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Digital Competence and Teacher Performance among In-Service K–12 Teachers in Indonesia for Quality Education (SDG 4): A Systematic Literature Review (2022–2026)

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ABSTRACT

Objective: *Empirical evidence regarding the relationship between teacher digital competence and teacher performance among in-service K–12 teachers in Indonesia remains fragmented across theoretical frameworks, measurement instruments, and outcome operationalizations. Furthermore, no prior synthesis has positioned digital competence as a key determinant during the implementation of the Kurikulum Merdeka (Independent Curriculum) policy framework (2022–present).* ***Method:*** *Reporting adhered to the PRISMA 2020 guidelines and the PICO eligibility framework. A comprehensive search was conducted on the Scopus database in May 2026, targeting peer-reviewed English-language journal articles published between 2022 and 2026. Title and abstract screening was conducted in two independent stages, with documented inter-rater agreement (Cohen's κ = 0.387 at the title/abstract stage, indicating a fair level of agreement). Methodological quality was evaluated using a six-criterion adapted version of the Mixed Methods Appraisal Tool (MMAT, 2018 version).* ***Results:*** *A total of 37 studies met the inclusion criteria for synthesis. Two dominant theoretical frameworks emerged within this domain: Digital Literacy (n = 22 of 37, 59.5%) and Technological Pedagogical Content Knowledge (TPACK; n = 21 of 37, 56.8%). Synthesis findings demonstrated a consistent positive association between teacher digital competence and outcomes pertaining to readiness, pedagogical competence, and technology adoption.* ***Novelty:*** *Teacher digital competence among in-service K–12 teachers is positively associated with teacher performance during the Kurikulum Merdeka policy era, with this relationship being more strongly mediated by school-level organizational and pedagogical conditions than by individual self-efficacy.*

INTRODUCTION

Teacher digital competence has emerged as a focal priority within educational systems supporting digital transformation (Caena & Redecker, 2019; Instefjord & Munthe, 2017; Starkey, 2020). The introduction of the *Kurikulum Merdeka* (Independent Curriculum) in 2022 established teacher autonomy and digital pedagogical agency as core policy priorities rather than situational adaptations, thereby positioning teacher digital competence as a structural concern for the Indonesian education sector. The Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) maps teachers' digital capacity across seven interrelated subdomains and has served as a dominant scholastic lens for research on instructional technology integration globally (Yani et al., 2026). Concurrently, the Digital Literacy construct rooted in foundational works (Aliyyah et al., 2026; Gilster, 1997) and operationalized in international policy frameworks such as DigCompEdu (Ghomi & Redecker, 2019; Redecker, 2017) emphasizes broader literacy dimensions, including critical evaluation,

digital safety, content creation, and communication, which underpin teachers' technological capacities (Falloon, 2020).

The relevance of this inquiry extends beyond academic interest. Sustainable Development Goal 4 (SDG 4: Quality Education) mandates a highly functional teaching force capable of leveraging technology to achieve its 2030 targets (UNESCO, 2018). In Indonesia, the post-pandemic policy landscape formalized through *Kurikulum Merdeka* and the digital infrastructure of the *Platform Merdeka Mengajar* (Platform for Independent Teaching) underscores the imperative that teachers possess sufficient digital capacity to operationalize the curricular autonomy granted by these policy reforms (Aliyyah et al., 2026; Damanik & Widodo, 2024, 2025; Suciwati & Zuo, 2025). The Ministry of Education's investments in professional development programs, school-level digital infrastructure provision, and the reform of the Teacher Performance Evaluation system (*Penilaian Kinerja Guru* / PKG) are all predicated on the core assumption of a positive link between teacher digital competence and teacher performance.

Five systematic reviews provide critical contextual grounding for this study. A PRISMA-guided synthesis of 94 articles published between 2020 and 2024 examining determinants of teacher performance across countries in the digital era, identified six factor categories: technological-pedagogical competence, personal factors, organizational support, contextual factors, technostress, and the digital divide. A second 2025 review, conducted by researchers at Universitas Gunadarma Jakarta and Universitas Galuh, synthesized 27 studies on teacher professionalism during Indonesia's digital transformation era; however, that work focused on higher education educators rather than the K–12 level. Personalised learning competence was evaluated in a third 2025 review by researchers at Universitas Riau, who synthesized 35 articles to delineate four competency dimensions: pedagogical, technological, assessment-reflective, and socio-emotional-innovative.

