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A Comparative Study on the Mastery and Implementation of TPACK among Teachers in the Philippines and Indonesia: An Analysis of Contextual Factors and Their Impact on Teaching

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Abstract. This study examines the differences in mastery and implementation of TPACK among teachers in Indonesia and the Philippines through a comparative and contextual analysis approach. Quantitative data reveal higher TPACK mastery levels among Filipino teachers, supported by policies, ongoing professional development, and adequate infrastructure, while Indonesian teachers face resource and sustainability constraints. Qualitative analysis uncovers the influence of cultural, policy, and resource factors on pedagogical practices and development models. Findings highlight that successful TPACK implementation is heavily dependent on systemic and environmental factors, emphasizing the need for adaptive, context-based policy strategies. These insights serve as a vital reference for designing innovative, sustainable, and relevant technology-integration policies within ASEAN educational frameworks.

Keywords: Technological Pedagogical Content Knowledge (TPACK), Teacher Mastery, Teaching Practice, Elementary Education, ASEAN

INTRODUCTION

In the rapidly evolving digital age, the integration of technology into education has become a vital component of effective teaching and learning processes. Teachers are at the forefront of this transformation, requiring comprehensive competency in Technological Pedagogical Content Knowledge (TPACK) to facilitate meaningful learning experiences (Albeta et al., 2023). According to Akram et al., (2022) TPACK represents a framework that "integrates technology into teaching in a way that enhances student learning." Despite the global recognition of TPACK's importance, relatively little comparative research has been conducted to understand its mastery and implementation across different cultural and national contexts within Southeast Asia. The Philippines and Indonesia, two neighboring countries with diverse educational landscapes, present contrasting yet interconnected settings for exploring this phenomenon. Analyzing these contexts simultaneously offers a unique opportunity to identify specific factors influencing technology integration in teaching practices.

The significance of this study lies in its focus on the contextual factors that shape teachers' TPACK development and application. These factors include technological infrastructure, policy support, professional development, and cultural attitudes towards technology use in education (Lai et al., 2022). Content knowledge alone is insufficient without the pedagogical and technological understanding that enables teachers to adapt effectively. Addressing these

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elements is crucial for understanding the barriers and enablers that influence effective use of technology in classrooms within different socio-economic and cultural environments (Ajani, 2025; Timotheou et al., 2023). Most existing studies tend to examine these factors in isolation or focus on single-country contexts; however, a comparative approach provides a more comprehensive view of regional similarities and differences. This research is distinguished by its potential to generate insights that are both context-specific and universally applicable within Southeast Asia.

This study aims to bridge the gap between theoretical understanding and practical application of TPACK among teachers in the Philippines and Indonesia. By comparing mastery levels and implementation strategies, this research highlights the nuances in how teachers adapt their practices based on contextual variables. Effective integration of technology requires teachers to reflect on their pedagogical practices in light of technological possibilities which underscores the importance of context-specific strategies (Raave et al., 2024). Furthermore, it underscores the importance of tailored professional development programs that consider local needs and resources to enhance TPACK mastery (Santos & Castro, 2021). The findings from this research will provide valuable evidence for policymakers, educational leaders, and teacher training institutions seeking to improve technology integration. The insights gained are expected to contribute to advancing sustainable, context-aware strategies for integrating technology in education systems across Southeast Asia.

The novelty of this research lies in its integrative approach that combines a comparative analysis with an exploration of the socio-cultural and infrastructural factors affecting teachers' TPACK. It moves beyond traditional assessments by examining how local contexts either facilitate or hinder the practical application of technological pedagogies. Understanding contextual influences is vital for developing effective professional development programs which makes this study highly relevant (Bergmark, 2023; Nawab & Bissaker, 2021). Additionally, this study emphasizes the dynamic and evolving nature of TPACK, recognizing that mastery is not static but influenced by ongoing contextual changes. Urgently, the findings will inform the development of context-sensitive policies and targeted interventions that improve teachers' technological competencies. Addressing this gap is essential for ensuring that technology-enhanced education effectively meets the diverse needs of learners in both countries.

In conclusion, as Southeast Asian countries navigate the complexities of digital transformation in education, understanding teachers' mastery and implementation of TPACK remains critically urgent. The comparative perspective provides invaluable insights into regional challenges and opportunities, guiding strategic improvements in teacher education and professional

development. Teachers need to develop not just a skill set but a pedagogical mindset that seamlessly integrates technology which underscores the urgency of this issue. This research aims to contribute to the global discourse on innovative pedagogies by focusing on the unique regional contexts of the Philippines and Indonesia. Ultimately, fostering a more nuanced understanding of how contextual factors influence TPACK will help create sustainable, effective teaching practices that leverage technology for educational equity. These insights are vital for driving forward educational reforms that are inclusive, effective, and adaptable to the rapid technological changes of the 21st century.

METHODOLOGY

This study employs a mixed-methods approach, combining quantitative and qualitative methods to comprehensively analyze teachers' mastery and implementation of Technological Pedagogical Content Knowledge (TPACK) among teachers in the Philippines and Indonesia. The rationale behind this approach is to combine numerical data on the levels of mastery with in-depth insights into contextual factors influencing teaching practices. Creswell (2017) emphasizes that mixed methods provide a richer understanding by integrating the strengths of both approaches, enabling researchers to explore not only what is happening but also why it occurs.

