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Developing an In-House Training Model for Digital Pedagogical Competence of Islamic Religious Education Teachers

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ABSTRACT
The digital transformation of education demands stronger digital pedagogical competence among Islamic Religious Education (IRE) teachers. This study aimed to develop, implement, and evaluate a contextual In-House Training (IHT) model using the Four-D framework (Define, Design, Develop, Disseminate). A mixed-methods sequential explanatory design was employed. Needs analysis involved 40 IRE teachers from 23 junior high schools; the development phase (limited trial) involved 20 teachers; the dissemination phase (full implementation) involved 40 teachers (the original 20 plus 20 additional teachers trained through peer-training). Data were collected through questionnaires (Cronbach's alpha 0.89), interviews, observations, and documentation. The model significantly improved digital lesson planning (from 45% to 82%, $p < 0.01$, $d = 1.24$), active learning strategies (68%), and educational app mastery (75%). Systemic effects included a 65% increase in digital media use and 30% reduction in preparation time. The novelty lies in operationalizing TPACK within IRE through a school-based, practice-oriented IHT model that explicitly integrates Islamic values. This study contributes a replicable prototype for digital religious pedagogy in developing countries.

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ABSTRAK
Transformasi digital pendidikan menuntut kompetensi pedagogik digital yang lebih kuat bagi guru Pendidikan Agama Islam (PAI). Penelitian ini bertujuan mengembangkan, mengimplementasikan, dan mengevaluasi model In-House Training (IHT) kontekstual menggunakan kerangka Four-D. Desain sequential explanatory mixed-methods digunakan. Analisis kebutuhan melibatkan 40 guru PAI dari 23 SMP; tahap pengembangan (uji terbatas) melibatkan 20 guru; tahap diseminasi (implementasi penuh) melibatkan 40 guru (20 guru awal ditambah 20 guru tambahan melalui peer-training). Data dikumpulkan melalui kuesioner (Cronbach's alpha 0,89), wawancara, observasi, dan dokumentasi. Model IHT meningkatkan signifikan penyusunan RPP digital (45% ke 82%, p<0,01, d=1,24), strategi pembelajaran aktif (68%), dan penguasaan aplikasi pendidikan (75%). Dampak sistemik meliputi peningkatan penggunaan media digital sebesar 65% dan pengurangan waktu persiapan mengajar sebesar 30%. Kebaruan penelitian ini terletak pada pengoperasionalan TPACK dalam konteks PAI melalui model IHT berbasis sekolah dan berorientasi praktik yang secara eksplisit mengintegrasikan nilai-nilai Islam.

KATA KUNCI
In-House Training, Kompetensi Pedagogik Digital, Pendidikan Agama Islam, Four-D Model

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Introduction

Pedagogical competence is a fundamental pillar of teacher professionalism, encompassing the ability to design instruction, facilitate learning, and assess student development. (Darling-Hammond et al., 2005). The contemporary educational landscape has been fundamentally transformed by digital technologies, creating new imperatives for teachers to integrate digital tools meaningfully into their pedagogical practice. (Fullan & Langworthy, 2004; Selwyn, 2022). However, research consistently shows that teachers worldwide struggle to move beyond basic technology adoption toward pedagogically sophisticated integration. (Ertmer & Ottenbreit-Leftwich, 2010). This gap between basic digital literacy and deeper, pedagogically transformative use of technology is well-documented in general teacher education literature. (Tondeur et al., 2017).

For Islamic Religious Education (IRE) teachers, this competence is particularly significant, as they bear the dual responsibility of imparting religious knowledge while nurturing students' moral character and spiritual development. (Halstead, 2004). In religious education contexts, these challenges are compounded by the need to align technological tools with philosophical and pedagogical traditions that emphasize character formation and spiritual development. (Sahin, 2018). Within the specific domain of Islamic education, this challenge is intensified by the imperative to ensure that technological tools and methods are in harmony with foundational educational philosophies that prioritize the cultivation of ethical character and spiritual consciousness (M. Halstead, 2004). In the Indonesian context, a preliminary needs analysis (n=40 IRE teachers) revealed that 85% face difficulties integrating digital platforms, with high teaching loads (average 24 hours/week) and limited infrastructure (65% of schools have <2 Mbps internet). International comparative studies confirm that infrastructure limitations and excessive teaching loads represent fundamental barriers to effective technology integration, especially in resource-constrained environments. (Thomson & Hillman, 2019).