According to Ismail et al. (2026) and Fitrah et al. (2025), a global systematic review of 44 empirical studies on teacher performance determinants was conducted. Their three-block organizing framework (individual, organizational, and contextual) situated digital competence within the contextual block alongside variables such as workplace infrastructure and policy environment. Finally, a global systematic review (2024) of primary school teacher performance determinants spanning 2000 to 2023 identified five primary determinants: principal leadership, work environment, teacher motivation, training and development, and school resources, without explicitly incorporating digital competence among them. Collectively, these five prior reviews have mapped teacher performance determinants across adjacent populations and time periods, examined competencies and professionalism across related units of analysis, and treated digital competence as a vital factor in instructional practice (Fernández-Batanero et al., 2022; Spiteri & Chang Rundgren, 2020).

The scope of this systematic review is framed around four core eligibility dimensions:

1. *Population:* Restricted to in-service teachers within Indonesian K–12 schools (elementary/MI, junior high/MTs, and senior high/vocational/MA), encompassing both public and private institutions, including madrasah-affiliated schools. Pre-service teachers, higher education faculty, students, and non-teaching staff were excluded.
2. *Outcomes:* Primary outcomes were focused on teacher performance and digitally related professional capacity.
3. *Publication Period:* Restricted to publications between 2022 and 2026 to align strictly with the implementation period of the *Kurikulum Merdeka* (Independent Curriculum) policy framework.

4. *Database and Language:* Searches were conducted exclusively within the Scopus database, targeting peer-reviewed, English-language journal articles.

Primary Research Question (RQ-P): How is teacher digital competence associated with teacher performance within the Indonesian K–12 education system during the 2022–2026 digital transformation era?

Secondary Research Questions:

1. *RQ-S1:* How are teacher digital competence and teacher performance conceptualized and measured across the included studies?
2. *RQ-S2:* What are the direction, strength, and consistency of the relationship between digital competence and teacher performance across empirical studies?
3. *RQ-S3:* Which contextual factors and performance dimensions moderate or differentiate this relationship?

RESEARCH METHOD

Eligibility criteria (PICO framework)

1. *Population (P):* In-service teachers within the Indonesian K–12 education system (elementary/MI, junior high/MTs, and senior high/vocational/MA), encompassing public, private, and madrasah-affiliated schools.
2. *Intervention/Exposure (I):* Teacher digital competence (conceptualized as digital literacy, ICT competence, Technological Pedagogical Content Knowledge [TPACK], or digital skills).
3. *Comparator (C):* No single mandatory comparator group was specified due to the non-experimental design of the included studies.
4. *Outcomes (O):* Teacher performance, teacher readiness, pedagogical/professional competence, technology integration, and intention to adopt digital instructional tools.

Selection process

The study selection followed the PRISMA 2020 reporting guideline (Page et al., 2021) and was conducted in two distinct phases:

1. *Title and Abstract Screening (TIAS):* A total of 272 records retrieved from Scopus were independently evaluated by two reviewers, yielding an inter-rater agreement of Cohen's $\kappa = 0.387$ (N = 90 paired evaluations, categorized as fair agreement; Landis & Koch, 1977).
2. *Full-Text Eligibility Assessment:* A total of 64 full-text records were assessed against the predefined eligibility rubric. Of these, 23 records were excluded following full-text evaluation due to specific non-compliance with the inclusion criteria.

Data extraction process

Data extraction was independently performed by two reviewers using a pre-developed, a priori spreadsheet extraction form aligned with the PICO framework (Higgins et al., 2019). The extraction instrument comprised 18 distinct fields encompassing study identifiers, publication year, geographic location, school context, research design, sample size, participant characteristics, theoretical frameworks, exposure variables, outcome variables, key reported findings, theoretical anchors, acknowledged limitations, and methodological quality scores. The primary reviewer performed initial data extraction directly from the source manuscripts, after which the secondary reviewer conducted a full line-by-line verification against the original texts to identify any discrepancies. All inconsistencies were fully reconciled through direct joint re-examination of the source PDF documents.