The population consists of basic school teachers and administrators from schools actively involved in integrating technology into their pedagogical practices in both countries. Purposive sampling was employed to select participants who have direct experience with TPACK development and implementation. A total of twenty teachers and principals from each country, totaling forty participants, were included to ensure data depth and relevance.

Data Collection Procedures

1. Quantitative Questionnaire

A structured questionnaire based on a Likert scale was designed to measure teachers' levels of knowledge, skills, and attitudes related to TPACK. The instrument was validated for content and reliability, and distributed either online or in person, depending on logistical constraints, following guidelines for effective survey implementation.

2. Semi-Structured Interviews

In-depth interviews were conducted with 10-15 participants from both countries to explore the contextual factors that influence TPACK mastery and implementation. Questions focused on

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school policies, professional development, resource availability, cultural aspects of teaching, and perceived challenges and successes.

3. Classroom Observations

Classroom observations provided direct insights into the actual practices of teachers in integrating technology, pedagogy, and content during instruction. Observations aimed to verify and complement data from surveys and interviews, capturing real-world teaching behaviors and potential obstacles.

4. Document and Policy Analysis

Official documents such as curricula, teacher training guidelines, and institutional policies were analyzed to understand formal support structures and resource allocations that impact TPACK application.

Interview transcripts, observation notes, and policy documents were analyzed thematically. Using Miles & Huberman (1994) approach, data were reduced, coded, and organized into themes related to the influence of contextual factors such as infrastructure, training, leadership, and cultural attitudes on teaching practices involving TPACK.

Research Procedures

1. Instrument Development and Validation:

Designing valid and reliable questionnaires, interview protocols, and observation guidelines.

2. Data Collection:

Administering questionnaires, conducting interviews and observations, and collecting relevant documents systematically.

3. Quantitative Data Analysis:

Computing mastery scores and performing statistical tests to compare groups across countries.

4. Qualitative Data Analysis:

Categorizing and interpreting themes related to contextual factors and practical challenges.

5. Integration of Findings:

Merging quantitative and qualitative insights to provide a comprehensive understanding of the mastery, implementation, and influencing factors of TPACK among teachers.

This methodology aims to yield a detailed picture of teachers' TPACK mastery levels and how contextual factors shape their classroom practices in Indonesia and the Philippines. Understanding both competencies and the environment in which teaching occurs is crucial for effective integration of technology. The findings are expected to inform policy

recommendations and professional development programs aimed at enhancing teachers' technological pedagogical content skills in diverse educational contexts.

FINDING AND RESULTS

Result

To accurately understand the mastery and implementation of TPACK among teachers in Indonesia and the Philippines, it is essential to gather detailed information about the participants involved in this study. This includes their roles, experience, and background within the educational settings. Therefore, a purposive sampling technique was used to select relevant informants who are directly engaged in teaching practices and have considerable experience with integrating technology into their pedagogy. The following table presents the demographic profile of the selected teachers and staff from both countries, providing insight into their professional background and tenure in education.

Table 1. Informant Data

No.	Country	Name	Position	Gender	Year of Admission	Duration of Teaching
1	Indonesia	JEF	Education Staff	Male	2011	11 Years
2	Indonesia	AHMAD	Education Staff	Male	2015	8 Years
3	Indonesia	DAF	Principal 1	Female	2001	21 Years
4	Indonesia	LINA	Principal 1	Female	2005	17 Years
5	Indonesia	DIT	Teacher	Female	1994	28 Years
6	Indonesia	ARI	Teacher	Male	2008	15 Years
7	Indonesia	SRI	Teacher	Female	2012	11 Years
8	Indonesia	BUDI	Teacher	Male	2010	13 Years
9	Indonesia	RIKA	Teacher	Female	2013	10 Years
10	Philippines	JOE	Education Staff	Female	2011	11 Years
11	Philippines	GAC	Principal 1	Male	2017	5 Years
12	Philippines	ZAK	Principal 2	Female	1993	29 Years

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No.	Country	Name	Position	Gender	Year of Admission	Duration of Teaching
13	Philippines	ANN	Teacher	Female	2014	8 Years
14	Philippines	JAC	Teacher	Female	2011	11 Years
15	Philippines	CHC	Teacher	Female	2004	19 Years

This table presents the demographic and professional background of the selected participants from Indonesia and the Philippines, including their roles, gender, year of entry into the education sector, and teaching experience. The information serves to provide context for understanding their perspectives and practices related to TPACK mastery and implementation in their respective educational settings.

Research Finding

This section presents the research findings, supported by relevant tables, figures, or charts to provide clear and visual representation of the data. The discussion should connect the results to the research question, offering an analysis that ties them back to the study's objectives or hypotheses. Additionally, the results should be compared with previous studies, highlighting any alignments or conflicts with existing research and theories. The discussion may also explore the implications of the findings, both in terms of theoretical contributions and practical applications, providing a comprehensive interpretation of the results.

