The Effect of Technological Pedagogical Content Knowledge (TPACK) Approach in PAI Learning on Student Achievement at SMA Negeri 1 Ponorogo

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ABSTRACT: *The integration of technology into Islamic Religious Education (PAI) has become a pressing imperative in the digital era. However, empirical evidence on the effectiveness of the Technological Pedagogical Content Knowledge (TPACK) framework specifically within PAI learning contexts in Indonesian senior high schools remains limited. This study aims to examine the influence of the TPACK approach on student academic achievement in PAI learning at SMA Negeri 1 Ponorogo. A quantitative research design was employed, with data collected through a structured Likert-scale questionnaire administered to 80 students selected from a population of 324 Grade 11 students using the Slovin formula. Validity and reliability of the instrument were confirmed through Pearson correlation and Cronbach's alpha tests. Data were analyzed using simple linear regression via SPSS 25. The results revealed a significant positive effect of TPACK on student achievement (F = 165.387; Sig. = 0.000 < 0.05), with a coefficient of determination (R^2 = 0.682), indicating that TPACK explains 68.2% of the variance in student achievement. These findings confirm that TPACK is a statistically robust predictor of learning outcomes in PAI and provide practical implications for teacher professional development in integrating technology into religious education instruction.*

Keywords: *TPACK; Islamic Religious Education; Student Achievement; Technology Integration; Quantitative Research.*

ABSTRAK: Integrasi teknologi dalam Pendidikan Agama Islam (PAI) menjadi kebutuhan mendesak di era digital. Namun, bukti empiris mengenai efektivitas kerangka Technological Pedagogical Content Knowledge (TPACK) khususnya dalam konteks pembelajaran PAI di sekolah menengah atas di Indonesia masih terbatas. Penelitian ini bertujuan untuk menguji pengaruh pendekatan TPACK terhadap prestasi akademik siswa dalam pembelajaran PAI di SMA Negeri 1 Ponorogo. Desain penelitian kuantitatif digunakan dengan pengumpulan data melalui angket berskala Likert yang diberikan kepada 80 siswa yang dipilih dari populasi 324 siswa kelas 11 menggunakan rumus Slovin. Validitas dan reliabilitas instrumen dikonfirmasi melalui uji korelasi Pearson dan Cronbach's alpha. Data dianalisis menggunakan regresi linier sederhana melalui SPSS 25. Hasil penelitian menunjukkan pengaruh positif yang signifikan dari TPACK terhadap prestasi belajar siswa (F = 165,387; Sig. = 0,000 < 0,05), dengan koefisien determinasi (R^2 = 0,682), yang mengindikasikan bahwa 68,2% varians prestasi belajar siswa dijelaskan oleh pendekatan TPACK. Temuan ini menegaskan bahwa TPACK merupakan prediktor yang secara statistik kuat terhadap hasil belajar PAI dan memberikan implikasi

praktis bagi pengembangan profesional guru dalam mengintegrasikan teknologi ke dalam pembelajaran pendidikan agama.

Kata Kunci: TPACK; Pendidikan Agama Islam; Prestasi Belajar; Integrasi Teknologi; Penelitian Kuantitatif.

I. INTRODUCTION

The rapid advancement of information and communication technology in the 21st century has fundamentally transformed educational practices across the globe, including in Indonesia (Kuswandi et al., 2025; Zh, Sani, et al., 2024). Islamic Religious Education (PAI), as a core component of the national curriculum, is not immune to this transformation (Novita et al., 2026; Zh, Putra, et al., 2024). PAI is not merely a vehicle for transferring religious knowledge; it serves the broader purpose of shaping student character, morality, and spiritual identity within an increasingly digitally mediated learning environment (Wahidin et al., 2022; Syam, 2017). The challenge, therefore, lies in how PAI educators can maintain the integrity and depth of Islamic content while adapting their pedagogical methods to align with contemporary technological affordances.