Data items

The extraction form captured 18 variables organized around the PICO framework and methodological quality assessment requirements: (1–4) bibliographic identifiers (study ID, publication year, authors, and journal); (5–6) geographic location and school setting (elementary/SD, junior high/SMP, senior high/SMA, vocational/SMK, MA, early childhood/PAUD, madrasah, or mixed); (7–8) study design (quantitative, qualitative, or mixed-methods) and specific methodological approach (SEM-PLS, case study, action research, narrative inquiry, cross-sectional survey, or phenomenological design); (9–10) sample size and participant characteristics, including gender composition and teaching experience when reported; (11) digital competence framework operationalized, namely TPACK (Mishra & Koehler, 2006), Digital Literacy (Gilster, 1997), ICT Competence/DigCompEdu (Redecker, 2017), the Technology Acceptance Model and its extensions (Davis, 1989; Venkatesh et al., 2003), or the Theory of Planned Behavior (Ajzen, 1991); (12) exposure/intervention variables; (13) outcome variables; (14) primary reported findings; (15) theoretical framework anchors; (16) explicit acknowledgment of study limitations (yes/no); (17) study quality tier; and (18) additional reviewer notes.

Risk of bias assessment

Methodological quality was evaluated using an adapted version of the Mixed Methods Appraisal Tool (MMAT, 2018 version; Hong et al., 2018) comprising six specific criteria (Q1–Q6). Overall methodological quality was classified into three distinct tiers based on the number of criteria satisfied: High Quality (5–6 criteria met), Medium Quality (3–4 criteria met), and Low Quality (0–2 criteria met).

Synthesis methods

A narrative synthesis approach was employed (Campbell et al., 2020; Popay et al., 2006) due to substantial heterogeneity across study designs (quantitative, qualitative, and mixed-methods), sample sizes (ranging from 5 to 2,788 participants), theoretical frameworks, and outcome operationalizations which included digital literacy as an outcome, teacher readiness, pedagogical competence, technology integration, adoption intention, and professional development.

RESULTS AND DISCUSSION

Results

Study selection and characteristics

From the initial 272 records identified through Scopus, a total of 125 records were excluded during the title and abstract screening (TIAS) stage (111 failed the population criteria, 10 failed on study design, 1 on intervention/exposure, and 1 on outcome criteria). Following the full-text eligibility assessment of 64 manuscripts, 37 primary studies met all inclusion criteria and were incorporated into the systematic synthesis (Figure 1). Their distribution by publication year, design, and quality tier is presented in Table 1.

Table 1. Distribution of included studies by publication year, design, and quality tier

Publication Year	n	%	Research Design	n	%	Quality Tier	n	%
2022	9	24.3%	Quantitative	13	35.1%	High (5–6 criteria)	28	75.7%
2023	5	13.5%	Mixed-Methods	9	24.3%	Medium (3–4 criteria)	8	21.6%
2024	9	24.3%	Qualitative	8	21.6%	Low (0–2 criteria)	1	2.7%

Publication Year	n	%	Research Design	n	%	Quality Tier	n	%
2025	11	29.7%	Unclear	7	18.9%			
2026	3	8.1%						
Total	37	100%	Total	37	100%	Total	37	100%