Conventional professional development approaches frequently prioritize technical skills over the development of pedagogical strategies specifically tailored to religious education contexts. (Guskey, 2002). This complexity is often inadequately addressed by standard professional development models, which tend to focus disproportionately on software proficiency at the expense of fostering the nuanced pedagogical reasoning required for a subject like IRE. (Darling-Hammond, 2017). This misalignment has tangible consequences, as studies suggest that inadequate pedagogical preparation for digital integration can diminish educational quality and student engagement in religious education settings. (Suhid et al., 2021). Empirical evidence indicates that a lack of targeted pedagogical support for digital integration can lead to superficial implementation, resulting in a decline in the depth of student learning and engagement in religious education. (Amirudin et al., 2025).

Current scholarship on teacher professional development provides robust theoretical foundations, including the efficacy of job-embedded, collaborative professional learning (Fullan, 2016), the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler et al., 2013), professional learning communities and collaborative inquiry models (Stoll et al., 2006), and the importance of contextually relevant professional development (Desimone, 2009; Timperley, 2011). Studies have examined technology integration in general educational contexts (Voogt et al., 2013) and the effectiveness of professional development (Kennedy, 2016). However, four specific gaps remain: When compared to prior work: (a) unlike Koehler et al. (2013) who focused on generic TPACK, this study develops a Four-D-based IHT model specifically for IRE teachers; (b) unlike Hefner (2020) who provided theoretical analysis, this study provides empirical evidence

on preserving Islamic values through digital pedagogy; (c) unlike Voogt et al. (2018) who studied Western contexts, this study contextualizes IHT for Indonesian junior high schools with high teaching loads (24 hrs/week) and low bandwidth (2 Mbps); (d) unlike Suhid et al. (2021) who used only quantitative surveys, this study employs mixed-methods with effect sizes and qualitative themes

This study aims to develop, implement, and evaluate a contextualized In-House Training (IHT) model using the Four-D framework (Define, Design, Develop, Disseminate) to enhance digital pedagogical competence among IRE teachers in Indonesian junior high schools. The study addresses two primary research questions: (1) What are the essential components of an effective IHT model for developing IRE teachers' digital pedagogical competence? (2) How does participation in a contextualized IHT program impact IRE teachers' digital pedagogical practices? The novelty lies in: (a) the first Four-D-based IHT model specifically for IRE teachers; (b) explicit operationalization of TPACK within Islamic religious pedagogy, not just generic edtech; (c) mixed-methods evidence including effect sizes (Cohen's d) and qualitative themes on Islamic value integration; and (d) contextual innovation addressing high teaching loads (24 hrs/week) and low bandwidth (2 Mbps) through practical, school-based mentoring. This research contributes a replicable prototype for digital religious pedagogy in developing countries and offers insights into how traditional educational systems can navigate digital transformation while maintaining their cultural and religious identity (Selwyn, 2022). The findings also have implications for educational policy, aligning with international frameworks for technology leadership. (R. E. Anderson & Dexter, 2005) and educational change (Elmore, 2004; Fullan, 2016; Schleicher, 2012; Warschauer, 2003; Zhao & Frank, 2003), as well as culturally responsive pedagogy (Gay, 2010) and design-based research (T. Anderson & Shattuck, 2012).

This study addressed five research questions: (1) What are the needs for developing an IHT model for IRE teachers? (2) What is the design of the IHT model? (3) How is the IHT model developed and validated? (4) How is the IHT model disseminated across schools? (5) What is the impact of the IHT model on teachers' digital pedagogical and professional competence, as well as on student engagement and learning outcomes?

Methods

This study employed a mixed-methods sequential explanatory design (Creswell, 2015), combining quantitative and qualitative data collection to evaluate the developed In-House Training (IHT) model. The Research and Development (R&D) methodology was adopted using the Four D model (Define, Design, Develop, Disseminate), originally developed by Thiagarajan et al. Quantitative data (pre-post competence scores) were prioritized, followed by qualitative data (interviews, observations) to explain the quantitative findings. Integration of both data types occurred during the Develop and Disseminate phases. The study was conducted over nine months in Cilaku District, West Java, Indonesia, across 23 public and private junior high schools. Participant numbers varied by phase: the Define phase involved 40 IRE teachers from 23 schools for needs analysis; the Design phase used an expert panel of five (two educational technology experts, one Islamic education specialist, and two senior teachers); the Develop phase involved a limited trial with 20 teachers from six schools; and the Disseminate phase involved full implementation with 40 teachers from 23 schools (consisting of the 20 teachers from the develop phase plus 20 additional teachers trained through a peer-training model). Inclusion criteria for teacher participants were a minimum of three years of teaching experience, prior exposure to at least one digital platform (Wordwall, Canva,

or Quizizz), and willingness to participate in the entire IHT program. All participants provided written informed consent.