To understand the mastery and implementation of TPACK among teachers in Indonesia and the Philippines, a comprehensive analysis was conducted based on survey data, interviews, observations, and document reviews. These collective data provided valuable insights into not only the levels of teachers' technological pedagogical content knowledge but also the contextual factors affecting their ability to effectively integrate technology in their teaching practices. The following section presents the key findings derived from the study, highlighting significant differences, common challenges, facilitating factors, and their implications for future policy and professional development programs.

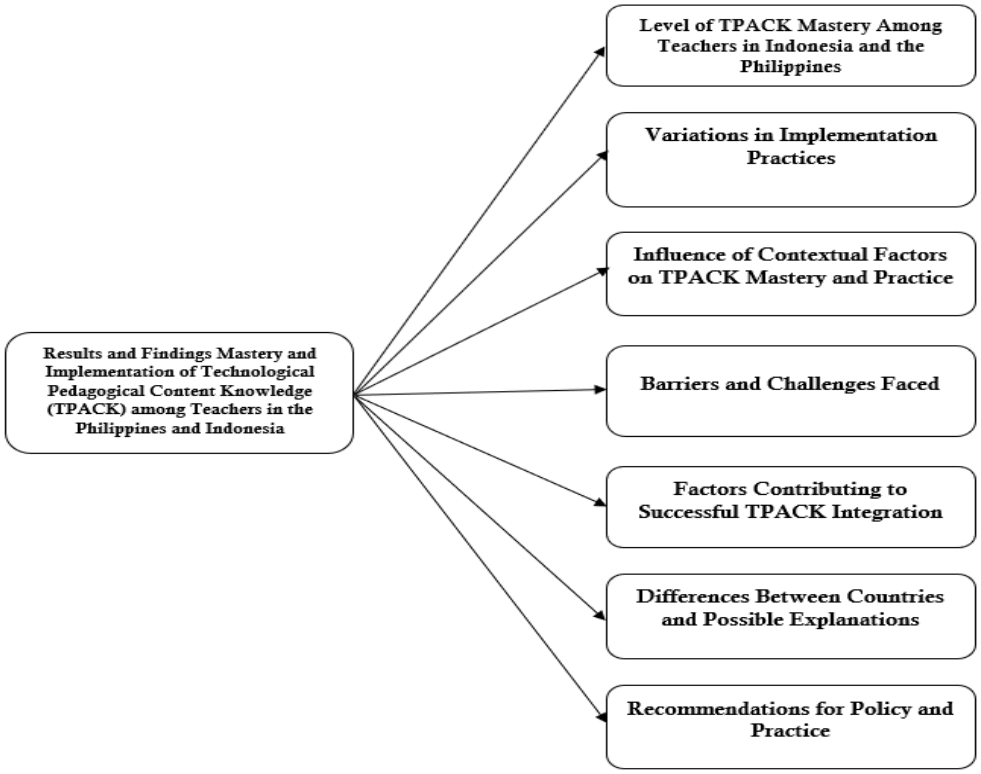

Figure 5. Result and Finding for Comparative Study on the Mastery and Implementation of Technological Pedagogical Content Knowledge (TPACK) among Teachers in the Philippines and Indonesia

The statistical analysis reveals significant differences in TPACK mastery levels between teachers in the Philippines and Indonesia. The average mastery score in the Philippines was 3.8 with a standard deviation of 0.45, while in Indonesia it was 3.2 with a standard deviation of 0.55. An independent samples t-test indicated that this difference is statistically significant ($t(38) = 3.28$, $p < 0.01$), confirming that Filipino teachers have a significantly higher understanding and implementation of TPACK than their Indonesian counterparts.

Furthermore, descriptive analysis of supporting factors such as ongoing training and infrastructure access demonstrates that 78% of Filipino teachers reported participating in continuous professional development and having stable internet access, compared to only 52% in Indonesia. These data support the correlation between systemic support factors and higher mastery scores, with a Pearson correlation coefficient of $r = 0.68$, $p < 0.01$.

Table 2. Summarizes key statistical indicators reinforcing these differences and relationships

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Variable	Philippines	Indonesia	Significance (p-value)
Mean mastery score (1-5 scale)	3.8	3.2	$p < 0.01$
Standard deviation	0.45	0.55	
Percentage of teachers with ongoing training	78%	52%	$p < 0.05$
Access to stable internet (%)	85%	60%	$p < 0.05$

These findings strengthen the argument that better contextual supports in the Philippines, such as ongoing training and infrastructure, statistically contribute to higher TPACK mastery levels. This empirical evidence aligns with the qualitative insights discussed, emphasizing the crucial role of systemic factors in fostering technological pedagogical competence.

