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Reconstruction Of The TPACK Framework Through Islamic Pedagogical Knowledge: Development And Effectiveness Of The Smartpai-Assisted I-TPACK-DL Model In Islamic Religious Education Learning

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Abstract

Islamic Religious Education (PAI) learning in the digital era faces tensions between the demands of technological integration, the diversity of student characteristics, and the value orientation that is the core of Islamic education. The Technological Pedagogical and Content Knowledge (TPACK) framework has not accommodated the normative dimension of Islam, while technology-based learning practices tend to be technocentric and uniform. This research aims to develop and test the I-TPACK-DL Model, which is a differentiated PAI learning model based on the integration of TPACK with Islamic pedagogical values implemented through the SmartPAI application. The research used a Research and Development approach with three stages of field tests involving 224 Phase D junior high school students at SMPN 5 Bojonegoro and one control class. Validation was carried out by learning design experts, material experts, and media experts, while effectiveness was measured through pretest-posttest differential tests, Cohen effect size, and covariance analysis (ANCOVA). The validation results obtained percentages of 86.00% (design), 88.24% (material), and 83.53% (media) in the feasible to very feasible categories. The effectiveness test showed a significant improvement in learning outcomes in six of the seven experimental classes (85.71%), with the mean effect size evolving from 0.699 to 0.716, and superiority to the control class was demonstrated through ANCOVA (p between 0.033 to 0.043). The novelty of the research lies in the formulation of Islamic Pedagogical Knowledge (IPK) as the fourth domain of TPACK, a five-phase syntax that integrates the Joyce and Weil models with Tomlinson differentiation, as well as the positioning of SmartPAI as an implementing system, not just a medium. This model has implications for the adaptive PAI learning design without losing the

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orientation of manners and Islamic values.

Keywords: Islamic Pedagogical Knowledge; TPACK; differentiated learning; Islamic Religious Education; SmartPAI

INTRODUCTION

The digital transformation of education puts teachers in a position that demands integrative mastery between content, pedagogical strategies, and technology. The TPACK framework formulated by Mishra and Koehler emphasizes that the effectiveness of digital learning is not determined by the presence of technology, but by the meaningful integration between content knowledge, pedagogical knowledge, and technological knowledge along with the interdomain relationships that make up PCK, TCK, TPK, and TPACK (Weidlich & Kalz, 2026). This framework has proven to be relevant across subjects, including in learning contexts that require careful technological-pedagogical decision-making so that teachers' technological knowledge correlates with students' active engagement and learning (Wu et al., 2025). Recent developments have even expanded the framework towards Intelligent-TPACK when artificial intelligence challenges the basic assumptions of conventional technology integration that have been deterministic (Chiu, 2025).

Islamic Religious Education learning is in a more complex field. In addition to demanding technological integration, PAI carries a value orientation that cannot be reduced to cognitive achievements. Islamic education understands the learning process as the formation of a whole human being who is knowledgeable, charitable, and moral, so that technology is positioned as a means, not a purpose (Ahmed & Chowdhury, 2025). Studies of Islamic pedagogy show that the cultivation of manners and the internalization of values require a planned pedagogical design, not incidental practices that take place spontaneously in between learning (Memon et al., 2021). The diversity of students in cognitive capacity, readiness, and learning styles reinforces the need for responsive learning, as shown by studies on the application of multiple intelligences that are able to increase learning engagement (Ghaznavi et al., 2021). Collaborative learning for prospective PAI teachers in Indonesia also shows that academic self-concept and Islamic literacy can be strengthened through design that respects diversity (Fakhruddin et al., 2025).

This is where the research gap becomes apparent. The TPACK framework in its original form is value-neutral, so the integration of technology is not automatically directed towards the goal of Islamic education. The development of TPACK in the teacher education environment still

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focuses on general technical and pedagogical competencies without linking them to the value framework (Weidlich & Kalz, 2026). Teacher preparation programs that are responsive to the diversity of students also do not explicitly link differentiation strategies with value orientation, but stop at instructional skills (Hinojosa, 2023). Studies of contemporary Islamic pedagogy have emphasized the importance of manners and the justice of learning, but have rarely translated them into operational syntax integrated with technology (Ahmed & Chowdhury, 2025; Memon et al., 2021). The unfilled conceptual space is how to formulate a knowledge framework for PAI teachers that unites Islamic values, learning differentiation, and technological integration in one coherent construction that is empirically tested.

Preliminary findings in the field confirm the gap. In-depth interviews with four PAI teachers at SMPN 5 Bojonegoro showed four structural problems, namely heterogeneous classes managed with uniform treatment, the dominance of conventional methods without differentiation of content, processes, and products, the partial and technical use of technology, and the reflection of Islamic values that have not been structured in the learning design. These four issues show that the integration of technology without value control has the potential to give birth to a technocentric approach, while uniform learning is contrary to the principle of pedagogical justice that is at the core of Islamic education. This condition is in line with the demands of the PAI Learning Outcomes Phase D which emphasizes strengthening manners, critical thinking, moderate attitudes, and responsible use of technology.

This research offers a contribution in the form of the I-TPACK-DL Model, which is a differentiated PAI learning model based on the integration of TPACK with Islamic pedagogical values implemented through the SmartPAI application. The main theoretical contribution lies in the formulation of Islamic Pedagogical Knowledge (IPK) as the fourth domain that expands the TPACK framework, as well as the positioning of SmartPAI as a support system for model implementation, not just digital media. Five research questions guide this study: how the model is conceptually developed; how valid, practical, and effective the model is; how SmartPAI is implemented in the model; how the model improves differentiated PAI learning; and what theoretical contribution GPA makes to the TPACK framework. The novelty of this research is the explicit articulation of GPA as a normative controller of the TPACK framework which has been absent from the learning technology integration literature.

RESEARCH METHODS

The research uses a modified Research and Development approach according to the

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characteristics of differentiated PAI learning. The development procedure moves from needs analysis, conceptual construction of the model, expert validation, revision, to three stages of a staged field test, namely limited field test, main field test, and operational field test. Tiered design allows for continuous improvement of the model based on evidence at each stage, while testing the stability of implementation on an increasingly broad scale.

The subject of the study is Class VII Phase D students of SMPN 5 Bojonegoro. The limited field test involved 32 students (Class VII J), the main field test involved 64 students (Class VII A and VII H), and the operational field test involved 128 students (Class VII B, C, D, and E) with Class VII G as the control class that applied conventional learning. The material is focused on the fiqh of worship, especially prostration of gratitude, prostration of recitation, and prostration of sahwi, which are in line with the Learning Outcomes of PAI Phase D.

