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Enhancing ICT Competencies of Madrasah Ibtidaiyah Teachers through TPACK-Based Coaching in Digital Learning Media Development in Cirebon City

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abstract

This study aims to examine the effectiveness of TPACK-based coaching in improving the ICT competencies of Madrasah Ibtidaiyah (MI) teachers in Cirebon City. The research employed a quasi-experimental design, specifically a one-group pretest–posttest design, to measure changes in teachers' competencies before and after the intervention. The participants were 25 MI teachers selected through purposive sampling, and the study was conducted in October 2023. The intervention consisted of a one-month intensive TPACK-based coaching program integrating group workshops (8 hours) and individual mentoring (8 hours), focusing on the development of pedagogically sound and contextually relevant digital learning media. Data were collected using the TPACK Survey Instrument (42 items; Cronbach's α = 0.89) and a Digital Media Quality Assessment Rubric. Data analysis was conducted using a paired-samples t-test. The results revealed statistically significant improvements across all TPACK domains ($p < .001$), with the largest effect sizes found in Technological Knowledge ($d = 3.26$) and TPACK integration ($d = 3.12$). Teachers' TPACK competencies increased from a low category ($M = 2.48$, $SD = 0.55$) to a high category ($M = 3.97$, $SD = 0.39$). Furthermore, all participants successfully developed good-quality digital learning media ($M = 3.22$, $SD = 0.48$), including interactive video learning, multimedia presentations, and educational games. These findings confirm that TPACK-based coaching implemented through a quasi-experimental approach is effective in enhancing MI teachers' ICT competencies and digital pedagogical skills, contributing to sustainable professional development in madrasah contexts.

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Penelitian ini bertujuan menganalisis efektivitas pendampingan berbasis TPACK dalam meningkatkan kompetensi ICT guru Madrasah Ibtidaiyah di Kota Cirebon. Penelitian ini merupakan kuasi eksperimen dengan desain *one-group pretest-posttest*, penelitian melibatkan 25 guru MI yang dipilih melalui purposive sampling dan dilaksanakan selama Oktober 2023. Program pendampingan intensif selama satu bulan mengintegrasikan workshop kelompok (8 jam) dan mentoring individual (8 jam) dengan fokus pada pengembangan media pembelajaran digital. Data dikumpulkan melalui Instrumen Survei TPACK (42 item, α = 0.89), dan Rubrik Penilaian Kualitas Media Digital. Analisis paired-samples t-test menunjukkan peningkatan signifikan pada seluruh domain TPACK ($p < .001$), dengan effect size terbesar pada Technological Knowledge ($d = 3.26$) dan TPACK ($d = 3.12$). Kompetensi TPACK guru meningkat dari kategori rendah ($M = 2.48$, $SD = 0.55$) menjadi tinggi ($M = 3.97$, $SD = 0.39$). Seluruh partisipan berhasil mengembangkan media pembelajaran digital berkualitas baik ($M = 3.22$, $SD = 0.48$), dengan jenis media yang beragam meliputi video pembelajaran interaktif (32%), multimedia presentasi (24%), dan game edukasi (20%). Temuan mengonfirmasi bahwa model pendampingan berbasis TPACK efektif meningkatkan kompetensi ICT guru madrasah dan kemampuan mengembangkan media pembelajaran digital yang pedagogis dan kontekstual. Penelitian ini memberikan kontribusi teoretis berupa model pendampingan TPACK untuk madrasah dan rekomendasi praktis bagi pengembangan profesional guru MI yang berkelanjutan.

INTRODUCTION

Digital transformation in education has become an urgent global agenda, especially following the COVID-19 pandemic, which accelerated the adoption of technology in learning (Dhawan, 2020). The integration of information and communication technology (ICT) into the learning process is no longer merely an option but a fundamental necessity to prepare students to face the challenges of the 21st century (Voogt & Pareja Roblin, 2023). In Indonesia, the Merdeka Belajar policy launched by the Ministry of Education, Culture, Research, and Technology emphasizes the importance of innovative, student-centered technology-based learning (Wahyudin et al., 2024). However, the success of technology integration in learning depends heavily on teachers' competence in holistically integrating technology, pedagogy, and learning content (Mishra & Koehler, 2006; Valtonen et al., 2017)

Madrasah Ibtidaiyah (MI), as an Islamic educational institution at the elementary school level, faces complex challenges in adopting learning technology. Research shows that madrasah teachers experience a more significant digital divide compared to public schools, both in terms of technology access and ICT utilization competency (Malla et al., 2023). A study by Hasanah et al., (2022) identified that low digital literacy among madrasah teachers results in minimal learning innovation and limited development of contextual digital learning media. This condition is exacerbated by the limited availability of ongoing

professional development programs specifically designed to improve madrasah teachers' ICT competency, taking into account the specific characteristics and needs of madrasah learning.

