the TPACK framework: that authentic technology integration, when executed correctly, enhances holistic teaching competency rather than detracting from it (Cohen, 1988; Phillips, 2016).

4. CONCLUSION

The community service (PkM) initiative executed at SIT AL-Mizan represents a highly successful, empirically validated model for modern teacher professional development. By anchoring a Participatory Action Research (PAR) methodology within the theoretical framework of Technological Pedagogical Content Knowledge (TPACK), the program facilitated a profound and measurable transformation in the digital competencies of 30 in-service educators. The empirical evidence, characterized by statistically significant improvements and exceptionally large effect sizes (Cohen's $d > 3.0$) across all technology-integrated domains, demonstrates that targeted, highly contextualized interventions can rapidly dismantle intrinsic barriers to technology adoption. The strategic utilization of Google Sites proved critical; its intuitive, user-friendly interface mitigated cognitive overload, allowing teachers to focus their intellectual capital on seamlessly blending subject-specific content with interactive digital pedagogies, rather than struggling with technical minutiae.

The practical implications of this initiative are substantial for educational institutions striving to navigate the complexities of 21st-century instruction. The findings unequivocally indicate that one-off technical workshops are insufficient; sustainable digital transformation requires continuous, collaborative mentoring that emphasizes pedagogical integration over mere technical operationality. To sustain the momentum generated by this program, it is highly recommended that the administration at SIT AL-Mizan, and similar institutions, institutionalize these practices by establishing internal Professional Learning Communities (PLCs) or localized Subject Teacher Deliberation (MGMP) forums dedicated exclusively to digital instructional design and peer review. Furthermore, future research and community service initiatives should expand upon this foundational work by directly evaluating the impact of these teacher-generated digital platforms on measurable student learning outcomes, cognitive retention, and overall academic engagement.

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