The validation instrument is in the form of an assessment sheet on a Likert scale of 1 to 5. The learning design expert sheet covers ten aspects of model construction, the material expert sheet covers 17 items on five components in the form of material, language, presentation, learning differentiation, and TPACK integration, while the media expert sheet includes 17 items on four components in the form of design, validity, practicality, and effectiveness. Effectiveness data was obtained through pretest and posttest learning outcomes, while process data was collected through observation of syntax implementation, material reflection, and media reflection. The initial diagnostic assessment measures three dimensions of differentiation, namely learning readiness, learning interest, and learning profile.

The feasibility analysis was carried out by calculating the percentage of scores and interpreting them based on the five-level eligibility criteria, where the achievement of 85 to 100% was categorized as very feasible and 70 to 84% was categorized as feasible. The effectiveness analysis began with the Kolmogorov-Smirnov normality test to determine the different types of tests. Normally distributed data were analyzed with the Paired Samples T-Test, while data that did not meet the normality assumptions were analyzed with the Wilcoxon Signed-Rank Test. The power of influence is calculated with Cohen's d according to Sawilowsky's categorization. The superiority of the model over conventional learning was tested through covariance analysis (ANCOVA) with pretest scores as covariates and learning model types as category variables. The research procedure pays attention to ethical principles in the form of school approval, confidentiality of student identities disguised in the form of initials, and voluntary participation without academic risk.

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RESEARCH RESULTS

Philosophical, Theoretical, and Curricular Foundations of the Model

The construction of the I-TPACK-DL Model departs from the Islamic education paradigm which views learning as a process of forming human beings which includes intellectual, spiritual, moral, and social dimensions. The principle of muwāfaqat al-mudarris li al-murīd from Al-Ghazali places the teacher's understanding of the capacities, maturity, interests, and conditions of students as the basis for determining the learning process, so that differentiation is read as the actualization of the classical Islamic pedagogical tradition, not just the adoption of a modern approach (Hanafi & Achmad, 2026). The delivery of material that exceeds the ability of students is seen as pedagogical injustice, while neglecting the potential of students is seen as not in accordance with nature. The concept of ta'dīb Al-Attas completes the foundation by placing knowledge, educators, and students in the right order, so that the learning objectives of PAI cannot be reduced to cognitive competence, technology functions as a medium of ta'dīb, and differentiation is a response to the diversity of levels of manners and moral maturity (Holis & Damyati, 2025).

The synthesis of Al-Ghazali and Al-Attas' thought resulted in Islamic Pedagogical Knowledge (GPA) as the fourth domain of TPACK. GPA is understood as the knowledge of PAI teachers regarding the integration of Islamic values, Islamic teaching ethics, orientation in the formation of adab, and Islamic pedagogical principles into the overall instructional decision-making. The values of 'adl, rahmah, hikmah, and tarbiyah are not positioned as separate end goals, but rather as principles that color the way teachers analyze needs, choose strategies, utilize technology, design assessments, and facilitate reflection (Ahmed & Chowdhury, 2025). The psychopedagogical foundation strengthens this argument through Maslow's hierarchy of needs which asserts that the internalization of values only develops when basic needs are met (Soikkeli, 2024), Alderfer's ERG theory which shows the dynamics of existential needs, relationships, and growth (Nilsson & Cederqvist, 2025), and Gardner's compound intelligence which explains the variations in the way learners understand and express religious knowledge (Ghaznavi et al., 2021). A curricular analysis of PAI Learning Outcomes Phase D shows that the achievement structure requires the integration of knowledge, values, skills, and learning experiences as a whole. The achievement characteristics of the four elements emphasize the need for adaptive, contextual, and valuable learning, as presented in Table 1.

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Table 1. Characteristics of PAI Phase D Learning Outcomes

Elements	Characteristics of Learning Outcomes
The Qur'an and Hadith	Understand the definition and position of the Qur'an and Hadith as the source of Islamic teachings, environmental conservation as Islamic teachings, moderate attitudes in religion, and the scientific spirit of Islamic intellectuals
Faith	Exploring the six pillars of faith as the foundation of faith
Morals	Understand the role of prayer as self-protection, the importance of tabayyun information, the definition of tolerance based on the Qur'an and Hadith, and the dimension of beauty and art in Islam
Fiqh	Understand the internalization of the value of prostration and prayer, the concepts of muʿāmalah, riba, rukhsah, fiqh schools, and the provisions of qurbani worship

The characteristics of achievement that require critical thinking, tabayyun, strengthening tolerance, and internalizing values show that PAI learning requires the integration of pedagogy, content, and technology that is implemented in a meaningful and reflective manner. The diversity of achievement elements also shows the need for differentiation so that students develop their potential according to their readiness, interests, and learning profiles.

Conceptual Construction of the I-TPACK-DL Model

The model is constructed through a synthesis between empirical findings, curricular demands, and theoretical foundations. Field gaps are not only identified, but also linked to ideal pedagogical conditions and their implications for model structures, as presented in Table 2.

Table 2. Synthesis of Empirical Gaps and Implications for Model Construction

Guru Code	Empirical Gap	Pedagogical Ideal Conditions	Model Construction Implications
HYT	Heterogeneous classes are managed with uniform learning	Learning responsive to readiness, interests, and learning profiles based	Analysis of student characteristics as a basis for differentiation with

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Guru Code	Empirical Gap	Pedagogical Ideal Conditions	Model Construction Implications
	without differentiation	on Al-Ghazali and multiple intelligences	GPA as a normative controller
SYT	Dominate conventional methods without differentiation of content, processes, and products	Tomlinson-based differentiation supported by Maslow's theory and Alderfer's ERG	A syntax that systematically integrates content, process, and product differentiation
AFN	Technology is used partially without the pedagogical integration and substance of PAI	TPACK integration means with technology as a tool	Integration of TPACK in GPA control so that technology has Islamic value
RN	The reflection of Islamic values has not been structured in the learning design	Inculcation of manners and internalization of values based on the concept of ta'dīb	GPA as a normative foundation that directs all components towards the formation of insān kāmil

The model is constructed through four core components that form a pedagogical cycle, namely Islamic pedagogy as a normative controller, TPACK as a framework for knowledge integration, differentiated learning as pedagogical principles, and digital media as an implementive means. The function and conceptual rationality of each component are presented in Table 3.