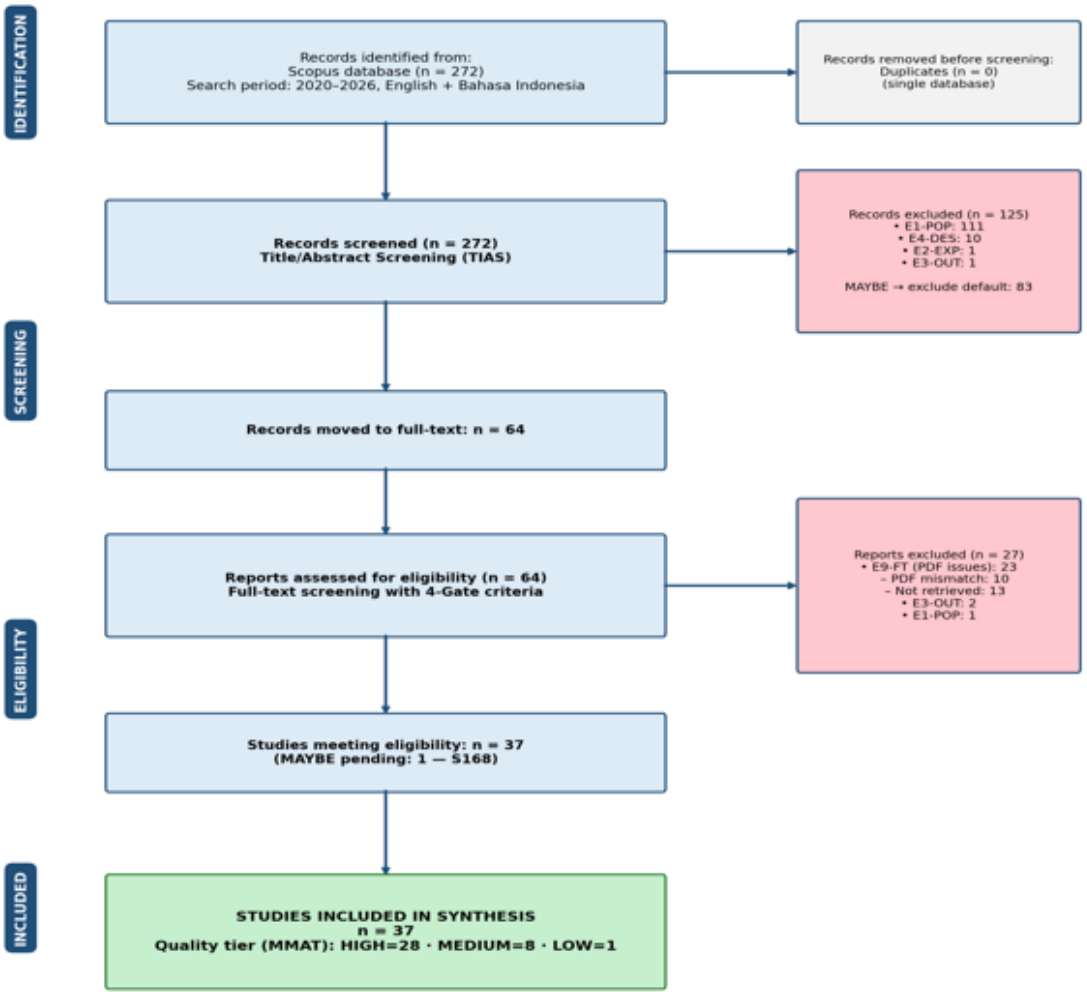


Figure 1. PRISMA flow diagram

Geographic Distribution: Java dominated the empirical landscape, accounting for 23 studies (62.2%), followed by Sulawesi (n=2), Bali (n=2), Sumatra (n=1), and multi-regional or unspecified settings (n=9). Eastern Indonesia and Kalimantan remained markedly underrepresented.

Research Design: Quantitative survey/SEM designs were the most prevalent (35.1%), followed by mixed-methods approaches (24.3%), qualitative designs (21.6%), and unclassified methodologies (18.9%).

Primary Theoretical Frameworks: Digital Literacy (59.5%) and TPACK (56.8%) emerged as the dominant theoretical lenses, with 40.0% of the included studies integrating both frameworks. The Technology Acceptance Model (TAM; Davis, 1989) and the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003) were operationalized in 24.3% of the studies. The full distribution of theoretical frameworks is presented in Table 2.

Table 2. Theoretical frameworks used in the included corpus

No.	Theoretical Framework	Frequency (n)	Percentage (%)
1	Digital Literacy	22	59.5%
2	Technological Pedagogical Content Knowledge (TPACK)	21	56.8%
3	Technology Acceptance Model (TAM) / UTAUT / UTAUT2	9	24.3%
4	ICT Competence / DigCompEdu	5	13.5%
5	Theory of Planned Behaviour (TPB)	1	2.7%
6	TPACK + Digital Literacy (Combination)	~15	~40.0%

Methodological quality and risk of bias

Methodological quality evaluation using the adapted MMAT instrument revealed that among the 37 included studies, 28 (75.7%) were classified as High Quality (satisfying 5–6 criteria), 8 (21.6%) were rated as Medium Quality (satisfying 3–4 criteria), and 1 (2.7%) was designated as Low Quality (satisfying 0–2 criteria).

Narrative synthesis findings

1. *RQ-S1 (Conceptualization and Measurement):* Strong theoretical convergence was observed around the TPACK and Digital Literacy frameworks. A vast majority of studies operationalized self-report survey scales; however, comprehensive psychometric re-validation remains sparse across the literature.
2. *RQ-S2 (Direction and Consistency):* All empirical studies explicitly examining the target relationship demonstrated a consistently positive association between teacher digital competence and teacher performance.
3. *RQ-S3 (Moderation and Mediation Pathways):* Three primary mediating pathways emerged from the structural models.
4. *RQ-P (Integrated Synthesis):* Teacher digital competence is consistently and positively associated with teacher performance. Crucially, this relationship is more strongly mediated by school-level organizational culture and instructional quality than by individual self-efficacy.