The research implementation followed four distinct phases based on the Four-D model. In the Define phase (months 1-- 2), a comprehensive needs analysis was conducted through structured classroom observations (n=10 teachers), in-depth semi-structured interviews with 10 IRE teachers and three school principals, and document analysis of existing lesson plans. This phase identified specific digital platforms that teachers struggled with (Wordwall, Canva, Quizizz) as well as contextual barriers such as limited internet bandwidth and heavy teaching loads averaging 24 hours per week. In the Design phase (month 3), the initial IHT prototype was developed, consisting of training manuals, digital modules, assessment instruments, and collaborative learning activities.

The curriculum was structured into 40 lesson hours with a composition of 30% theory and 70% practice, emphasizing andragogical principles. (Knowles, 1984) and the TPACK framework (Koehler et al., 2013). Core components included digital orientation (2 hours), digital platform mastery (20 hours), learning media development (12 hours), digital learning strategies (3 hours), learning evaluation (2 hours), and post-IHT mentoring (2 hours). Islamic value integration was explicitly embedded in every module. In the Develop phase (months 4-- 6), the IHT prototype and research instruments underwent rigorous validation by two educational technology experts and one Islamic education specialist using an assessment instrument that covered content feasibility, construct validity, and linguistic appropriateness. Validity was calculated using Aiken's V (Aiken, 1985), yielding a score of 0.87 ($p<0.05$).

Expert feedback led to revisions to the module's language and activity sequences. A limited trial was then conducted with 20 non-sampled teachers from the same district to evaluate practicality. Pre-test and post-test data were collected using the digital pedagogical competence questionnaire, and reliability was calculated with Cronbach's alpha ($\alpha = 0.89$). Participant satisfaction was measured using a 5-point Likert scale. In the Disseminate phase (months 7-- 9), full implementation was carried out with 40 teachers (the 20 teachers from the limited trial plus 20 additional teachers trained by the original 20 using a peer-training model).

The IHT program was delivered over two weeks (40 lesson hours) in each school site, with the researcher serving as facilitator and observer. Immediately after the program, a post-test was administered. Focus group discussions (n=12 teachers) were conducted to explore qualitative changes in teaching practice and in the integration of Islamic values. Sustainability indicators were tracked three months after the program, including the number of digital teacher working groups formed and the percentage of schools allocating technology budgets.

Four types of instruments were developed or adapted for this study. First, a Digital Pedagogical Competence Questionnaire (5-point Likert) consisted of 25 items across four dimensions: digital lesson planning (6 items), active learning strategies (7 items), educational app mastery (6 items), and integration of Islamic values (6 items). An example item is: "I can design a digital lesson plan that integrates Qur'anic verses into interactive quizzes." Response options ranged from 1 (strongly disagree) to 5 (strongly agree). Content validity was assessed using Aiken's V (0.87, $p<0.05$), and reliability was established with Cronbach's alpha ($\alpha = 0.89$). Second, a semi-structured interview protocol was developed with open-ended questions that focused on perceived barriers, changes in teaching practice, the integration of Islamic values, and suggestions for program improvement. Each interview lasted 30 to 45 minutes and was audio-recorded with the participant's consent. Third, a structured observation checklist was created based on the TPACK framework, covering frequency of digital tool use, student engagement indicators, and explicit articulation of Islamic values during lessons.

Observations were conducted before and after the IHT program in 10 randomly selected classrooms. Fourth, a document analysis framework was applied to examine lesson plans and school technology policies, focusing on digital components and their alignment with Islamic educational objectives.

Quantitative data were analyzed using SPSS version 26. Descriptive statistics (means, standard deviations, percentages) were calculated for pre-test and post-test scores. Normality was checked using the Shapiro-Wilk test ($p > 0.05$ for all dimensions, indicating a normal distribution). A paired-samples t-test was conducted to compare pre- and post-test mean scores for each dimension and total competence. Effect sizes were calculated using Cohen's d (Cohen et al., 2018), with $d > 0.8$ considered large. A p-value <0.05 was considered statistically significant. Qualitative data underwent thematic analysis following the six phases of Braun & Clarke (2006): familiarization, generating initial codes (open coding), searching for themes (axial coding), reviewing themes, defining and naming themes, and producing the final report. Coding was performed manually by two independent researchers, with disagreements resolved through discussion. To ensure trustworthiness, four strategies were implemented: source triangulation (cross-referencing interview transcripts, observation notes, and document analysis), method triangulation (comparing quantitative survey results with qualitative themes), member checking (12 participants reviewed interview summaries to verify accuracy), peer debriefing (two colleagues with expertise in educational research reviewed the coding process and themes), and an audit trail documenting all research decisions and analytical memos.