Table 3. Model I-TPACK-DL Components and Conceptual Rationality

Components	Pedagogical Function	Conceptual Rationality
Islamic Pedagogy	Normative operators at each point of pedagogical decision-making	A principle that colors all components from within, not just the end goal
TPACK	A framework for meaningful	Being in control of the values and

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Components	Pedagogical Function	Conceptual Rationality
	integration of PAI content, pedagogy, and technology	needs of the learners, not technology for technology
Differentiated Learning	The realization of the values of 'adl and rahmah towards heterogeneous students	Includes differentiation of content, processes, products, and assessments based on readiness, style, and learning profile
Digital Media	A tool that bridges conceptual frameworks with classroom practice	Selected based on suitability for learners' needs and PAI goals, not technology popularity
Five-phase syntax	Reflective pedagogical decision-making flow from diagnosis to reflection of values	It is cyclically reflective, rather than a linear procedure, allowing for contextual adaptation
Instructional & accompanying impact	PAI's academic achievements as well as the formation of Islamic character	The explicit separation affirms that PAI's success goes beyond academic achievement

The five-phase syntax includes analysis of learner characteristics, TPACK knowledge integration, learning experience design, implementation of differentiated assessments, and reflection of Islamic values. This flow is a reflective cycle so that teachers can return to the previous phase according to the dynamics of the class. Each TPACK domain is translated into the SmartPAI model structure and features, as presented in Table 4.

Table 4. Operationalization of TPACK Domains in I-TPACK-DL and SmartPAI Models

Domain TPACK	Implementation in the Learning Model	Implementation in SmartPAI
CK	Contextual and differentiated PAI material	Multiformat material: video, audio, PPT, concept map
PK	Differentiation strategies, formative assessments, learning interactions	Digital learning and reflection groupings

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Domain TPACK	Implementation in the Learning Model	Implementation in SmartPAI
Kindergarten	Technology as a learning support system	Teacher dashboard, digital evaluation, learning monitoring
PCK	Adjustment of strategies to the character of PAI material	Learning activities according to the character of the material
TPK	Integration of technology in differentiation of learning	Automated pretest-posttest and real-time feedback
TCK	Selection of media according to the substance of PAI material	Interactive multimedia PAI learning
TPACK	Simultaneous integration of content, pedagogy, and technology	SmartPAI as an implementing system model

SmartPAI Model and Application Eligibility

Eligibility is assessed through three panels of validators. Learning design experts assessed ten aspects of model construction and obtained a total score of 43 out of 50 or 86.00%, with aspects of Islamic pedagogical integration, syntax clarity, and model novelty obtaining perfect scores. PAI subject matter experts assessed 17 items on five components and obtained a score of 75 out of 85 or 88.24% with an average of 4.41, where the language and integration components of TPACK obtained perfect scores. Media experts assessed 17 items on four components and obtained a score of 71 out of 85 or 83.53% with an average of 4.18, with the validity component obtaining a perfect score. The third recapitulation of validation is presented in Table 5.

Table 5. Recapitulation of Expert Validation Results of Model and SmartPAI

Panel Validator	Score	Max Score	Percentage	Categories
Learning design expert	43	50	86,00%	Highly Worth It
PAI material expert	75	85	88,24%	Highly Worth It
Learning media experts	71	85	83,53%	Worthy

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The validator's notes are the basis for the directed revision. The design expert suggested the affirmation of the interconnectedness of Islamic pedagogy, differentiation, and TPACK in each phase of the syntax as well as the details of the function of SmartPAI as a supporting system. The subject matter expert highlighted one point on the critical thinking stimulation aspect that obtained a decent score, so the developer added contextual case studies and Higher Order Thinking Skills-based exercises to each subsubject. Media experts highlighted three points on audiovisual clarity, ease of use, and application guidance, which were followed up with image resolution improvements, navigation simplification, and redrafting of user guides. The entire revision confirms that the final product has passed academic quality control before empirical testing.

Learning Profile and Syntax Implementation

Diagnostic mapping in the limited field test showed a marked variation in learning characteristics in Class VII J. Learning styles were multimodal with auditory dominance of 53.12%, followed by visual or audiovisual 21.88%, kinesthetic 15.62%, and verbal 6.25%. Conceptual understanding, emotional response to the Qur'an, and experience of worship practice are also diverse, as presented in Table 6.

Table 6. Initial Diagnostic Profile of Class VII J Students (n = 32)

Diagnostic Dimensions	Dominant Categories	Percentage
Understanding the concept of prostration of gratitude	Understanding prostration of gratitude as an expression of gratitude	84,38%
Emotional response to the Qur'an	Feeling calm and peaceful	78,12%
The Importance of Sahib's Practice	Never implemented	56,25%
Dominant learning style	Auditory	53,12%

This distribution is the empirical basis for adaptive grouping through SmartPAI into Groups A, B, and C, while legitimizing the provision of multiformat content. The implementation of the syntax develops progressively. In the limited test, all components were at a stable-initial level with interface display constraints on content differentiation components. In the main test all

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components move towards a stable and near-optimal level, while in the operational test almost all components reach an optimal and consistent level. This development pattern is in line with the principle of continuous improvement in development research.

Effectiveness of the Test Between Stage Models

Effectiveness is measured through a pretest-posttest differential test whose type of test is determined by the results of the normality test. In the limited field test, the data was distributed normally, with a significance value of pretest normality of 0.188 and posttest 0.052, so the Paired Samples T-Test was used. The results showed an average difference of -8.938, $t(31) = 3.957$, $p < 0.001$, and an effect size of 0.699 in the medium category. In the main field test, Class VII A had an abnormal posttest distribution so it was analyzed with the Wilcoxon Signed-Rank Test, with 25 students improving, 5 decreasing, 3 fixed, and $Z = -3.721$ ($p < 0.001$). Class VII H met the assumption of normality so the Paired Samples T-Test was used, with an average difference of -7.344, $t(31) = 4.481$, $p < 0.001$. The effect size of the two classes was different, namely 0.849 in VII A and 0.508 in VII H, in line with the difference in the initial characteristics of the experience of worship practice. A summary of the inter-stage effectiveness test is presented in Table 7.