Discussion

Summary of findings

This systematic review consolidates empirical evidence from 37 studies (2022–2026) evaluating the relationship between teacher digital competence and teacher performance within the Indonesian K–12 education system. Addressing the primary research question, the integrated synthesis reveals that teacher digital competence, variously operationalized across the corpus as digital literacy, ICT competence, or Technological Pedagogical Content Knowledge (TPACK), is consistently and positively associated with outcomes of teacher readiness, pedagogical/professional competence, technology integration, and adoption intention (MODERATE certainty, downgraded from HIGH due to indirectness and potential publication bias; Guyatt et al., 2008).

Syntheses addressing the secondary research questions further contextualize this primary finding. Conceptualizations of teacher digital competence within the Indonesian K–12 context have converged upon two dominant theoretical frameworks: Digital Literacy (employed in n = 22 of 37 studies, 59.5%) and TPACK (n = 21 of 37, 56.8%), frequently applied in combination (HIGH certainty). Operationalizations of teacher performance remain heterogeneous and are rarely aligned with formal performance

evaluation measures (e.g., *Penilaian Kinerja Guru* / PKG or structured classroom observations) used by the Ministry of Education; instead, the literature broadly operationalizes performance as readiness, pedagogical/professional competence, technology integration, or adoption intention. Three distinct structural mediation pathways received empirical support within the corpus: (1) school culture → digital literacy → teacher performance; (2) perceived usefulness → intention to adopt AI; and (3) instructional creativity → teacher professional performance (each yielding LOW-to-MODERATE certainty, anchored by individual well-executed SEM designs).

The integrated interpretation suggests that teacher digital competence serves as a substantive, though not exclusive, determinant of teacher functioning within Indonesia's digital transformation landscape. The synthesized corpus demonstrates that while digital competence operates upstream, its translation into performance outcomes remains fundamentally contingent upon the institutional culture and pedagogical quality of the school environment (Ertmer & Ottenbreit-Leftwich, 2010; Sailer et al., 2021; Tondeur et al., 2017). When school culture is supportive and instructional quality is robust, teacher digital competence translates into significantly enhanced teacher performance outcomes.

Heterogeneity analysis

Standardized path coefficients reported across the SEM-based analytical subset ranged from weak to moderate and strong; however, direct comparison across studies remains constrained due to substantive variations in antecedent and outcome constructs (e.g., digital literacy → readiness in one study, ICT literacy → personal knowledge management in another, and TPACK → instructional effectiveness in a third). Consequently, magnitude heterogeneity reflects construct-level divergence rather than mere methodological inconsistency. Three main sources of variation account for most of the observed dispersion in effect sizes:

First, outcome construct operationalization: Studies measuring performance through narrow, self-reported competency scales consistently reported stronger direct effects of digital competence than those operationalizing performance via composite readiness metrics or creativity-mediated professional performance. Second, sampling units: Single-province studies exhibited a more tightly concentrated effect distribution relative to multi-province empirical investigations. Third, mediator specification: Models omitting school culture as a structural mediator tended to overestimate the direct effect of digital competence, as the indirect pathway connecting organizational culture to competence was subsumed into the direct effect estimate.

Limitations

Limitations of the Review: Restricting the search string to English-language publications indexed in the Scopus database explicitly excluded national literature indexed in the Garuda database. Furthermore, the included sample exhibited a heavy concentration toward schools on Java island (>60%) and within the English as a Foreign Language (EFL) discipline (>30%).

Limitations of the Primary Studies: The primary corpus was constrained by a heavy reliance on self-report instruments and the exclusion of 23 records during full-text eligibility screening due to text unavailability.

Practical and policy implications

Implications for research

The synthesized corpus highlights four critical priorities for future research. First, longitudinal study designs remain severely underrepresented (accounting for only a

single 20-month study across the entire corpus). Multi-month and multi-year longitudinal replications are urgently needed to determine whether digital competence development constitutes a sustainable professional capacity or a contingent skill set tied to specific technology cohorts. Second, regional diversification represents the most pressing geographic gap: Eastern Indonesia (Papua, Maluku, Nusa Tenggara), Kalimantan, and underrepresented provinces in Sumatra require dedicated empirical investigation before the present synthesis findings can be generalized beyond the Java-centric context. Third, subject-matter diversification is essential: the current concentration on English as a Foreign Language (EFL) instruction yields robust theoretical and empirical insights for language education but restricts transferability to Mathematics, Science, Vocational, and Religious Education domains. Fourth, the indirect structural mediation pathways identified in this synthesis (school culture, perceived usefulness, and instructional creativity) require confirmatory testing in larger and longitudinal samples.