Recent scholarship has highlighted a structural gap between teachers' mastery of content and their capacity to leverage technology in meaningful instructional design. Mishra and Koehler (2006) introduced the TPACK framework as a synthesis of three knowledge domains: Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK), as well as their intersections. The framework has since been applied in a variety of educational contexts globally. Studies such as those by Voogt et al. (2013) and Chai et al. (2013) have affirmed that teachers with higher TPACK competence tend to design more effective and engaging lessons. In Indonesian contexts, studies have applied TPACK in science (Rahmawati & Erwin, 2021) and mathematics (Suryani et al., 2020), as well as in general education settings. Yet, its application specifically within PAI instruction at the senior secondary level remains significantly underexplored.

Existing literature on TPACK in Indonesia has largely focused on teacher perceptions and competency measurement rather than examining the direct impact of TPACK-based instruction on measurable student learning outcomes. For example, Hanik (2022) explored TPACK integration among elementary school teachers but did not provide a quantitative link between TPACK use and student achievement scores. Similarly, Salsabila and Agustian (2021) discussed technology's role in education broadly without empirically testing effects on academic performance. This gap is significant: while the theoretical merits of TPACK in PAI are often asserted, rigorous empirical validation in a senior secondary PAI context is lacking. Furthermore, previous research has not specifically tested TPACK's influence on all learning outcome domains in the context of Islamic Education, where the affective and spiritual dimensions of student achievement must also be considered.

This study aims to fill this gap by empirically investigating the extent to which the TPACK approach influences student academic achievement in PAI learning at SMA Negeri 1 Ponorogo — a high-performing school in East Java that has actively implemented TPACK-based instruction. The central

argument of this study is that TPACK, as an instructional framework, constitutes a statistically significant predictor of student achievement in PAI at the senior secondary level. Using quantitative methods, specifically simple linear regression, the study tests the hypothesis that H_1: There is a significant positive influence of the TPACK approach (X) on student academic achievement (Y) in Grade 11 PAI learning.

This article proceeds as follows: Section II presents the research methodology, including sampling, instrumentation, and data analysis procedures. Section III reports the research findings, including descriptive and inferential statistical results. Section IV provides a discussion that interprets findings in light of prior literature. The article concludes with theoretical and practical implications for PAI instruction and teacher professional development in Indonesia.

II. METHOD

This study employs a quantitative research design with an explanatory approach, intended to examine the causal relationship between the TPACK approach as the independent variable (X) and student academic achievement as the dependent variable (Y)(Zh et al., 2025). Quantitative methods were chosen because the study's objective requires measurable, generalizable, and statistically testable findings (Creswell, 2014). The unit of analysis is the individual student within Grade 11 classes at SMA Negeri 1 Ponorogo, East Java, Indonesia.

Population and Sample

The study population comprised all Grade 11 students at SMA Negeri 1 Ponorogo during the 2022/2023 academic year, totaling 324 students across nine classes. A probability sampling technique was applied using the Slovin formula to determine the minimum sample size required for a margin of error of 5% (e = 0.05), yielding a calculated sample of n = 75.9, rounded up to 80 students. Simple random sampling was used to select participants proportionally from each class, ensuring representativeness across the population.

Instrument

The primary data collection instrument was a structured questionnaire employing a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The TPACK variable was operationalized across seven sub-dimensions: Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Technology Content Knowledge (TCK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPACK), consistent with the domains defined by Mishra and Koehler (2006). The student achievement variable was operationalized through eight indicators: physical health, intellectual capacity, student talent, learning interest, creativity, motivation, psycho-emotional stability, and school physical environment drawn from achievement motivation theories (Rahayu, 2022; Syam, 2019).