Table 7. Summary of Learning Outcome Effectiveness Tests Between Field Test Stages

Class (n)	Stages	Statistical Test	Test Results	p	Cohen's d
VII J (32)	Limited	Paired T-Test	Mean diff -8,938; t(31)=3.957	< 0.001	0.699 (medium)
VII A (33)	Home	Wilcoxon	Z=-3,721; up 25, down 5, stay 3	< 0.001	0.849 (large)
VII H (32)	Home	Paired T-Test	Red diff -7,344; t(31)=4,481	< 0.001	0.508 (medium)
VII B (32)	Operational	Paired T-Test	The red diff -5,469; t(31)=2,781	0,018	0.544 (medium)
VII C (32)	Operational	Wilcoxon	Z=-1,991; up 21, down 8, stay 3	0,047	0.280 (small)
VII D (32)	Operational	Wilcoxon	Z=-3,274; up 25, down 4, stay 3	0,001	1,323 (very large)

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Class (n)	Stages	Statistical Test	Test Results	p	Cohen's d
VII E (32)	Operational	Wilcoxon	Z=-1.628; up 19, down 8, stay 5	0,103	insignificant

In the operational field test, three of the four experimental classes showed significant improvements, namely VII B (p = 0.018), VII C (p = 0.047), and VII D (p = 0.001), while VII E was insignificant (p = 0.103). The wide range of effect size from 0.280 in VII C to 1.323 in VII D reflects the interaction between class characteristics, teacher implementation quality, and learning dynamics. In aggregate, six out of seven experimental classes or 85.71% showed statistical significance. The insignificance in VII E is suspected to be influenced by contextual factors in the form of student characteristics and class dynamics.

The superiority of the model over conventional learning was tested through ANCOVA with Class VII G as the control and the pretest score as the covariate. The learning model variables contributed significantly to the overall comparison, while the pretest covariates emphasized the role of initial ability in the final outcome. A summary of ANCOVA's results is presented in Table 8.

Table 8. Summary of Experimental Class ANCOVA Tests against Control Class VII G

Comparison	F Model	Sig. Model	F Pretest	Sig. Pretest	Sig. Model
VII B vs G	12,988	< 0.001	11,018	0,002	0,033
VII C vs G	30,064	< 0.001	33,636	< 0.001	0,036
VII D vs G	30,064	< 0.001	33,636	< 0.001	0,036
VII E vs G	17,375	< 0.001	11,874	0,001	0,043

The F-value of the learning model variable ranged from 4.254 to 4.776 with a significance between 0.033 and 0.043 in the entire comparison. This consistency shows the stability of the model's contribution after the initial ability is controlled, while empirically proving that the SmartPAI-assisted I-TPACK-DL Model is more effective than conventional learning in improving PAI learning outcomes.

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Development of Material Reflection, Media, and Effectiveness

Cross-stage analysis shows consistent strengthening of implementation quality. The average material reflection increased from 94.34% in the limited test to 96.34% in the main test and 96.71% in the operational test. The most prominent increase was seen in the indicators of appreciation of the Qur'an, the recitation of istighfar, efforts to get closer to Allah, and the implementation of prostration of recitation, while the indicators of acknowledgment of mistakes and the implementation of prostration of gratitude were stable at high achievements. The development of the material reflection indicator is presented in Table 9.

Table 9. Development of Material Reflection Between Test Stages (%)

Indicator	Limited	Home	Operational
Admitting mistakes	100,0	100,0	100,0
Apologize	96,9	98,4	98,4
Internalizing the Qur'an	84,4	89,1	88,3
Be thankful for the blessings	90,6	93,8	93,8
Reciting istighfar	90,6	92,2	94,5
Drawing Closer to Allah	93,8	95,3	96,9
Bowing down to the Prophet	87,5	92,2	93,0
Average	**94,34**	**96,34**	**96,71**

The average media reflection increased more sharply, from 86.66% to 93.82% and 96.79%, with a significant proportion of media items moving from seven out of eleven items (63.6%) to all items (100%) since the main test. The aspect of diversity of format and image quality jumped from less than 70% to 100%, while the relevance aspect of PowerPoint actually decreased and required further study. The development of key indicators of media reflection is presented in Table 10.

Table 10. Development of Key Indicators of SmartPAI Media Reflection Between Stages (%)

Media Indicators	Limited	Home	Operational
Diversity of material formats	62,5	96,9	100,0
Image quality	65,6	96,9	100,0

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Media Indicators	Limited	Home	Operational
Helpful videos	71,9	67,2	92,2
PowerPoint helps	68,8	67,2	62,5
Posttest questions are easy to understand	93,8	100,0	100,0
Overall average	**86,66**	**93,82**	**96,79**

The average aggregate effect size was above the moderate threshold at all stages, namely 0.699 in the limited test, 0.679 in the main test, and 0.716 in the operational test. The slight decrease in the main test was influenced by the presence of a more heterogeneous Class VII H, while an increase in the operational test occurred after an insignificant class was excluded from the aggregation. A comparative matrix of effectiveness is presented in Table 11.

Table 11. Comparative Matrix of Effectiveness of the Inter-Stage I-TPACK-DL Model

Dimension of Effectiveness	Limited Test	Main Test	Operational Tests
Number of students	32	64	128
Syntax implementation	Early adaptation	Stable	Optimal & consistent
Average reflection of the material	94,34%	96,34%	96,71%
Average media reflection	86,66%	93,82%	96,79%
Significant media items	7 of 11	11 of 11	11 of 11
Cohen's Average d	0,699	0,679	0,716
Validation vs control class	Not yet	Not yet	Significant (ANCOVA)

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DISCUSSION

The findings of this study confirm that the effectiveness of digital PAI learning is not born from the presence of technology, but from the meaningful integration between values, pedagogy, content, and technology. The consistency of improved learning outcomes in 85.71% of experimental classes, accompanied by superiority over control classes through ANCOVA, is in line with a synthesis of evidence showing that differentiated learning in general improves academic achievement and diverse student engagement, although its success is highly dependent on teacher training and systemic support (Farida et al., 2025). This pattern of results demands an explanation of why the model works, how the mechanism works, and what distinguishes it from other technology integration models.

Empirical Effectiveness in Literature Maps

Significant improvements in six of the seven classes reinforce the position of differentiation as a valid pedagogical response to class heterogeneity. Effective differentiation demands a meaning that is not just technical, but rooted in the way teachers understand and narrate the diversity of their students in daily practice (Zerai et al., 2023). This validity is also seen in the technological dimension, where selective and context-aware integration decisions determine outcomes more than the intensity of tool use, as found in the technology integration practices of prospective teachers who choose tools according to content and pedagogy (Lopez et al., 2025). The I-TPACK-DL model links the two dimensions in a single framework.