Ethical approval for this study was obtained from the Research Ethics Committee of Universitas Islam Negeri Sunan Gunung Djati Bandung (Approval Letter No. 123/2023). Prior to data collection, all participants received a clear explanation of the research purpose, procedures, and their rights. Written informed consent was obtained from each teacher and school principal. Participants were assured that their participation was voluntary and that they could withdraw at any time without penalty. All data were anonymized using pseudonyms, and school names were replaced with codes (e.g., SMP-01; SMP-02) to protect institutional identity. Data were stored securely and used only for academic purposes. No financial incentives were provided, and no conflicts of interest were declared.

Results and Discussion

Results

Needs for IHT Model Development

The first research question examined the need for developing an IHT model to enhance IRE teachers' digital pedagogical and professional competence. A needs analysis involving 40 IRE teachers from 23 junior high schools in Cilaku District was conducted through surveys, interviews, and observations.

The quantitative data from the needs assessment showed that 84% of teachers were interested in participating in digital-based IHT. However, 93% reported infrastructure barriers as the main obstacle, including unstable internet connections and limited devices. Furthermore, 80% of teachers requested direct practical guidance in creating and using digital teaching materials. Regarding media preferences, 97% agreed that digital media such as videos, animations, and quizzes make PAI learning more engaging.

The qualitative findings from the interviews reinforced these needs. One teacher stated, "I am interested in using digital platforms, but I lack the technical skills and confidence." Another teacher explained, "We need practical training, not just theory, because the infrastructure at our school is very limited." Specific challenges identified

included difficulties using Wordwall (72%), Canva (68%), and Quizizz (65%). Additionally, 78% of teachers faced constraints due to high teaching loads averaging 24 hours per week, and 65% of schools had internet connections below 2 Mbps. These findings indicate a high and urgent need for a structured, practice-oriented IHT model tailored to the local context of IRE teachers.

Design of the IHT Model

The second research question examined the design of the IHT model. Based on the needs analysis, and grounded in andragogical principles and the TPACK framework, the IHT model was designed as a structured training programme consisting of 20 lesson hours (JP). The training structure was distributed across seven core sessions with a composition of 30% theory and 70% practice.

The seven core sessions included: (1) introduction and orientation (2 JP), (2) andragogical learning approaches (3 JP), (3) utilisation of technology in learning (4 JP), (4) development of digital media and content (4 JP), (5) digital learning strategies, including flipped classroom and project-based learning (3 JP), (6) reflection and evaluation of learning (2 JP), and (7) post-training mentoring (2 JP).

The model also incorporated several digital platforms relevant to IRE learning. Canva was used for visual content creation, Wordwall for interactive learning games, Quizizz for gamified assessment, Google Classroom for learning management, Padlet for collaborative learning boards, and PowerPoint for instructional presentations. In addition, the design included pre-test and post-test instruments to measure teachers' competence improvement. The learning format adopted a blended learning approach by combining face-to-face workshops with online mentoring.

Development of the IHT Model

The third research question examined the development process of the IHT model. Following the Four-D development model, the development phase involved expert validation, model revision, and a limited trial.

Expert Validation

The initial validation involved material experts, instrument experts, and practitioners. The validation results showed that the material aspect obtained a score of 78, the instrument aspect obtained a score of 73, and the practitioner assessment obtained a score of 76. These scores indicate that the model was feasible to use with minor revisions.

Revisions were made based on expert feedback. The revisions included simplifying the language used in the training materials, adding more contextual examples related to IRE teaching practices, and increasing the proportion of hands-on activities. These improvements were intended to make the IHT model more practical, accessible, and responsive to the actual needs of IRE teachers.

Limited Trial

A limited trial was conducted with 20 teachers from six schools. The pre-test and post-test results showed a significant increase in teachers' digital pedagogical competence after participating in the IHT programme. Table 1 presents the comparison between pre-test and post-test scores, including the mean, standard deviation, t-value, p-value, and effect size for each competence dimension.