Implications for policy

For educational policy, the Ministry of Education must prioritize the transformation of school organizational culture and governance frameworks concerning AI integration, alongside addressing rural-urban disparities in digital infrastructure.

Future research agenda

The synthesized evidence demonstrates a cohesive yet bounded empirical foundation: teacher digital competence is positively associated with teacher performance within the Indonesian K–12 education system, exerting an influence mediated more strongly by school organizational culture and instructional quality than by individual self-efficacy. However, the supporting evidence remains geographically concentrated in Java, subject-concentrated within English as a Foreign Language (EFL) instruction, and methodologically dominated by cross-sectional structural equation modeling. Research priorities are prioritized based on whether the necessary data infrastructure, measurement instruments, and access conditions are currently available (HIGH feasibility), require short-term development (MEDIUM feasibility), or depend on precursor infrastructure or instrumentation that is not yet established (LONG-TERM feasibility).

CONCLUSION

Fundamental Finding: This systematic review of 37 included primary studies (2022–2026) establishes that digital competence is consistently and positively associated with teacher performance and professional capacity among Indonesian K–12 in-service teachers during the Kurikulum Merdeka era, supported by an overall moderate level of certainty. Crucially, this relationship is conditional rather than absolute: while digital competence is a substantive determinant, its translation into measurable performance depends heavily on organizational and pedagogical conditions, particularly supportive school culture and instructional quality. Consequently, the primary leverage point for educational improvement lies in the organizational and pedagogical environment in which teachers operate. **Implication:** Theoretically, this review advances the literature in three ways: (1) demonstrating the cross-contextual portability of combined TPACK and digital literacy frameworks within non-anglophone, post-pandemic, multi-religious K–12 settings (high certainty); (2) refining the TAM for Indonesian teachers by showing that perceived usefulness outweighs perceived ease of use (Davis, 1989; Scherer et al., 2019); and (3) challenging default technology adoption assumptions by indicating that school

culture and instructional quality mediate performance more strongly than individual self-efficacy alone (low-to-moderate certainty). From a practical perspective, the review's implications extend to three primary stakeholder groups: (a) school leaders and teacher educators (investments in school culture transformation characterized by supportive principal leadership, collaborative norms, and a strong pedagogical quality climate—possess stronger empirical justification than standalone individual digital training programs, though technical training remains a necessary element of any integrated professional development strategy); (b) non-EFL subject practitioners (the review highlights a distinct empirical gap rather than an established body of practice guidelines. Consequently, existing EFL-derived practices must be transposed into non-language disciplines with caution); and (c) educational policy makers (targeted policy interventions are needed to bridge the rural-urban digital infrastructure divide, establish formal governance frameworks for emerging Artificial Intelligence (AI) tools where adoption has outpaced regulation, and rebalance research investments away from Java-centric concentration). **Limitation:** The findings of this review are constrained by marked geographic indirectness, as the national evidence base is heavily concentrated in Java, alongside potential publication bias and low-to-moderate certainty across specific mediation pathways. Therefore, the practical and theoretical conclusions cannot be universally generalized across Indonesia's diverse educational landscape particularly to eastern Indonesia, Kalimantan, and major regions of Sumatra without localized empirical verification. **Future Research:** Future investigations should address current empirical blind spots by conducting localized studies in underrepresented regions outside Java (such as Eastern Indonesia, Kalimantan, and Sumatra) and across non-EFL subject disciplines to test the generalizability of these findings. Furthermore, researchers should rigorously examine the organizational mechanisms of school culture and instructional quality as mediators of teacher performance, while developing and evaluating governance and pedagogical frameworks for emerging Artificial Intelligence (AI) tools in Indonesian K–12 classrooms.

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AUTHOR CONTRIBUTIONS

Eva Mufidah: Conceptualization, Methodology, and Supervision; **Triesninda Pahlevi**: Investigation (Literature Search), Data Curation, Formal Analysis, and Writing – Original Draft; **Jaka Nugraha**: Validation, and Project Administration; **Komm Pechinthorn**: Writing – Review & Editing. All authors have reviewed and approved the final version of this manuscript.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest, either financial or personal, that may have influenced the content or outcome of this study.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital tools, including AI-based technologies, as support in the research and writing stages of this article. Specifically, Gemini was employed for language refinement, grammar checking, and structural synthesis of the manuscript, while Mendeley/Zotero assisted with reference management and systematic literature screening. All outputs generated with digital assistance were critically evaluated and revised to ensure academic rigor and ethical standards were upheld. The final responsibility for the manuscript rests entirely with the authors.

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