An interpretation of these findings suggests that the effectiveness of the model does not come from the application of differentiation or the use of technology as two independent components, but rather from the synergistic relationship between the two. Differentiation provides a pedagogical mechanism to respond to the diversity of learners' readiness, interests, and learning profiles, while technology serves as *an enabler* that allows such differentiation to be implemented in a systematic, adaptive, and sustainable manner. This perspective is in line with the recent development of TPACK theory which places the quality of pedagogical decisions as the main factor for the success of technology integration, not just the level of mastery of digital devices (Wu et al., 2025; Weidlich & Kalz, 2026). Thus, the success of the I-TPACK-DL Model is more accurately understood as the result of the optimization of technology-supported pedagogical decisions than the success of the technology itself.

The findings also show that diagnostic assessments conducted before learning play an important role in determining the effectiveness of differentiation. Identifying learning readiness,

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interests, and learning profiles allows teachers to design content, processes, and learning products that are more suited to the needs of each group of learners. This approach is consistent with the concept of *adaptive teaching*, which is the ability of teachers to dynamically adjust learning strategies based on information about the characteristics of students so that each individual gets equal learning opportunities to achieve learning goals (Parsons et al., 2018). In the context of this study, SmartPAI not only helps the process of identifying these characteristics, but also translates them into recommendations for different learning activities without changing the standard of learning outcomes.

The wide *range of effect sizes*, from 0.280 in Class VII C to 1.323 in Class VII D, is not an anomaly but a reflection of the interaction between the characteristics of students and the intensity of differentiation needs. Variations in the way learners perceive and express knowledge confirm that the impact of adaptive learning will be greater in groups with more prominent intelligence diversity (Ghaznavi et al., 2021). This difference can also be read through the fulfillment of tiered learning needs, because the internalization of grades and cognitive achievements only develops optimally when students' basic needs and sense of security are met first (Soikkeli, 2024). Classes with more uneven initial readiness get the benefits of more pronounced differentiation.

The phenomenon of effect *size* variation also indicates that the effectiveness of the learning model is contextual and influenced by the quality of implementation (*implementation fidelity*). The literature shows that the same learning model can produce different impacts when teachers apply syntax with different levels of consistency or when classroom characteristics are not fully aligned with the model's design assumptions (O'Donnell, 2008). Therefore, the variation in results between classes in this study does not show the weakness of the I-TPACK-DL Model, but rather confirms that the success of learning innovation is the result of an interaction between the quality of model design, teacher competence in implementing syntax, and the characteristics of students as end users of the model.

These findings also provide a new perspective on research on differentiated learning. Most previous research has positioned differentiation as a strategy to improve learning outcomes through customization of learning content, processes, and products. This study shows that differentiation gains higher effectiveness when integrated with the teacher knowledge framework (TPACK), is guided by Islamic pedagogical values, and is supported by a digital system that is able to manage diagnostic data in a sustainable manner. This means that the contribution of the I-TPACK-DL Model does not stop at proving that differentiated learning is effective, but offers a

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conceptual mechanism on how differentiation, technology, and pedagogical values reinforce each other so as to produce a more adaptive, meaningful, and oriented learning experience that is oriented towards the formation of competencies as well as the character of students.

Why the Model Works: GPA as a TPACK Normative Controller

The Technological Pedagogical Content Knowledge (TPACK) framework has become one of the dominant paradigms in explaining teacher competence in the digital era because it is able to describe the relationship between content *knowledge*, *pedagogical knowledge*, and technology (*technological knowledge*)) in producing effective learning. However, the epistemological construction of TPACK was built from the beginning to explain how teachers integrate technology into learning, not why certain pedagogical decisions should be chosen based on a particular value orientation. As a result, instructional decisions in TPACK tend to be understood as a professional process that is relatively neutral to the value system, as long as they are able to improve the effectiveness of learning. This tendency is still seen in contemporary teacher education that prepares more technology integration competencies than the ability to place technology within the value framework that is the goal of education itself (Weidlich & Kalz, 2026).

TPACK's latest developments do show efforts to expand the framework. Various studies have begun to include new dimensions, such as *Artificial Intelligence Knowledge*, *AI literacy*, and *AI-TPACK* to explain changes in teacher competence in the artificial intelligence era (Ning et al., 2024). Chiu (2025) even proposed Intelligent-TPACK (i-tpack) as an evolution of TPACK that incorporates artificial intelligence literacy and competencies into teachers' knowledge networks. This development is an important step because it shows that TPACK is dynamic and able to adapt to technological developments. However, all of these expansions are still moving on the dimension of technological capabilities, not on the dimension of pedagogical orientation. In other words, the development of TPACK is still centered on the question of how technology is used effectively, while the question of what value drives the use of technology has not received adequate attention.

This gap becomes even more evident when TPACK is applied in Islamic Religious Education. In contrast to other subjects that are oriented towards mastering academic competence, PAI inherently integrates the dimensions of knowledge (*ta'lim*), character development (*tarbiyah*), and the formation of adab (*ta'dib*). Therefore, the quality of PAI learning cannot be measured only through improving learning outcomes, but also through the ability of teachers to guide students towards the formation of Islamic personalities. In this context, the decision to choose methods,

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media, assessments, and technology is not just a technical decision, but a pedagogical decision that contains moral and spiritual consequences. Research on the development of TPACK instruments for PAI teachers has indeed mapped seven domains of knowledge as the classic TPACK framework, but has not placed Islamic values as a stand-alone domain of knowledge and affects the relationship between these domains (Suwadi et al., 2025). This condition shows that there is still a conceptual space that has not been filled in the development of TPACK for Islamic Religious Education.

Departing from this gap, this study proposes Islamic Pedagogical Knowledge (IPK) not just as an additional new domain, but as a normative controller that directs the entire decision-making process in TPACK. This position is fundamentally different from the previous TPACK expansion. If AI-TPACK expands the capacity of teachers to utilize new technologies, then GPA expands the epistemological foundation of TPACK by placing value as the principle that directs the relationship between content, pedagogy, and technology. Within this framework, the decision to choose technology is no longer based on the level of sophistication or popularity of the application, but on the extent to which the technology supports the achievement of Islamic educational goals, respects the characteristics of learners, and strengthens the process of forming manners. Thus, GPA does not replace TPACK, but changes the way TPACK works from a technology-oriented framework to a value-oriented framework.

This interpretation receives empirical support from the results of this study. The relatively consistent improvement in learning outcomes in six of the seven experimental classes cannot be explained by the use of SmartPAI alone or learning differentiation separately. The stability of effectiveness shows the existence of a more basic mechanism, namely the consistency of teachers in making Islamic pedagogical values as the basis when analyzing the needs of students, choosing learning strategies, determining forms of differentiation, and utilizing technology. In other words, GPA works as a meta-knowledge that controls the teacher's thinking process before pedagogical decisions are realized in learning practice. This perspective explains why the technology in the I-TPACK-DL Model does not function as a center of innovation, but as an instrument that is always subject to the orientation of Islamic character formation.