Validity and Reliability

Prior to the main data collection, a pilot test was conducted with 30 students to assess instrument quality. Validity was established through Pearson product-moment correlation; items with r-calculated exceeding the r-table value ($r = 0.361$, $df = 28$, $\alpha = 0.05$) were retained. Reliability was

confirmed using Cronbach's alpha, with all sub-scales yielding $\alpha > 0.7$, meeting the accepted threshold for internal consistency (Sugiyono, 2019; Hair et al., 2019).

Data Analysis

After confirming normality (Kolmogorov-Smirnov test) and linearity (ANOVA for linearity), simple linear regression was conducted using SPSS version 25 to test the hypothesized relationship between the TPACK approach and student achievement. The significance threshold was set at $\alpha = 0.05$. Additionally, the coefficient of determination (R^2) was computed to estimate the proportion of variance in student achievement explained by the TPACK approach.

III. RESULT AND DISCUSSION

RESULT

TPACK Approach Variable

A descriptive analysis of the TPACK approach questionnaire revealed generally positive perceptions among Grade 11 students regarding teachers' implementation of TPACK. As presented in Table 1, the dominant response category across all seven TPACK indicators was "Agree" (average: 49%), followed by "Strongly Agree" (average: 29%), and "Neutral" (average: 21%). The combined positive response rate ("Strongly Agree" + "Agree") averaged 78% across indicators, with no respondents choosing "Strongly Disagree" on any item. The highest positive agreement was observed in the Technology Content Knowledge (TCK) dimension (87%), while the lowest, though still predominantly positive, was in the TPACK integration dimension (71%).

Table 1. Questionnaire Results: TPACK Approach Variable

No.	Indicator	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Technological Knowledge	32%	53%	15%	0%	0%
2	Pedagogical Knowledge	24%	51%	24%	0%	0%
3	Content Knowledge	31%	52%	17%	1%	0%
4	Technological Pedagogical Knowledge	23%	52%	25%	0%	0%
5	Technology Content Knowledge	40%	47%	13%	0%	0%
6	Pedagogical Content Knowledge	31%	43%	25%	0%	0%
7	Technology Pedagogy Content Knowledge	25%	46%	28%	1%	0%
Average		29%	49%	21%	0%	0%

Source: Primary data processed by researchers, 2023

The data in Table 1 indicate that the TPACK approach is effectively implemented in PAI learning at SMA Negeri 1 Ponorogo. The near-absence of negative responses (0% "Disagree" and "Strongly Disagree" across most dimensions) suggests strong teacher competence in integrating technology, pedagogy, and content in instruction in Islamic education. These findings are consistent with Amalia and Radiansyah (2023), who documented similar positive student perceptions of TPACK-based instruction in elementary education contexts.

Student Achievement Variable

The student achievement variable was measured across eight indicators reflecting both internal and external factors influencing learning performance. As shown in Table 2, respondents predominantly selected "Agree" (average: 46%) and "Neutral" (30%), with only a small proportion choosing negative responses ("Disagree": 1%; "Strongly Disagree": 1%). The "Creativity" indicator recorded the highest neutral response (41%), suggesting that students perceive creativity development as a more nuanced outcome of TPACK-based learning.

Table 2. Questionnaire Results: Student Achievement Variable

No.	Indicator	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Physical Health	32%	44%	19%	4%	1%
2	Intellectual Capacity	27%	47%	23%	2%	1%
3	Student Talent	22%	49%	27%	1%	1%
4	Learning Interest	19%	44%	35%	1%	0%
5	Creativity	18%	39%	41%	1%	1%
6	Motivation	17%	50%	33%	0%	0%
7	Psycho-emotional Stability	15%	48%	37%	0%	0%
8	School Physical Environment	20%	48%	30%	1%	0%
Average		21%	46%	30%	1%	1%

Source: Primary data processed by researchers, 2023

The aggregate data in Table 2 suggest that students' achievement indicators align broadly with the conditions observed in the field, with the majority of respondents affirming positive experiences across all achievement dimensions. The distribution of responses is consistent with established literature indicating that internal motivational factors and a supportive school environment are central to academic achievement in secondary education (Syam, 2019; Rahayu, 2022).