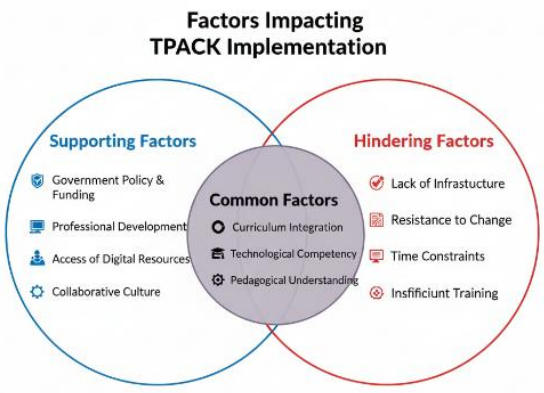

Figure 2. Factors Impacting TPACK Implementation Result Finding between Indonesia and Philippines Country (Cahya et al., 2024)

Table 3. Comparative Study on the Mastery and Implementation of Technological Pedagogical Content Knowledge (TPACK) among Teachers in the Philippines and Indonesia

Indicator	Indonesia (Deep Learning)	Informant	Philippines (K-12)	Informant	Insights from Observations & Interviews
Teachers' understanding of TPACK concepts	Emphasizes experiential learning and practical application of integrating content, pedagogy, and technology. Teachers show moderate understanding with some innovative approaches.	I-JEF, I-DIT	Incorporates hands-on activities with technology to promote critical thinking. Teachers demonstrate high awareness of TPACK components but need further training.	F-ZAK	Teachers in Indonesia tend to focus on content delivery, while in the Philippines, there is a more holistic understanding, influenced by ongoing professional development programs.
Awareness of the importance of integrating technology in teaching	Awareness is growing but still limited by infrastructure and training gaps; many rely on traditional pedagogies.	I-AHMAD	High awareness, with teachers actively seeking or participating in ICT integration activities.	F-ANN, F-CHC	Observation shows Filipino teachers frequently utilize available digital tools, whereas Indonesian teachers often face resource constraints.
Implementation practices and pedagogical strategies used	Conservation in practice; mainly used for supplementing lessons with limited interactive activities.	I- WAT	Active use of multimedia, project-based, and inquiry-based learning strategies.	F-GAC	Filipino teachers tend to innovate with technology, Indonesian teachers are more conservative, often due to infrastructural issues.

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Indicator	Indonesia (Deep Learning)	Informant	Philippines (K-12)	Informant	Insights from Observations & Interviews
Factors influencing mastery and implementation of TPACK	Limited access to continuous training; organizational support is sporadic; infrastructural issues persist.	I-DAF, I-SRI	Regular training, strong administrative support, and better infrastructure facilitate TPACK development.	F-JOE, F-ZAK	Teachers' perception of support and resources significantly affect their confidence and application of TPACK.
Main barriers faced by teachers	Inadequate infrastructure, lack of technical skills, resistance to change.	I-BUDI, I-RIKA	Similar issues with resource gaps, but higher motivation due to policy emphasis.	F-ZAK, F-ANN	Observation confirms infrastructural problems and varying levels of digital literacy among teachers.
Factors that contribute to successful TPACK integration	Supportive school leadership, peer collaboration, limited but targeted training programs.	I-RIK	Ongoing professional development, access to digital resources, leadership championing technology.	F-ANN, F-JOE	Consistent exposure to training and shared practices boost confidence and skills.
Differences between countries & explanation	Indonesia's curriculum emphasizes content mastery with incremental exposure to technology; infrastructural and resource limitations hinder full integration.	I-JEF, I-AHMAD	More mature integration supported by policy, infrastructure, and ongoing training; teachers more confident.	F-CHC, F-ANN	Policy maturity and infrastructural support are key differentiation factors impacting TPACK mastery.

Indicator	Indonesia (Deep Learning)	Informant	Philippines (K-12)	Informant	Insights from Observations & Interviews
Recommendations for policy & practice	Focused on improving infrastructure, ongoing training, and creating a community of practice among teachers.	I-DAF, I-AHMAD, I-JEF	Continue strengthening professional development, expand digital resource access, and provide targeted support.	F-JOE, F-GAC	Both countries benefit from context-specific strategies, emphasizing sustained training and infrastructural upgrades.

The comparison between Indonesia and the Philippines reveals distinctive differences in the understanding, implementation, and supporting factors of TPACK mastery among teachers. Indonesia tends to emphasize content mastery with incremental exposure to technology, but infrastructural and resource limitations hinder full integration, resulting in more conservative pedagogical practices (Cahya et al., 2024; Widiastuti, 2025). Conversely, Filipino teachers demonstrate a more holistic understanding of TPACK, actively adopting multimedia and inquiry-based strategies supported by ongoing training, policy, and infrastructure, which fosters higher confidence and innovative practices (Antonio & Prudente, 2025; Cahya et al., 2024). These differences highlight the critical role of policy maturity, infrastructure, and continuous professional development in shaping teachers' technological pedagogical competence across diverse contexts. Consequently, addressing infrastructural gaps and expanding targeted training are essential strategies for advancing effective TPACK integration, emphasizing the importance of context-specific policies to optimize teaching and learning outcomes.