The placement of GPA as a normative controller derives a strong legitimacy from the philosophy of Islamic education. Ahmed and Chowdhury (2025) explain that Islamic education is built on the principle of structuring knowledge, educators, and students in an order oriented to the development of human beings as a whole. Within this framework, knowledge is never separated from the moral purpose that underlies it. Memon et al. (2021) added that the

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cultivation of manners is not a by-product of learning activities, but requires pedagogical design that is consciously, consistently, and systematically. This view is emphasized by the concept of *ta'dib* Syed Muhammad Naquib al-Attas which places all educational activities as a process of putting something in the right position in accordance with the hierarchy of knowledge and values (Holis & Damyati, 2025). Consequently, technology in Islamic education is never seen as an end, but rather as a *testament* whose significance is determined by the value orientation that controls it.

The conceptual implications of this position can be seen in the way the I-TPACK-DL Model interprets differentiated learning. The international literature generally describes differentiation as a pedagogical strategy to respond to the diversity of readiness, interests, and learning profiles of students (Hinojosa, 2023). This research does not reject this view, but expands it through the perspective of Islamic pedagogy. The principle *of muwāfaqat al-mudarris li al-murīd* put forward by Al-Ghazali emphasizes that teachers are obliged to adapt learning to the intellectual, psychological, and spiritual capacities of students so that the educational process takes place fairly (Hanafi & Achmad, 2026). Based on this perspective, differentiation is no longer understood only as a modern instructional strategy, but as an actualization of the values of 'adl and rahmah in learning practice. Teachers do not treat students equally, but treat them fairly according to their individual needs. This is the reason why the diagnostic assessments, adaptive groupings, and variations of learning activities in the I-TPACK-DL Model are not just technical procedures, but rather a manifestation of the principles of Islamic pedagogical justice.

The conceptual contribution of this research lies in the paradigm change offered to the TPACK framework. So far, the development of TPACK has tended to move from technology integration to intelligent technology integration, but this study shows the need for a shift towards value-driven technology integration. In this paradigm, the effectiveness of technology integration is no longer determined solely by the teacher's ability to connect content, pedagogy, and technology, but by the teacher's ability to make grades the basis of all instructional decisions. Thus, Islamic Pedagogical Knowledge not only expands the structure of TPACK, but also offers a new epistemological perspective that in value-based education, the relationship between technology and learning must always be mediated by a clear moral and pedagogical orientation. This perspective opens up new space for the development of TPACK in other disciplines that have a strong normative character, such as religious education, character education, and civic education.

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How the Model Works: SmartPAI as an Implementing System

The mechanistic contribution of this research lies in the positioning of SmartPAI as a supporting system that operationalizes each phase of the syntax, rather than as a stand-alone medium. Diagnostic assessments result in data-driven clustering, multimodal presentations cater to a diversity of learning styles, multi-level exercises adjust readiness, and digital evaluations close the learning cycle. This functional integration explains why the quality of the media is evolving more rapidly than the understanding of the material, as the teacher's technological knowledge has an impact on engagement and active learning precisely when the technology is designed pedagogically and not simply added as a complement (Wu et al., 2025).

The development pattern of SmartPAI media is also in line with the findings in the context of Islamic education in Indonesia, that targeted technology integration strengthens the quality of teaching practices when supported by teacher readiness and adequate governance (Siregar et al., 2025). The experience of curriculum management in Islamic education units shows that the successful use of technology depends on the harmony between the support system, learning objectives, and institutional characteristics (Rodliyah et al., 2024). SmartPAI embodies this alignment by linking each feature to the syntax phase and the purpose of adab formation.

The decline in the relevance aspect of PowerPoint is an informative exception, as it shows that not all automatic technology formats have pedagogical value. The use of digital technology in the religious realm requires caution so as not to slip into a technical orientation that actually reduces meaning (Kholili et al., 2024). Learning designs that value diversity and collaboration have been proven to strengthen students' academic self-concept and Islamic literacy rather than just the completeness of media formats (Fakhruddin et al., 2025). The decision to select media in this model is still subject to consideration of GPA and student needs.

Conceptual Contribution of Model I-TPACK-DL to the Development of Islamic Pedagogical Learning Models

The findings of this study show that the contribution of the I-TPACK-DL Model does not stop at the development of digital learning tools or the expansion of the TPACK framework, but also produces a learning model that meets the conceptual characteristics as formulated by Joyce and Weil. In this perspective, a learning model does not only consist of learning steps (*syntax*), but also has a social system, the principle of teacher reaction, a support system, as well as instructional and accompanying impacts that form a pedagogical unit. The presence of all these components distinguishes the learning model from strategies, methods, and learning media that only partially

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regulate the learning process.