Table 1. Pre-Post Comparison of Digital Pedagogical Competence (Limited Trial, n=20)

Dimension	Pre (mean±SD)	Post (mean±SD)	t-value	p-value	Cohen's d
Digital lesson planning	**2.8±0.6**	**4.4±0.5**	**12.3**	**<0.001**	**1.24**

Active learning strategies	**2.9±0.7**	**4.3±0.6**	**10.8**	**<0.001**	**1.08**
Educational app mastery	**2.5±0.8**	**4.2±0.7**	**11.5**	**<0.001**	**1.18**
Integration of Islamic values	**3.1±0.6**	**4.5±0.5**	**13.1**	**<0.001**	**1.36**
Total competence	**2.8±0.5**	**4.4±0.4**	**14.2**	**<0.001**	**1.52**

Note: Scores ranged from 1, indicating the lowest score, to 5, indicating the highest score. The paired t-test results assume normality, with Shapiro-Wilk $p > 0.05$ for all dimensions. Effect sizes above 0.8 indicate large practical significance.

The results in Table 1 show that all dimensions of digital pedagogical competence improved after the implementation of the IHT model. The average total competence score increased from 2.8 ± 0.5 in the pre-test to 4.4 ± 0.4 in the post-test, with a mean gain of 1.6 points. The paired t-test showed a statistically significant difference between pre-test and post-test scores, with $t = 14.2$ and $p < 0.001$. The effect size was very large, with Cohen's $d = 1.52$, indicating that the IHT model had strong practical significance in improving teachers' competence.

The highest improvement was found in the dimension of integrating Islamic values into digital learning, with Cohen's $d = 1.36$. This finding indicates that the IHT model was not only effective in improving teachers' technical digital skills, but also successful in helping them integrate Islamic values into digital pedagogy.

Several examples from the limited trial illustrate this improvement. Teacher A integrated Qur'anic verses from Surah Al-Fatihah into a Quizizz game, where each question was preceded by a relevant verse that students had to reflect on before answering. Teacher B used Canva to create an interactive infographic comparing prayer times and embedded the hadith, "The first deed for which a person will be brought to account on the Day of Resurrection is prayer" from Sunan An-Nasa'i. Teacher C designed a Wordwall matching activity in which students paired Islamic terms such as *tawakkal*, *ikhlas*, and *sabr* with their meanings and relevant digital learning scenarios.

In addition, 80% of participants achieved scores above the minimum competency standard of 75 on a 0–100 scale. Participant satisfaction reached 4.6 on a 5-point scale, with hands-on practice receiving the highest score of 4.8. These results indicate that the IHT model was effective, practical, and positively received by the participating teachers.

Dissemination of the IHT Model

The fourth research question examined the dissemination of the IHT model. After revisions were made based on the limited trial, the model was implemented more broadly with 40 teachers from 23 junior high schools.

The final expert validation showed improved results. Material experts gave a score of 88, instrument experts gave a score of 85, and practitioners gave a score of 91. These scores indicate that the revised model was categorised as very feasible and did not require major revision.

The wider implementation also showed positive results. The average pre-test score was 59, while the average post-test score increased to 84. Before the training, the highest score was 84 and the lowest score was 30. After the training, the highest score reached 100, while the lowest score increased to 75. This improvement indicates that the IHT model was effective in improving teachers' competence across a broader group of participants.

Participant satisfaction was also high across several indicators. The relevance of the material scored 83.00, teaching methods scored 84.50, comfort in using digital platforms scored 90.50, speaker delivery scored 97.00, time allocation scored 92.50, usefulness of material scored 87.50, motivation scored 86.00, interaction scored 91.00, and facilities

scored 91.50. These results show that the dissemination phase was positively received by the participants.

The dissemination phase also produced sustainable outcomes beyond the training sessions. Five digital teacher working groups were formed spontaneously, and 70% of schools expressed commitment to allocating funds for technology development. Furthermore, teachers' participation in online professional communities increased by 60% compared to before the IHT programme.

Impact of the IHT Model

The fifth research question examined the impact of the IHT model on IRE teachers' digital pedagogical and professional competence. The results from the full implementation involving 40 teachers showed positive impacts across several indicators.

The percentage of digital lesson plans that met the rubric standards increased from 45% to 82%. The adoption of active learning strategies reached 68%, while mastery of educational applications based on the minimum rubric standard reached 75%. Classroom use of digital media increased by 65%, and lesson preparation time decreased by 30%. These findings indicate that the IHT model contributed to measurable improvements in teachers' instructional planning, digital media use, and pedagogical efficiency.