Simple Linear Regression Analysis

Prior to regression analysis, normality and linearity assumptions were tested and confirmed. The Kolmogorov-Smirnov test indicated normally distributed residuals ($p > 0.05$), and the linearity test

confirmed a linear relationship between the TPACK approach and student achievement. The ANOVA table from the regression analysis is presented in Table 3.

Table 3. ANOVA Results: Simple Linear Regression

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5724.545	1	5724.545	165.387	.000b
	Residual	2665.202	77	34.613		
	Total	8389.747	78			

a. Dependent Variable: Student Achievement; b. Predictors: (Constant), TPACK Approach

As shown in Table 3, the F-value obtained is 165.387 with a significance level of 0.000, which is far below the threshold of 0.05. This result confirms that the overall regression model is statistically significant and that the TPACK approach significantly predicts student academic achievement. The model can therefore be considered valid for estimation purposes.

Coefficient of Determination

The model summary statistics are presented in Table 4, showing the correlation coefficient (R) and coefficient of determination (R^2).

Table 4. Model Summary: Coefficient of Determination

Model	R	R Square	Adjusted R-Square	Std. Error of the Estimate
1	.826a	.682	.678	5.883

a. Predictors: (Constant), TPACK Approach

The results in Table 4 indicate a strong positive correlation (R = 0.826) between the TPACK approach and student achievement. The coefficient of determination, $R^2 = 0.682$, indicates that 68.2% of the variance in students' academic achievement is explained by the TPACK approach. In comparison, the remaining 31.8% is attributable to other variables outside the model, such as students' intrinsic motivation, family support, peer dynamics, and school leadership quality. The unidirectional relationship between TPACK implementation and student achievement confirms the directionality hypothesized in this study.

DISCUSSION

TPACK as a Predictor of PAI Learning Achievement

The primary finding of this study, that the TPACK approach exerts a significant positive influence on student achievement in PAI learning ($F = 165.387$, $p = 0.000$, $R^2 = 0.682$), corroborates and extends previous scholarship on TPACK's pedagogical efficacy. The R^2 value of 0.682 is notably high in educational research, suggesting that TPACK is not merely a supplementary instructional component but a primary driver of learning outcomes in the PAI classroom.

This finding aligns with the foundational argument by Mishra and Koehler (2006) that effective technology integration in teaching requires the simultaneous development of technological,

pedagogical, and content knowledge, rather than any one in isolation. When teachers possess TPACK, they are equipped to select and deploy technologies that are contextually appropriate for specific content areas, a competency particularly critical in PAI, where the content carries spiritual and ethical dimensions that require sensitive pedagogical handling. The significant influence of TPACK on PAI also aligns with the findings of Chai, Koh, and Tsai (2013), who demonstrated that, across diverse educational settings, TPACK positively predicted perceived quality of instruction and student engagement.

Furthermore, the study by Safitri and Rizky (2021) at Esa Unggul University found that TPACK-based instruction increased students' enthusiasm, classroom participation, and positive attitudes toward learning. The present study's quantitative findings provide empirical validation for these qualitative observations within the specific domain of Islamic Religious Education at the senior secondary level in Indonesia, a context not previously examined with this methodological rigor.

Student Achievement in the Context of TPACK-Based PAI

The student achievement data (Table 2) reveal that the majority of respondents hold positive perceptions across eight achievement indicators, including physical health, intellectual capacity, talent, interest, creativity, motivation, psycho-emotional stability, and school environment. This multidimensional operationalization of student achievement reflects the holistic understanding of educational performance advocated in the Merdeka Curriculum (Rahayu, 2022), which emphasizes creative thinking, critical engagement, and 21st-century skills alongside mastery of academic content.