Technological Pedagogical Content Knowledge (TPACK), developed by Mishra & Koehler (2006) has become a dominant framework in the international literature for understanding and developing teacher competencies in integrating technology into learning. TPACK emphasizes the importance of synergistic integration between technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) as the foundation for effective technology-based learning (Koehler et al., 2013; Schmid et al., 2020). A meta-analysis conducted by Chai et al., (2013) of 74 studies showed that the TPACK framework effectively improves teachers' technological pedagogical competencies and has a positive impact on learning quality. However, the implementation of TPACK in developing countries, particularly in the context of Islamic education, still requires further exploration given the differences in socio-cultural contexts and technological infrastructure (Baturay et al., 2017).

Teacher professional development through coaching has been shown to be more effective than conventional training in improving competency and transforming learning practices (Kraft et al., 2018). Coaching provides teachers with opportunities to learn in authentic practice contexts, receive direct feedback, and build competency gradually through reflection and continuous improvement (Teemant, 2014). Research by Tondeur et al. (2012) shows that systematic and structured TPACK-based coaching can improve teacher self-efficacy in integrating technology and encourage the development of innovative learning practices.

Cirebon City, one of the regions with a high concentration of madrasahs in West Java, continues to face challenges related to the ICT competencies of Madrasah Ibtidaiyah (MI) teachers. A preliminary descriptive survey conducted in September 2023 involved 45 MI teachers and employed a validated self-administered questionnaire based on TPACK and ICT competency indicators (Cronbach's $\alpha = 0.82$). The results showed that 78% of teachers still relied on conventional teaching methods, 75% experienced difficulties in using digital learning applications, and only 25% had independently developed digital learning media. These findings indicate an urgent need for a systematic and empirically grounded program to improve MI teachers' ICT competencies.

The development of digital learning media was chosen as the primary focus of this mentoring program for several theoretical and practical reasons. First, learning media is a concrete representation of TPACK integration, where teachers directly apply knowledge of technology, pedagogy, and content in creating learning resources (Mishra & Koehler, 2006). Second, the process of developing digital learning media facilitates active and constructivist learning for teachers through hands-on experience designing, developing, and evaluating digital products (Kay, 2006). Third, the digital learning media developed by teachers can be directly implemented in learning practices, thus having a direct impact on the quality of student learning (Kimmons et al., 2020).

Although there are several studies on developing teachers' TPACK competencies, research specifically exploring the implementation of TPACK-based mentoring for elementary madrasah teachers in Indonesia is still very limited. The majority of previous research focuses on the context of general schools or secondary education (Pamuk et al.,

2015), while the unique characteristics of madrasahs that integrate general and religious education require a special approach to developing teachers' ICT competencies (Zuhdi, 2018). Furthermore, research on effective and sustainable mentoring models for the resource-constrained madrasah context remains a gap in the literature (Ubaedullah et al., 2025).

The objectives of this study are: (1) to analyze the TPACK competency profile of MI teachers in Cirebon City before and after mentoring; (2) to implement a TPACK-based mentoring model that is appropriate to the characteristics of elementary madrasas; and (3) to measure the effectiveness of mentoring on improving teachers' abilities in developing digital learning media. The results of this study are expected to provide theoretical contributions in the form of a contextual TPACK mentoring model for madrasas, and provide practical recommendations for policy makers in designing more effective and sustainable MI teacher professional development programs.

METHODS

Reseacrh Design

This study used a one-group pretest-posttest design to assess the effectiveness of TPACK-based mentoring in improving the ICT competency of elementary school teachers. This quasi-experimental design was chosen due to the practical limitations of forming a control group in the madrasah context and the ethical consideration of providing professional development opportunities to all participating teachers (Creswell & Creswell, 2018). The study was conducted for one month in October 2023, integrating quantitative data on TPACK competency development with qualitative insights into teachers' experiences during the mentoring process.