Student responses also supported the positive impact of the model. Based on responses from 30 students, digital-based PAI learning increased students' enthusiasm, engagement, and perceived learning gains. Students reported that digital platforms made PAI learning more interesting, helped them understand the material more easily, and enabled them to remember PAI material longer. They also reported increased confidence in using digital learning applications and expressed hope that digital-based PAI learning would continue.

The qualitative findings from interviews with teachers and principals revealed three main themes. The first theme was the shift "from fear to confidence." One teacher explained, "Before IHT, I avoided Canva because it seemed complicated. After two weeks of peer mentoring, I now design interactive Islamic quiz games for my students." This statement shows that the IHT programme helped teachers overcome anxiety and build confidence in using digital tools.

The second theme was "digital tools as a means, not an end." One teacher stated, "I can embed verses from Surah Al-'Alaq into Quizizz, so technology becomes a vehicle for reflection, not just entertainment." A principal also added, "We observed that teachers started selecting apps based on their alignment with Islamic values, not just because they were popular." These findings indicate that teachers began to use digital technology more pedagogically and reflectively, rather than merely as a technical tool.

The third theme was "sustainable communities." One principal noted, "Teachers now share digital resources via WhatsApp groups weekly. This never happened before." Another teacher explained, "We created a shared Google Drive folder for PAI materials. Everyone contributes, and everyone benefits." These statements show that the IHT model encouraged collaboration among teachers and supported the formation of sustainable professional learning communities.

Overall, these findings confirm that the IHT model had a positive impact on both technical and pedagogical competence. More importantly, the model also encouraged teachers to integrate Islamic educational values into digital learning practices and fostered sustainable professional learning communities among IRE teachers

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Discussion

The findings demonstrate that the Four-D approach (Define, Design, Develop, Disseminate) effectively bridges the technological-pedagogical divide persistently documented in contemporary educational literature. (Fullan & Langworthy, 2004; Hattie, 2008). The substantial improvement in teachers' digital lesson planning capabilities, increasing remarkably from 45% to 82%, aligns strongly with the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler et al., 2013; Mishra & Koehler, 2006), confirming that successful technology integration requires the synergistic interplay of technological, pedagogical, and content knowledge rather than treating these domains as separate entities.

The research context reveals significant challenges that resonate with broader findings in educational technology research, particularly in developing regions. According to the Thomson & Hillman (2019) TALIS report and international comparative studies indicate that infrastructure limitations and excessive teaching loads represent fundamental barriers to effective technology integration, especially in resource-constrained environments. However, this study advances current understanding by demonstrating that job-embedded professional development, when properly structured, can effectively overcome these constraints through its practical orientation and contextual relevance. The exceptionally high participant satisfaction rate (4.6/5.0) strongly supports Opfer & Pedder (2011) and Guskey (2002) emphasis that effective professional development must be directly applicable to teachers' daily classroom practices and immediate challenges.

When contextualized within religious education literature, this study offers novel contributions that extend existing understanding. While Hefner (2020) emphasized theological and philosophical considerations in technology integration for Islamic education, our empirical findings demonstrate that practical, hands-on training can effectively harmonize technological tools with religious educational objectives without compromising pedagogical integrity. The significant increase in classroom digital media usage (65%) and substantial reduction in preparation time (30%) provide compelling empirical evidence supporting the efficiency arguments presented by Puentedura (2006) in his SAMR model. The largest effect size (d = 1.36) was observed in the dimension "integration of Islamic values." This was operationalized through concrete practices: teachers embedded Qur'anic verses as reflective pauses within digital quizzes; one teacher turned Surah Al-'Alaq into a Quizizz journey of revelation; another used Canva to create Zakat presentations with hadith reflection buttons. These practices demonstrate that digital tools serve as vehicles for spiritual reflection rather than secularizing religious instruction.

The demonstrated effectiveness of the andragogical approach in the IHT model aligns with Taylor & Hamdy's (2013) research on adult learning principles in professional development, while simultaneously extending this understanding to the specific context of religious education in developing countries. Meanwhile, the successful contextualization of digital platforms within religious education offers new insights into how technological adoption can be adapted within specific cultural and religious frameworks, thereby extending the work of Voogt et al. (2018) on technology integration in diverse educational contexts. Furthermore, the integration of digital tools within Islamic educational content helped overcome resistance sometimes observed when introducing technology in religious educational settings, supporting findings from studies on culturally responsive pedagogy (Gay, 2010).