The relatively higher neutral responses on the "Creativity" indicator (41%) merit further investigation. One possible interpretation is that, despite TPACK integration, PAI learning has not yet fully leveraged technology to stimulate students' creative expression. This suggests an area for future intervention: specifically designing TPACK-enriched PAI activities that emphasize project-based or problem-based approaches to Islamic content, which have been shown to enhance creativity and higher-order thinking (Amalia & Radiansyah, 2023).

The internal and external achievement factors identified in this study are consistent with classical achievement motivation theory. Syam (2019) and others have noted that motivation, academic self-concept, and a supportive classroom environment jointly mediate the relationship between instructional approach and learning outcomes. In this study, 31.8% of the unexplained variance in student achievement is attributed to factors beyond TPACK, likely reflecting these motivational, familial, and school management variables. Future research employing multi-variable models, such as structural equation modeling (SEM), could more precisely map these relationships.

Implications for PAI Teacher Professional Development

The magnitude of TPACK's influence on student achievement (68.2%) has significant practical implications for PAI teacher education and professional development in Indonesia. The national policy on teacher certification and continuing education (Permendiknas No. 16/2007) mandates pedagogical and technological competency, yet systematic TPACK training for PAI teachers in Islamic schools (madrasah and pesantren-affiliated schools) remains underdeveloped (Hanik, 2022; Wahidin et al., 2022). The findings of this study strengthen the evidence base for integrating

TPACK development as a core component of PAI teacher professional development programs, particularly within the framework of the Merdeka Belajar policy initiative.

Moreover, school leadership plays a facilitative role in enabling TPACK implementation. Syam (2017) highlighted that transformational school leadership creates the organizational conditions vision, resource allocation, teacher empowerment necessary for instructional innovation. The 31.8% unexplained variance in student achievement in this study may partly be accounted for by leadership and managerial factors that shape the institutional context within which TPACK is deployed. Future studies might benefit from incorporating school leadership quality as a mediating variable in models of TPACK-student achievement relationships.

Contribution and Novelty

This study makes several contributions to the literature. First, it provides rigorous quantitative evidence for TPACK's significant influence on PAI student achievement at the senior secondary level a gap explicitly absent in prior Indonesian research. Second, it employs a theoretically grounded operationalization of both TPACK (seven dimensions) and student achievement (eight indicators), offering a more comprehensive measurement model than previous single-domain studies. Third, the study's findings affirm TPACK's relevance beyond secular subject areas, demonstrating its validity as a framework for Islamic education instruction in Indonesia's multicultural, technology-driven learning landscape.

IV. CONCLUSION

This study examined the influence of the Technological Pedagogical Content Knowledge (TPACK) approach on student academic achievement in PAI learning at SMA Negeri 1 Ponorogo. Based on simple linear regression analysis of data from 80 Grade 11 students, the results established a statistically significant positive relationship between TPACK implementation and student achievement ($F = 165.387$, $Sig. = 0.000 < 0.05$). The coefficient of determination ($R^2 = 0.682$) indicates that 68.2% of the variance in student academic achievement is attributable to the TPACK approach, with the remaining 31.8% attributable to other contextual factors.

These findings confirm the hypothesis that H_1 is accepted: the TPACK approach (X) significantly and positively influences student academic achievement (Y) in Grade 11 PAI learning at SMA Negeri 1 Ponorogo. The study thus validates TPACK as a theoretically sound and empirically effective pedagogical framework for enhancing learning outcomes in Islamic Religious Education in Indonesia's senior secondary schools.

In practical terms, this study recommends that (1) PAI teachers pursue systematic TPACK competency development through professional training programs; (2) school leaders create enabling infrastructures for technology-enriched PAI instruction; and (3) curriculum developers integrate TPACK-based learning design principles into the national PAI curriculum framework, particularly in the context of Merdeka Belajar. Future research should investigate TPACK's influence on the affective and spiritual dimensions of PAI achievement, and employ multivariable models to account for broader school management and family factors that jointly determine student learning success.

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