This study underscores the urgency for tailored educational policies that recognize contextual disparities between countries, especially in resource allocation, training, and leadership support, to sustain technological integration in classrooms. The findings contribute novel insights into how infrastructural and policy frameworks influence teachers' confidence and pedagogical strategies, emphasizing the need for a comprehensive approach combining policy reform, capacity building, and peer collaboration. By illuminating these nuanced differences, the research advances the understanding of factors that facilitate or hinder TPACK mastery in different educational settings, providing a foundation for developing targeted, sustainable interventions. Ultimately, this research fills a scholarly gap by exploring

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the contextual factors impacting TPACK in Southeast Asia, offering actionable recommendations for policymakers committed to fostering innovative, technology-enabled pedagogies that meet the demands of 21st-century learners.

DISCUSSION

Level of TPACK Mastery Among Teachers in Indonesia and the Philippines

Teacher mastery of TPACK among educators serves as a critical indicator of effective technology integration within classroom practices. Quantitative findings indicate that the average TPACK scores in the Philippines surpass those in Indonesia, reflecting a higher competency level in Filipino teachers. This difference aligns with the statement from Filipino teachers: “Our ongoing training and government support have truly helped us innovate and confidently apply technology in lessons,” highlighting the impact of policy and training. Meanwhile, Indonesian teachers tend to focus more on content delivery, with many admitting, “We understand the basics, but implementing technology remains a challenge due to infrastructure issues.” The key novelty here is emphasizing that continuous, targeted professional development significantly accelerates teacher competence, especially when embedded within systemic support.

Policy frameworks play a vital role, as the Philippines has adopted structured and systematic professional training programs that visibly enhance teachers’ digital literacy and pedagogical skills (Ballano et al., 2022). Conversely, Indonesia’s sporadic and resource-dependent training efforts have created disparities, with some teachers expressing, “We have limited access to quality training, and that hampers our ability to fully integrate technology.” This validates Saenen et al., (2024) assertion that the quality and sustainability of training are more influential than mere frequency. The findings also shed light on a crucial insight: sustainable policies with continuous support are essential in fostering higher levels of TPACK. As one Indonesian teacher noted, “Without ongoing support and infrastructure, it is hard to keep up with technological innovations.”

The proactive application of TPACK also varies markedly; Filipino teachers are generally more confident and innovative, partly due to continuous training and better access to digital infrastructure, as one teacher explained, “The support from the school makes me more comfortable to experiment with new tools.” Conversely, Indonesian teachers often exhibit a conservative approach, with some mentioning, “Limited resources mean I stick to what I know best, even if I want to try new ways.” This contrast illustrates that pedagogical innovation is

not merely about knowledge but is deeply influenced by the environment and opportunity for experimentation. The new insight emphasizes that a conducive ecosystem comprising training, infrastructure, and institutional support is fundamental to fostering technological pedagogical innovation (Zhao et al., 2024).

The strengths of the Filipino system lie in its comprehensive policies and sustained professional development, which effectively translate into improved teacher competencies, as one Filipino teacher shared, “Regular workshops and strong leadership support us to keep improving.” In contrast, Indonesia’s progress depends heavily on improving infrastructure and establishing continuous, contextually relevant training programs, echoed by a teacher who said, “Our challenge is that upgrades take time, and training is often sporadic.” These differences are primarily driven by the maturity of policies, resource availability, and the institutional support system in each country. The crucial novelty of this research lies in demonstrating that teacher readiness and capacity for innovation are fundamentally contingent upon broader systemic support pointing to the need for holistic policy reforms. Prioritizing sustained policy renovations and infrastructural development, therefore, becomes imperative for advancing TPACK mastery at a national scale.

Variations in Implementation Practices

The implementation of TPACK in classroom practice shows significant variation across Indonesia and the Philippines, heavily influenced by infrastructural and institutional support (Santos & Castro, 2021; Sogue & Natividad, 2024). Observations reveal that Filipino teachers actively incorporate multimedia, project-based, and inquiry-based strategies, reflecting a higher level of pedagogical innovation. One Filipino teacher remarked, “We experiment with different digital tools to make lessons more engaging and relatable to students,” indicating a proactive approach. Conversely, Indonesian teachers tend to adopt a more conservative stance, often limiting technological use to basic functionalities such as presentations or videos. This conservative approach is primarily driven by infrastructural limitations, as one teacher explained, “Limited internet access and lack of devices restrict our ability to innovate.” These findings underline that resource availability directly correlates with the level of pedagogical novelty observed in classrooms.

The disparity in practices also stems from differences in teacher training and familiarity with pedagogical strategies that effectively blend content, pedagogy, and technology. Teachers in the Philippines frequently partake in ongoing professional development, which fosters comfort and confidence in using a variety of digital tools (O.E.C.D., 2020). One teacher noted,

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“Continuous training allows us to learn new methods and develop creative ways to use technology in our lessons,” emphasizing the role of sustained support. Meanwhile, in Indonesia, many teachers display limited adaptability, citing a lack of consistent training: “We want to innovate, but we are held back by scarce resources and familiar routines.” This suggests that professional development not only builds skills but also influences teachers' willingness to experiment and innovate pedagogically.