The establishment of sustainable digital learning communities represents a crucial advancement in addressing the sustainability challenge in teacher development identified

by Borko (2004) and in educational reform literature (Elmore, 2004). This outcome suggests that the IHT model successfully creates conditions for continuous professional growth, effectively moving beyond the traditional "one-size-fits-all" workshop approach widely criticized by Webster-Wright (2009) and Lieberman & Miller (2011). The organic formation of five digital teacher working groups exemplifies the professional learning communities that Stoll et al. (2006) identify as essential for sustaining educational improvement, particularly in specialized contexts like religious education, where cultural and pedagogical considerations intersect uniquely. (Hargreaves et al., 2011).

The commitment from 70% of schools to allocate specific technology development budgets demonstrates the model's success in creating lasting change beyond the immediate training period. This aligns with the concept of "professional learning that makes a difference" found in international literature on educational change (Timperley, 2011). The significant increase in teachers' participation in online professional communities (60% growth) further demonstrates the development of self-sustaining professional networks that can continue to support growth beyond the formal training period (Stoll et al., 2006). The 70:30 practice-to-theory ratio aligns with contemporary understanding of effective professional development identified in international reviews (Desimone, 2009; Kennedy, 2016). In the Indonesian context specifically, these findings align with and extend previous research on educational reform and digital transformation (Zhao & Frank, 2003; Warschauer, 2003), demonstrating how similar transformations can be achieved in formal school settings through structured professional development that respects both educational traditions and contemporary demands.

Despite the positive outcomes, the study also reveals important limitations that merit careful consideration and further investigation. The persistent infrastructure challenges, despite significant pedagogical improvements, support Selwyn's (2022) critical argument that educational technology transformation requires concurrent attention to both human capacity development and physical resource allocation. The varying baseline digital literacy among participants underscores the necessity for differentiated professional development approaches, consistent with H. Timperley's (2007) research on addressing individual differences in teacher learning, particularly in contexts with diverse technological exposure and experience.

A critical observation is that, while technical skills improved substantially (a 75% increase in application mastery), the integration of technology with deep pedagogical reasoning for PAI remained uneven. This challenges the assumption that technical training alone leads to transformative pedagogy, supporting Koehler & Mishra's (2009) argument about the inseparable nature of technological and pedagogical knowledge. The study also acknowledges potential social desirability bias in self-reported satisfaction scores (4.6/5.0), as participants might have overestimated their competence gains due to the novelty of the intervention.

The study's implications for educational policy and practice are particularly significant in the current era of digital transformation. The successful implementation of the IHT model suggests that similar approaches could be effectively scaled across other educational contexts in Indonesia and beyond. However, careful adaptation to local conditions would be essential. International research on educational change consistently emphasizes that successful scaling requires meticulous attention to contextual factors and to local capacity building, rather than merely replicating successful models (Fullan, 2007). The research also highlights the critical importance of aligning professional development initiatives with national digital education policies, as emphasized in educational reform literature that prioritizes teacher autonomy and contextual relevance (Darling-Hammond, 2010).

The significant reduction in preparation time reported by teachers (30%) provides a practical motivation for technology adoption that complements the pedagogical benefits, aligning with research on teacher workload and efficiency. (Inan & Lowther, 2010). Furthermore, the high levels of participant satisfaction and engagement challenge pessimistic views about teachers' willingness to adopt new technologies in traditional educational settings, supporting (Ertmer & Ottenbreit-Leftwich, 2010) argument that teachers are willing to engage with technology when they perceive its relevance to their teaching goals and receive adequate support.

In terms of methodological contributions, the study demonstrates the effectiveness of the Four-D model for developing educational interventions in complex, context-specific situations. The iterative nature of the development process, incorporating continuous feedback and refinement, allowed for the creation of a model that was both theoretically sound and practically feasible. This approach addresses the common criticism of educational research being either too theoretical or too context-specific to provide generalizable insights. (T. Anderson & Shattuck, 2012).

Looking forward, the research suggests several important directions for future investigation. The longitudinal impact of the intervention on student learning outcomes is a crucial area for further study, as the current research has primarily focused on teacher-level outcomes. Additionally, research on the model's scalability across diverse educational contexts and cultural settings would provide valuable insights into its generalizability. (Kozma, 2003). The role of leadership in supporting technology integration, as reflected in school-level commitments, warrants more detailed investigation, particularly in relation to international frameworks for technology leadership in education. (R. E. Anderson & Dexter, 2005). From a theoretical perspective, this study contributes to the international discourse on educational change by demonstrating how the Four-D model can be effectively adapted for professional development in diverse cultural contexts. (Schleicher, 2012; Selwyn, 2022).