Participant

The research participants consisted of 25 elementary school teachers in Cirebon City, West Java, who were selected through purposive sampling based on the following criteria: (1) active teaching status at MI Cirebon City; (2) willingness to participate in an intensive mentoring program; (3) having basic computer literacy; and (4) commitment to developing digital learning media. The demographic profile of the participants included 16 female teachers and 9 male teachers with 3-18 years of teaching experience. 78% had a bachelor's degree in elementary school teacher education, while 22% had a degree in religious education. Only 6 teachers (24%) had previous experience developing digital learning media.

Procedure

The study was conducted in four systematic stages. The preparation stage (Week 1) included institutional permission, informed consent, a TPACK competency pretest, and needs analysis interviews. The mentoring implementation stage (Weeks 2 and 3) consisted of structured TPACK-based mentoring sessions through a combination of workshops, hands-on practice, collaborative design activities, and individual mentoring. Each participant received a total of 16 contact hours, including 8 hours of group workshops on TPACK principles and digital media development tools, and 8 hours of individual mentoring sessions for personal media development projects. The implementation and reflection stage (Week 4) required participants to apply the developed digital media in actual learning and engage in reflective practice sessions. The evaluation stage included a posttest, focus group discussions, and the collection of digital media products for quality assessment.

Data Collection

Three main instruments were used in data collection. First, the TPACK Survey Instrument adapted from Schmidt et al. (2009) to measure seven TPACK domains: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPACK). The instrument consists of 42 items with a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) and a Cronbach's alpha reliability of 0.89. Second, the Digital Media Quality Assessment Rubric was developed based on the criteria of Kimmons et al., (2020) evaluating digital media products on five dimensions: pedagogical appropriateness, content accuracy, technological functionality, design aesthetics, and usability with a 4-point scale.

Data Analysis

Quantitative data from the TPACK survey were analyzed using SPSS version 29. Descriptive statistics (mean, standard deviation, percentage) were calculated to map participants' TPACK competency profiles. Paired-samples t-tests were conducted to test for significant differences between pretest and posttest scores across all TPACK domains, with Cohen's d used to determine effect size (Cohen et al., 2021). The significance level was set at $\alpha = 0.05$. Digital media products were independently assessed by three raters using a quality assessment rubric, with inter-rater reliability using the Fleiss' kappa coefficient.

RESULTS AND DISCUSSION

RESULTS

TPACK Competency Profile of MI Teachers Before Coaching

The pretest results indicated that the TPACK competency profile of MI teachers in Cirebon City remained in the low to moderate category. Table 1 presents the average scores of each TPACK domain before the implementation of the coaching program.

Table 1.
TPACK Competency Profile of MI Teachers Before Coaching

Domain TPACK	Mean	SD	Kategori
Technological Knowledge (TK)	2.34	0.52	Low
Pedagogical Knowledge (PK)	3.45	0.48	Moderate
Content Knowledge (CK)	3.78	0.41	High
Technological Pedagogical Knowledge (TPK)	2.56	0.58	Low
Technological Content Knowledge (TCK)	2.42	0.61	Low
Pedagogical Content Knowledge (PCK)	3.52	0.45	Moderate
TPACK	2.48	0.55	Low

The data in Table 1 indicates that MI teachers have high content knowledge (CK) with an average score of 3.78, followed by pedagogical content knowledge (PCK) and pedagogical knowledge (PK) in the medium category with scores of 3.52 and 3.45, respectively. However, domains involving technology integration show low scores, especially in Technological Knowledge (TK = 2.34), Technological Content Knowledge (TCK = 2.42), and TPACK (2.48). These findings confirm the results of the preliminary survey that showed a significant gap in the technological competency of MI teachers.

Improvement of TPACK Competencies After Coaching

Table 2 displays a comparison of TPACK competency scores before and after the implementation of the TPACK-based mentoring program, along with the results of the paired-samples t-test.