Furthermore, infrastructural disparities profoundly shape classroom practices; Filipino teachers benefit from better technological ecosystems, enabling more dynamic interactions, as one observed, “Our school provided tablets and internet, so I can teach more interactively.” Conversely, the infrastructural deficits in Indonesian schools often result in minimal use of technology beyond traditional digital presentations, as an Indonesian teacher shared, “We mostly use it to show videos where the internet is available, but it’s not reliable.” The result is a tendency to rely on familiar, less interactive methods, which may hinder students' engagement and skill development. This highlights the importance of infrastructural support in facilitating meaningful pedagogical transformation (Lai et al., 2022). Notably, these barriers diminish the potential for teachers to employ innovative strategies effectively.

Emerging from these observations is a clear pattern: infrastructural and training disparities significantly influence teaching practices and levels of pedagogical innovation. Teachers with better resources and continuous professional support demonstrate greater flexibility and creativity in integrating technology, often sharing best practices with colleagues. One Filipino teacher reflected, “Our collaborative culture encourages sharing new ideas and tools, which inspires others to innovate,” illustrating how systemic support fosters pedagogical diversity. Meanwhile, Indonesian teachers express a desire to innovate, but face tangible barriers: “We want to do more, but lack the tools and time necessary to explore new methods.” The novelty of this finding lies in underscoring that actual classroom practices are context-dependent; without adequate infrastructure and ongoing training, pedagogical innovation remains limited, constraining the full realization of TPACK’s potential.

Influence of Contextual Factors on TPACK Mastery and Practice

The mastery of TPACK among teachers is significantly shaped by contextual factors such as resource availability and institutional support, which directly influence pedagogical practices (Kulaksız & Karaca, 2024; Raygan & Moradkhani, 2022). Quantitative analyses reveal that teachers operating in environments with better access to digital tools and infrastructural

support display higher levels of integration and confidence in applying TPACK (Huang et al., 2022). One Filipino teacher remarked, “Having access to reliable internet and devices makes it easier to implement new teaching strategies,” illustrating how infrastructure accelerates mastery. Conversely, Indonesian teachers often face resource constraints, which hinder their ability to innovate, as one educator explained, “Limited access to technology makes it hard for us to try new methods.” This highlights that without foundational resources, the development of effective TPACK remains an uphill battle, emphasizing the critical role of contextual factors.

Teacher training and professional development are also crucial components that influence both the mastery and practical implementation of TPACK (Lai et al., 2022). Recent studies indicate that teachers who participate in ongoing training programs tend to demonstrate more sophisticated pedagogical strategies that blend content, pedagogical approaches, and technology (Antonio & Prudente, 2025). An Indonesian teacher shared, “Regular training helped me understand how to use technology in ways that really benefit my students,” underscoring the impact of sustained capacity-building. On the other hand, teachers in Indonesia often report limited training opportunities, with one stating, “We attend training sporadically, and it’s hard to keep up.” The findings suggest that continuous, well-designed professional development not only enhances skills but also encourages teachers to experiment with innovative practices.

School support and the prevailing learning culture serve as vital environmental factors that influence teachers’ adoption and mastery of TPACK (Lai et al., 2022). Teachers working in schools with a collaborative culture and leadership that actively champions technology are more likely to implement varied pedagogical strategies (Keane et al., 2020; Roth & Price, 2016). One Filipino educator noted, “My school’s leadership encourages us to try new methods, sharing ideas and resources freely,” illustrating an enabling environment. Conversely, Indonesian teachers frequently encounter resistance or lack of encouragement, with one comments, “There’s little support from school leaders, so we tend to stick to familiar methods.” This demonstrates that organizational culture and leadership support are pivotal in fostering a climate conducive to pedagogical innovation.

Finally, broader school policies and educational culture significantly impact the development and application of TPACK, either facilitating or hindering teachers’ mastery and practice. Data indicates that the Philippines benefits from policies aligned with technology integration, which accelerates teachers’ capacity to innovate (Raygan & Moradkhani, 2022). Meanwhile, Indonesian policies remain in developmental stages, with teachers expressing, “Our policies encourage us, but implementation is slow due to infrastructural issues,” emphasizing systemic

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barriers. The distinct policy environments shape the opportunities for teachers to grow professionally and pedagogically; thus, systemic support and policy maturity emerge as key determinants. The recent findings underscore that an ecosystem supporting resources, training, and policy coherence is essential to realize the full potential of TPACK in diverse educational contexts.

Barriers and Challenges

One of the most prominent challenges confronting teachers in both Indonesia and the Philippines is the lack of comprehensive training programs that adequately develop their technological pedagogical content knowledge (TPACK). Recent research highlights that insufficient training hampers teachers' confidence and diminishes their capacity to implement innovative pedagogies involving technology (Stumbrienė et al., 2024; Timotheou et al., 2023). An Indonesian teacher remarked, “We often attend basic training sessions, but they do not sufficiently prepare us to integrate technology into complex lessons,” illustrating the gap between training and classroom needs. Additionally, many teachers report feeling overwhelmed by the rapid evolution of digital tools, leading to resistance or hesitation in adopting new methods. This hesitance directly impacts the evolution of effective TPACK, especially in settings where ongoing professional support is limited or absent.