The findings of this study reinforce the growing body of evidence that school-based professional development, particularly through the IHT model, effectively enhances both the pedagogical and professional competence of IRE teachers. This aligns with Rosadi et al. (2025), who demonstrated that school culture significantly shapes religious character when mediated by discipline and structured teacher development programs. Furthermore, the integration of Islamic values into digital pedagogy, which achieved the highest effect size in this study (d=1.36), resonates with Misbah & Saleh (2025), who found that embedding character and Islamic values into the Merdeka curriculum positively impacts students' learning discipline. The success of the IHT model in fostering sustainable digital learning communities also supports the work of Cahyanto et al., who showed that project-based learning integrated with literacy and socio-cultural contexts enhances both teacher capacity and student engagement. Finally, the improved ability of IRE teachers to align digital platforms with religious moderation principles—evidenced by the 75% mastery of educational applications and the organic formation of teacher working groups—echoes the findings of Khasanah et al (2025), who emphasized that teachers' understanding and implementation of religious moderation are critical for effective Islamic education in diverse Indonesian classrooms.

This research makes significant theoretical contributions by demonstrating how the TPACK framework can be effectively operationalized in religious education through structured school-based training. The comprehensive improvements across all TPACK domains suggest that the developed model offers a viable approach for addressing the complex interplay between technology, pedagogy, and content in specialized educational contexts. The practical implications extend beyond Indonesia, informing international practice in teacher professional development and offering a viable alternative to top-

down approaches that have often proven ineffective in diverse cultural contexts (Schleicher, 2012). This study not only addresses the research questions regarding effective strategies for improving IRE teachers' digital pedagogical competence but also makes substantial contributions to the broader international knowledge base on teacher professional development in developing contexts and specialized educational settings. Future research should explore the longitudinal impact on student learning outcomes and investigate scalable implementation strategies across diverse educational contexts, with particular attention to sustainability mechanisms that support continued growth and development.

Conclusion

Based on the research findings, it can be concluded that the development of the In-House Training (IHT) model using the Four-D approach has successfully addressed the critical gap in digital pedagogical and professional competence among Islamic Religious Education (IRE) teachers in Cilaku District, West Java. Prior to the intervention, teachers faced significant challenges: 85% struggled with integrating digital platforms, 78% were constrained by heavy teaching loads (averaging 24 hours per week), and 65% of schools had inadequate internet infrastructure. This study aimed to develop, implement, and evaluate a contextual, sustainable IHT model. The results demonstrate that the model significantly improved teachers' competence: digital lesson planning increased from 45% to 82%, adoption of active learning strategies reached 68%, mastery of educational applications reached 75%, and the integration of Islamic values into digital pedagogy showed the highest gain. Systemic effects included a 65% increase in digital media use and a 30% reduction in lesson preparation time.

The theoretical contribution of this study lies in operationalizing the TPACK framework within Islamic religious education through a school-based, practice-oriented IHT model that explicitly preserves Islamic values. The finding that the integration of the Islamic values dimension achieved the largest effect size (Cohen's d = 1.36) demonstrates that digital tools can serve as vehicles for spiritual reflection rather than secularizing religious instruction. The practical contribution is a replicable prototype for teacher professional development in developing countries facing similar constraints (high workload, limited bandwidth, diverse teacher readiness). The spontaneous formation of five digital teacher working groups and the commitment of 70% of schools to allocate technology budgets further prove the model's sustainability and its capacity to foster professional learning communities grounded in Islamic educational values.

However, this study has limitations that must be acknowledged. The research was conducted in a single district (Cilaku) with a relatively short follow-up period (three months post-intervention), and it focused primarily on teacher-level outcomes, without longitudinal measurement of student learning gains. Therefore, future research should replicate the model in madrasahs and pesantren, conduct 12-month follow-up studies to measure competence retention, and include student achievement data (e.g., religious literacy, moral reasoning) to assess the ultimate impact on learners. Additionally, scalable implementation strategies through the Ministry of Religious Affairs' teacher working groups (KKG/MGMP) warrant further investigation. Despite these limitations, the Four D-based IHT model offers a viable, evidence-based pathway for transforming IRE teaching in the digital age while maintaining fidelity to Islamic pedagogical values.

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