Table 2. Comparison of TPACK Competencies Before and After Mentoring

TPACK Domain	Pretest	Posttest	t	df	p	Cohen's d
TK	2.34)	3.89	-12.45	24	<.001	3.26
PK	3.45	4.12	-6.78	24	<.001	1.56
CK	3.78	4.23	-5.12	24	<.001	1.18
TPK	2.56	3.95	-11.23	24	<.001	2.76
TCK	2.42	3.82	-10.89	24	<.001	2.58
PCK	3.52	4.18	-6.34	24	<.001	1.61
TPACK	2.48	3.97	-13.67	24	<.001	3.12

The results of the paired-samples t-test analysis showed that there was a significant increase in all TPACK competency domains after the implementation of mentoring ($p < .001$). The most substantial increase occurred in the Technological Knowledge (TK) domain with a very large effect size (Cohen's d = 3.26), increasing from M = 2.34 (SD = 0.52) to M = 3.89 (SD = 0.43). The TPACK domain also experienced a very significant increase with an effect size of 3.12, increasing from the low category (M = 2.48) to the high category (M = 3.97). The Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK) domains also showed substantial increases with effect sizes of 2.76 and 2.58, respectively.

Although the Pedagogical Knowledge (PK), Content Knowledge (CK), and Pedagogical Content Knowledge (PCK) domains had higher pretest scores, these three domains still experienced significant improvements with a large effect size (Cohen's d > 1.0). This indicates that the mentoring program not only improved technological competence but also strengthened pedagogical and content understanding in the context of integrated learning technology.

Quality of Developed Digital Learning Media

All participants successfully developed and completed digital learning media products during the mentoring program. Table 3 displays the results of the teacher-developed digital learning media quality assessment based on five assessment dimensions.

Table 3. Results of the Digital Learning Media Quality Assessment

Assessment Dimension	Mean	SD	Category
Pedagogical Appropriateness	3.28	0.54	Good
Content Accuracy	3.52	0.51	Very Good
Technological Functionality	3.16	0.62	Good
Design Aesthetics	2.92	0.58	Good
Usability	3.24	0.56	Good
Total Score	**3.22**	**0.48**	**Good**

The assessment results showed that the digital learning media developed by teachers was in the good category with a total average score of 3.22 (SD = 0.48). The content accuracy dimension obtained the highest score (M = 3.52), indicating that teachers were able to integrate learning materials accurately and in accordance with the MI curriculum. The pedagogical suitability (M = 3.28) and usability (M = 3.24) dimensions also showed good quality, reflecting the teacher's ability to design media that is in accordance with learning principles and easy for students to use. The design aesthetics dimension obtained the lowest

score (M = 2.92), although it is still in the good category. This indicates that teachers still need further development in the visual design and interface aspects of learning media. The Fleiss' kappa coefficient of 0.78 indicates a substantial level of agreement among three independent assessors, confirming the reliability of the assessment results.

Types of Digital Learning Media Developed

Based on the analysis of the products developed, teachers created various types of digital learning media according to the needs and characteristics of their respective subjects. Table 4 displays the distribution of digital learning media types developed.

Table 4. Distribution of Digital Learning Media Types Developed

Media Type	Frequency	Percentage
Interactive Video Learning	8	32%
Interactive Multimedia Presentation	6	24%
Digital Educational Games	5	20%
Interactive E-Modules	4	16%
Interactive Digital Quizzes	2	8%
Total	**25**	**100%**

Data shows that interactive learning videos are the most commonly developed media type (32%), followed by interactive multimedia presentations (24%), and digital educational games (20%). The diversity of media developed indicates that the mentoring program has successfully facilitated teachers' creativity and independence in selecting digital platforms and applications appropriate to their respective learning contexts.

Discussion

The results of the study indicate that the TPACK-based mentoring program significantly improved the ICT competency of MI teachers in Cirebon City. The substantial increase in the Technological Knowledge (TK) domain with an effect size of 3.26 confirms the findings of Kraft et al., (2018) that intensive mentoring is more effective than conventional training in developing teachers' technological skills. The 8-hour individual mentoring provides teachers with the opportunity to learn to operate digital tools in the context of authentic practice with direct support from mentors, in contrast to mass training which tends to be transmissive.

The significant improvement in the TPACK domain aligns with Chai et al.'s (2013) meta-analysis, which concluded that TPACK framework-based interventions are capable of developing teachers' integrative abilities in combining technological, pedagogical, and content knowledge. This finding reinforces Mishra and Koehler's (2006) argument that TPACK is not simply the sum of the three knowledge domains, but rather a complex form of knowledge that develops through the experience of designing and implementing technology-based learning. The process of developing digital learning media in this study serves as an authentic learning experience that facilitates the holistic construction of TPACK knowledge (Kay, 2006).