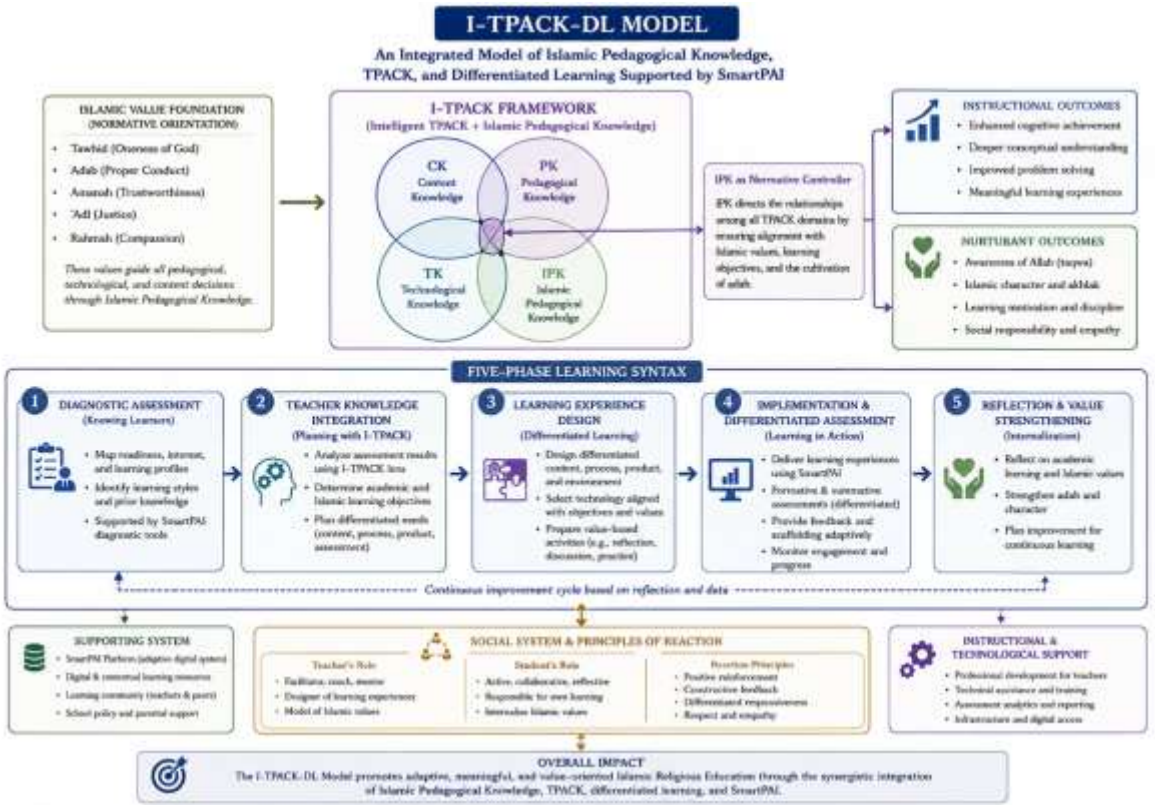


Figure 1 Conceptual Architecture of the I-TPACK-DL Model Integrating Islamic Pedagogical Knowledge, TPACK, Differentiated Learning, and SmartPAI

Figure 1 illustrates that the I-TPACK-DL Model is organized as an integrated pedagogical architecture rather than a linear instructional procedure. The model begins with Islamic Value Foundation, which provides the normative orientation for all pedagogical decisions. Islamic Pedagogical Knowledge (IPK) functions as the normative controller governing the interaction among the TPACK domains, while differentiated learning is operationalized through the five-phase instructional syntax supported by SmartPAI. This architecture demonstrates that the model integrates philosophical foundations, teacher knowledge, instructional processes, supporting systems, and instructional outcomes into a coherent learning model.

This position is important because most of TPACK's development over the past two

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decades has resulted in more teacher competency frameworks than learning models that can be implemented operationally in the classroom. Similarly, differentiated learning is essentially a pedagogical approach that provides general principles regarding the adjustment of content, processes, products, and assessments to the characteristics of learners, but does not provide a complete implementation structure. SmartPAI is also not designed as a learning model, but as a digital system that supports the implementation of learning. This study shows that the three components acquire an implementive form when integrated into the structure of a complete learning model.

The five-phase syntax in the I-TPACK-DL Model does not only regulate the sequence of learning activities, but builds a decision-making mechanism that moves from diagnostic assessment, teacher knowledge integration, learning experience design, implementation of differentiated assessments, to the reflection of Islamic values. The flow forms a reflective cycle that allows teachers to continuously adjust pedagogical decisions based on changes in student characteristics. Therefore, this model is not procedural, but adaptive, so it can still be applied to different class contexts without losing its conceptual consistency.

The integrity of the structure is also reflected in the explicit separation between instructional impact and companion impact. The instructional impact is realized through the improvement of the learning outcomes of Islamic Religious Education, while the accompanying impact is directed at the formation of adab, spiritual reflection, and Islamic character that develops during the learning process. This separation expands the characteristics of the digital learning model which has been more oriented towards academic achievement. The findings of Nilsson and Cederqvist (2025) regarding the formation of teachers' professional identities through structured learning experiences reinforce the argument that learning transformation occurs when pedagogical experiences are systematically designed, rather than simply through knowledge transfer. In the context of this research, the experience not only shapes students' learning competencies, but also internalizes Islamic values as an integral part of the learning process.

Thus, the conceptual contribution of the I-TPACK-DL Model lies not only in the integration of various learning theories, but in its success in transforming the conceptual framework into an operational learning model that meets the characteristics of the model according to Joyce and Weil while being responsive to the challenges of contemporary digital learning.

Theoretical Implications for Value-Driven TPACK

The findings of this study expand the TPACK discourse by showing that the effectiveness

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of technology integration in Islamic Religious Education is not only determined by the integration of content, pedagogy, and technology, but also by the existence of a value system that directs the entire learning decision-making process. In contrast to the development of TPACK, which has been moving towards strengthening technological capabilities, including AI-TPACK and Intelligent-TPACK (Chiu, 2025; Ning et al., 2024), this study places Islamic Pedagogical Knowledge (GPA) as a normative domain that mediates the relationship between TPACK domains. In this perspective, technology is positioned as *the will* that supports the achievement of educational goals, not as a center for learning innovation. These findings complement the view of Weidlich and Kalz (2026) that the development of teacher competencies requires contextual integration of knowledge by extending it towards integration based on value systems.

The broader implication is the opening up of opportunities for the development of value-driven TPACK, which is a technology integration framework that places values as the driver of pedagogical decisions. Although developed in the context of Islamic Religious Education, the principle has the potential to be adapted to other fields that have a normative orientation, such as character education, civic education, and multicultural education. Thus, the contribution of this research is not only in the form of a new learning model, but also offers a conceptual direction for the development of TPACK that is more responsive to the philosophical, ethical, and social dimensions of 21st-century learning

CONCLUSION

The I-TPACK-DL model was developed through the synthesis of Islamic pedagogy as a normative foundation, TPACK as a framework for knowledge integration, and differentiated learning as an implementive approach, with SmartPAI as an implementation support system. Expert validation placed the model in the category of feasible to very feasible, with a percentage of 86.00% in design, 88.24% in material, and 83.53% in media. The effectiveness test proved a significant increase in learning outcomes in 85.71% of experimental classes as well as superiority over conventional learning through ANCOVA, with a stable average effect size in the medium to large category throughout the three stages of the field test. The main theoretical contribution of this research is the formulation of Islamic Pedagogical Knowledge as the fourth domain that expands the TPACK framework, accompanied by a five-phase syntax that integrates the Joyce and Weil models, Tomlinson differentiation, and Islamic pedagogy. This model offers an avenue for PAI learning that is adaptive to the diversity of students and technological developments without losing the orientation of Islamic manners and values, while opening up a further research agenda

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to test the resilience of the GPA framework in a broader context.