Structural limitations, particularly infrastructural deficiencies, pose significant barriers in both contexts, but their effects differ in magnitude. In Indonesia, poor internet connectivity and a scarcity of digital devices severely restrict the scope and quality of technology-enabled practices, as one teacher observed, “Our school struggles with consistent internet, so we are limited in what we can do.” Conversely, teachers in the Philippines often have better access, yet still face challenges related to maintaining and upgrading infrastructure, especially in remote regions. These infrastructural challenges inevitably influence the consistency and sophistication of pedagogical strategies employed, constraining teachers’ ability to fully realize TPACK. The recent literature emphasizes that infrastructural adequacy is foundational to enabling effective technology integration (Albeta et al., 2023; Kulaksız & Karaca, 2024).

Resistance to change among teachers remains a persistent barrier, rooted in both psychological and systemic factors. Many teachers express reluctance stemming from fear of losing control or damaging their credibility, especially when trying unfamiliar technology-based approaches (Yang & Wang, 2024). An Indonesian educator explained, “I worry that shifting to new methods might backfire and affect my reputation,” highlighting the psychological resistance. Conversely, some Filipino teachers, despite enthusiasm, face systemic inertia,

where institutional policies and outdated assessment practices hinder pedagogical innovation. This resistance, whether personal or organizational, significantly impairs the development and dissemination of effective TPACK practices.

The cumulative effect of these barriers severely impacts teachers' ability to develop and implement meaningful pedagogical strategies that incorporate technology. Such limitations lead to shallow integration, where technology is used merely as a supplement rather than an integral component of pedagogy (Vetrivel et al., 2024). Interview insights reveal teachers' feelings of frustration; one said, "We want to innovate, but our basic needs are not even met, so we focus on survival." These systemic barriers create a cycle of limited growth and innovation, hampering the evolution of pedagogical practices aligned with 21st-century demands. Recognizing these challenges is crucial for designing targeted interventions that address both infrastructural and psychological obstacles in fostering effective TPACK implementation.

Factors Contributing to Successful TPACK Integration

The presence of structured, ongoing teacher training emerges as a crucial factor that facilitates effective TPACK development. Schools that implement regular professional development sessions foster a continuous learning environment, enabling teachers to refine their technological skills alongside pedagogical content knowledge. A recent study by Adera (2025) highlights that sustained training correlates positively with teachers' confidence and innovative practices. As one Filipino teacher stated, "Regular workshops and peer collaborations truly help us stay updated and confident in using new tools," emphasizing the importance of continuous support. By institutionalizing ongoing training, schools create a culture of growth that significantly enhances teachers' readiness to implement TPACK effectively. This approach underscores that professional development, when embedded into the school ecosystem, is a vital driver of pedagogical innovation.

Strong leadership from school administrators is identified as a key driver that creates an enabling environment for TPACK integration. Leaders who actively promote a shared vision of digital literacy and support teachers' experimentation contribute to a climate that encourages innovation (Rasdiana et al., 2024). An Indonesian principal explained, "Our school leadership encourages teachers to try new methods and provides resources to support their efforts," illustrating supportive leadership practices. Conversely, in schools lacking active leadership or with bureaucratic resistance, teachers often feel unsupported and less motivated to experiment. The implication is clear: fostering leadership that champions ongoing

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technological and pedagogical growth is essential for cultivating a culture conducive to TPACK mastery.

Access to comprehensive digital resources, including hardware, software, and curated content, significantly impacts teachers' capacity to practice and develop TPACK. Schools equipped with up-to-date devices and reliable internet enable teachers to implement more innovative and interactive pedagogies (Sofi-Karim et al., 2023). A Filipino teacher remarked, "Having access to digital resources and stable internet allows us to design more engaging lessons," illustrating the facilitative role of resources. Meanwhile, in Indonesian settings where infrastructure remains insufficient, teachers are often limited to basic functionalities, constraining pedagogical creativity. This underscores that infrastructural investments are fundamental to transforming pedagogical strategies from theoretical to practical.

Finally, a collaborative and supportive school culture fosters shared learning and collective growth in TPACK competencies among teachers. Schools that promote peer observation, mentoring, and resource sharing tend to see higher levels of pedagogical innovation (Hargreaves, 2019). An Indonesian teacher shared, "My colleagues regularly share new ideas and resources, which motivates me to try new approaches," indicating the positive effect of a collaborative environment. Conversely, schools that lack a collaborative culture often see stagnation in pedagogical practices and resistance to change. The evidence suggests that cultivating a community of practicewhere teachers learn from each other is instrumental in translating knowledge into effective classroom practices, thus creating a sustainable environment for TPACK development.

Differences Between Countries and Possible Explanations

The comparative analysis underscores significant differences in both mastery levels and practical implementation of TPACK between Indonesia and the Philippines, driven primarily by systemic factors. Filipino teachers demonstrate a higher proficiency and more innovative classroom practices, attributed to mature policies, continuous training, and better infrastructure (Albeta et al., 2023). One Filipino educator noted, "Our government policies and ongoing support make it easier for us to experiment and innovate in teaching," highlighting the systemic advantage. Conversely, Indonesian teachers tend to focus on foundational content delivery, often constrained by infrastructural inadequacies and inconsistent training, as one teacher shared, "Limited access to technology prevents us from exploring new teaching

methods." These disparities reveal that policy maturity, resource availability, and systemic support are key determinants that influence pedagogical practice and mastery in each context.