Although the PK, CK, and PCK domains had higher pretest scores, these three domains still experienced significant improvement. This indicates that the mentoring program not only added technological competency to teachers but also deepened pedagogical and content understanding in the context of digital learning. This finding supports the transformative perspective of TPACK (Teaching, Teaching, and Learning) by Angeli & Valanides, (2009)

which states that technology integration changes how teachers understand pedagogy and content, rather than simply adding technology to existing practices.

The quality of the digital learning media developed by teachers (M = 3.22) indicates that TPACK-based mentoring successfully facilitated the development of high-quality digital products, even within a relatively short period of time (1 month). A high score on the content accuracy dimension (M = 3.52) reflects the strength of MI teachers in mastering learning materials, while a good score on pedagogical suitability (M = 3.28) indicates the teachers' ability to apply learning principles appropriate to the characteristics of MI students. These findings confirm Tondeur et al.'s (2012) argument that systematic mentoring can increase teachers' self-efficacy in integrating technology in a pedagogically meaningful manner.

The relatively lower score on the design aesthetics dimension (M = 2.92) indicates that developing visual design skills requires more time and extensive practice. This aligns with the findings of Kimmons et al. (2020) who stated that graphic and user interface design competencies require continuous learning and cannot be mastered in short-term programs. The practical implication is the need for continued mentoring programs specifically focused on developing competency in learning media design.

The diversity of media developed by teachers (five different categories) demonstrates that the mentoring program successfully fostered creativity and did not limit teachers to a single tool or application. The dominance of interactive learning videos (32%) aligns with the global trend of using video in digital learning (Kay, 2014), while the development of educational games (20%) indicates that teachers are beginning to explore gamification approaches in Islamic elementary school (MI) learning. These findings reinforce the argument of Harris et al. (2009) about the importance of providing teachers with flexibility in selecting activity types and technologies appropriate to their specific learning contexts.

In the context of Islamic elementary schools (madrasah ibtidaiyah), the success of this mentoring program is particularly significant given the resource and access limitations commonly faced by Islamic educational institutions (Zuhdi, 2018). The results show that with appropriate program design and intensive mentoring, Islamic elementary school (MI) teachers are able to develop ICT competencies equivalent to international standards. This opens up opportunities for digital transformation of learning in madrasahs, which have traditionally lagged behind public schools (Malla et al., 2023).

The limitations of this study include: (1) the relatively short duration of mentoring (1 month) so that it is not possible to measure the sustainability of competencies in the long term; (2) the absence of a control group which limits the ability to generalize causality; and (3) it has not measured the impact of the developed learning media on student learning outcomes. Further research is needed with a longitudinal design to examine the sustainability of TPACK competencies and their impact on the quality of MI student learning.

CONCLUSION

This study shows that the TPACK-based mentoring program significantly improved the ICT competency of elementary school teachers in Cirebon City. Paired-samples t-test analysis confirmed significant improvements across all TPACK competency domains ($p < .001$), with the most substantial improvements occurring in Technological Knowledge (Cohen's d = 3.26) and TPACK (Cohen's d = 3.12). The teachers' TPACK competency profile

improved from the low-moderate category (M = 2.48) to the high category (M = 3.97) after one month of intensive mentoring.

All participants successfully developed high-quality digital learning media (M = 3.22), encompassing five different media types: interactive learning videos (32%), interactive multimedia presentations (24%), digital educational games (20%), interactive e-modules (16%), and interactive digital quizzes (8%). The content accuracy dimension received the highest score (M = 3.52), while design aesthetics still requires further development (M = 2.92).

These findings confirm that a TPACK-based mentoring model that integrates group workshops, hands-on practice, and individual mentoring is an effective strategy for developing madrasah teachers' ICT competencies in a resource-constrained context. The mentoring program not only improves technological skills but also deepens pedagogical and content understanding within an integrated digital learning context.

Practical implications of this research include: (1) the need to adopt a continuous mentoring model as a professional development strategy for MI teachers; (2) the importance of providing adequate time and support for teachers to develop authentic digital learning media; and (3) the urgency of further programs focused on improving visual design competencies for learning media. For policymakers, the results of this study can serve as a basis for developing more systematic and contextual programs to improve madrasah teachers' ICT competencies.

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