BIBLIOGRAPHY

Ahmed, F., & Chowdhury, S. (2025). Rethinking contemporary schooling in Muslim contexts: An Islamic conceptual framework for reconstructing K-12 education. Educational Philosophy and Theory, 57(2), 152–165. https://doi.org/10.1080/00131857.2024.2411325

Chiu, T. K. F. (2025). Developing Intelligent-TPACK (I-TPACK) framework from unpacking AI literacy and competency: Implementation strategies and future research direction. Interactive Learning Environments, 33(7), 4189–4192. https://doi.org/10.1080/10494820.2025.2545053

Fakhruddin, A., Anwar, S., & Islamy, M. R. F. (2025). Enhancing academic self-concept and historical literacy in Islamic studies through collaborative learning: A study on prospective Islamic education teachers in Indonesia. Cogent Education, 12(1), 2491871. https://doi.org/10.1080/2331186X.2025.2491871

Farida, K. L., Baharudin, B., Sai'dy, S., & Hasanah, U. (2025). Effectiveness and challenges of differentiated learning in secondary school: A systematic literature review. International Journal of Business, Law, and Education, 6(1), 956–967. https://doi.org/10.56442/ijble.v6i1.1131

Ghaznavi, N., Haddad Narafshan, M., & Tajadini, M. (2021). The implementation of a multiple intelligences teaching approach: Classroom engagement and physically disabled learners. Cogent Psychology, 8(1), 1880258. https://doi.org/10.1080/23311908.2021.1880258

Hammerness, K., Darling-Hammond, L., Bransford, J., Berliner, D., Cochran-Smith, M., McDonald, M., & Zeichner, K. (2005). How teachers learn and develop. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing Teachers for a Changing World: What Teachers Should Learn and Be Able to Do* (pp. 358-389). Jossey-Bass.

Hanafi, S., & Achmad, M. (2026). The philosophy of Islamic education in the thought of Imam Al-Ghazali: A study of the objectives, curriculum, and methods of education. Journal of Islamic Religious Management and Education, 4(1), 329–342. https://doi.org/10.61132/jmpai.v4i1.1799

Hinojosa, D. M. (2023). Professional development program designed to support prospective teachers' enactment of instructional strategies to differentiate instruction for English learners. The Teacher Educator, 58(1), 49–71. https://doi.org/10.1080/08878730.2022.2088914

Copyright at authors some right reserved this work is licensed under a Creative Commons Attribution-Share Alike 4.0 International License

Holis, N., & Damyati, A. R. (2025). The concept of Islamic education according to Syed Muhammad Naquib al-Attas: An epistemological analysis and its implications for contemporary education, 11(2).

Joyce, B., Weil, M., & Calhoun, E. (2015). *Models of Teaching* (9th ed.). Pearson.

Kholili, M., Muhtarom, A., Rahmawati, F., & Nasrulloh, M. (2024). Islamic proselytizing in digital religion in Indonesia: The challenges of broadcasting regulation. Cogent Social Sciences, 10(1), 2357460. https://doi.org/10.1080/23311886.2024.2357460

López, A., Meneses, A., & Montenegro, M. (2025). Pre-service teachers' TPACK and its relationship to technology integration in science learning activities. Journal of Science Education and Technology, 34, 436–451. https://doi.org/10.1007/s10956-025-10201-8

Memon, N. A., Chown, D., & Alkouatli, C. (2021). Descriptions and enactments of Islamic pedagogy: Reflections of alumni from an Islamic teacher education programme. Pedagogy, Culture and Society, 29(4), 631–649. https://doi.org/10.1080/14681366.2020.1775687

Nilsson, P., & Cederqvist, A. M. (2025). Building teacher knowledge and identity: Career changers' transition into teaching through a short teacher education programme. European Journal of Teacher Education, 48(1), 132–152. https://doi.org/10.1080/02619768.2024.2432406

Ning, Y., Zhang, C., Xu, B., Zhou, Y., & Wijaya, T. T. (2024). Teachers' AI-TPACK: Exploring the relationship between knowledge elements. Sustainability, 16(3), 978. https://doi.org/10.3390/su16030978

O'Donnell, C. L. (2008). Defining, conceptualizing, and measuring fidelity of implementation and its relationship to outcomes in K-12 curriculum intervention research. *Review of Educational Research, 78*(1), 33-84. https://doi.org/10.3102/0034654307313793

Parsons, S. A., Vaughn, M., Scales, R. Q., Gallagher, M. A., Parsons, A. W., Davis, S. G., Pierczynski, M., & Allen, M. (2018). Teachers' instructional adaptations: A research synthesis. *Review of Educational Research, 88*(2), 205-242. https://doi.org/10.3102/0034654317743198

Rodliyah, S., Khusnuridlo, M., Fauzi, I., & Baharun, H. (2024). Optimizing the quality of Islamic Senior High School graduates through curriculum management of vocational programs based on pesantrens in East Java, Indonesia. Cogent Education, 11(1), 2423437. https://doi.org/10.1080/2331186X.2024.2423437

Siregar, H. S., Munir, M., & Fikri, M. (2025). Enhancing Islamic education through technology integration: A study of teaching practices in Indonesia. Peuradeun Scientific Journal, 13(2), 959–986. https://doi.org/10.26811/peuradeun.v13i2.1875

Soikkeli, A. (2024). Exploring Arctic housing and village planning based on Maslow's hierarchy of

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needs. International Planning Studies, 29(1), 87–104. https://doi.org/10.1080/13563475.2023.2291003

Suwadi, Sulistyowati, E., Hazrullah, & Adira, H. F. (2025). Development of TPACK instrument to measure teacher knowledge in Islamic education for in-service teacher professional training. Educational Process: International Journal, 16, e2025193. https://doi.org/10.22521/edupij.2025.16.193

Tomlinson, C. A. (2017). *How to Differentiate Instruction in Academically Diverse Classrooms* (3rd ed.). ASCD.

Weidlich, J., & Kalz, M. (2026). How well does teacher education prepare for teaching with technology? A TPACK-based investigation at a university of education. European Journal of Teacher Education, 49(1), 168–188. https://doi.org/10.1080/02619768.2023.2243645

Wu, S. H., Jong, M. S. Y., & Tsai, C. C. (2025). The impact of teachers' TK and TPACK in their composed SVVR on students' active learning and learning engagement: A multilevel structural equation modeling analysis. Journal of Research on Technology in Education. Advance online publication. https://doi.org/10.1080/15391523.2025.2529200

Zerai, D., Eskelä-Haapanen, S., Posti-Ahokas, H., & Vehkakoski, T. (2023). The meanings of differentiated instruction in the narratives of Eritrean teachers. Pedagogy, Culture & Society, 31(3), 419–437. https://doi.org/10.1080/14681366.2021.1914712

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