A crucial factor explaining the differences is the level of policy development and institutional commitment present in each country. The Philippines has established a well-structured framework that emphasizes ongoing professional development and resource allocation (Rivera et al., 2025). An Indonesian teacher remarked, "Our policies support us to some extent, but implementation varies widely, especially in rural areas." The contrasting maturity of policy environments results in varying degrees of teacher readiness and innovation, with systemic support correlating strongly with higher mastery levels. Recent studies show that policy coherence and targeted resource provision are essential in ensuring equitable access to professional development (Hirsch & Schechter, 2024; Khoyaled, 2023). This indicates that systemic policy strength directly impacts the capacity of teachers to practice and innovate with TPACK.

Cultural factors and professional norms also contribute to divergent practices, influencing teachers' receptiveness to adopting technology-enhanced pedagogies. Filipino teachers often operate within a culture of collaboration and openness to change, supported by national narratives that valorize innovation (Cahya et al., 2024). An interviewee from the Philippines stated, "Our school culture encourages us to share ideas and learn from each other," reinforcing the role of a supportive professional environment. In Indonesia, hierarchical school cultures and resistance to change remain barriers, with teachers saying, "We follow instructions, but changing our methods is challenging due to traditional expectations." This cultural dimension underscores that beyond resources and policies, normative practices shape how teachers engage with TPACK.

The analysis also reveals that resource allocation and infrastructural support are markedly different, directly influencing the scope and depth of TPACK practice. The Philippines generally benefits from better internet connectivity, more digital devices, and a richer content ecosystem, facilitating innovative pedagogies (Cahya et al., 2024). An Indonesian teacher explained, "Our limited infrastructure restricts us to traditional teaching methods, especially in remote areas," illustrating the inequity. These infrastructural disparities not only limit practical implementation but also perpetuate systemic inequality in teacher competence development. The novelty of this comparison is showing how structural factors policy, culture, and resources interact holistically, determining the extent of teachers' capacity to master and practice TPACK effectively.

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Recommendations for Policy and Practice

The comparative analysis underscores significant differences in both mastery levels and practical implementation of TPACK between Indonesia and the Philippines, driven primarily by systemic factors. Filipino teachers demonstrate a higher proficiency and more innovative classroom practices, attributed to mature policies, continuous training, and better infrastructure (Cahya et al., 2024). One Filipino educator noted, “Our government policies and ongoing support make it easier for us to experiment and innovate in teaching,” highlighting the systemic advantage. Conversely, Indonesian teachers tend to focus on foundational content delivery, often constrained by infrastructural inadequacies and inconsistent training, as one teacher shared, “Limited access to technology prevents us from exploring new teaching methods.” These disparities reveal that policy maturity, resource availability, and systemic support are key determinants that influence pedagogical practice and mastery in each context.

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CONCLUSION

This study provides a nuanced comparative analysis of TPACK mastery and implementation among teachers in Indonesia and the Philippines, revealing substantive differences shaped by systemic, infrastructural, and cultural factors. The findings demonstrate that teachers in the Philippines exhibit a higher level of pedagogical innovation and confidence, largely due to better policy support, ongoing professional development, and infrastructure. Conversely, Indonesian teachers face significant barriers related to resource limitations, inconsistent training, and resistant organizational cultures, which hamper pedagogical evolution. The research confirms that contextual elements such as policy maturity, infrastructure, and school culture are critical determinants influencing TPACK development. This contribution is novel in its integrative approach, combining quantitative mastery data with qualitative insights, offering a comprehensive understanding of the dynamics at play.

The results underscore that successful TPACK implementation requires a systemic approach that addresses both infrastructural deficiencies and capacity-building needs. Policymakers must prioritize sustained, context-sensitive professional training and equitable resource provision to foster innovative pedagogies. Furthermore, cultivating a collaborative and supportive school environment emerges as essential for translating knowledge into practice effectively. The study advances the current literature by emphasizing that technological integration is not solely a matter of access but also deeply rooted in organizational culture and systemic support. This holistic insight underscores the importance of adaptive, well-coordinated policies that are tailored to each country's unique educational landscape.

Overall, this research fills a significant scholarly gap by highlighting how systemic, infrastructural, and cultural factors interact to shape teachers' mastery and practice of TPACK

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across diverse Southeast Asian contexts. The innovative integration of empirical mastery scores with in-depth contextual analysis provides valuable insights for policy and practice, emphasizing that technological pedagogy must be supported by foundational systems. The findings reinforce that the path towards effective digital integration is complex, requiring targeted interventions that are adaptable and context-specific. As the educational landscape rapidly evolves, this study advocates for dynamic, evidence-based policies that foster continuous innovation and professional growth. Ultimately, the research offers a vital step forward in understanding how to optimize teacher preparedness for the digital age, thus contributing to the broader goal of advancing quality education in Southeast Asia.

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