

Bridging the Gap between Technology Use and Pedagogical Transformation: A TPACK-SAMR Qualitative Study in Island Contexts

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ABSTRACT

After the COVID-19 pandemic, education has become more digital. This change has made meaningful technology use more important, especially in remote areas where access to digital tools is still limited. The TPACK framework explains how teachers combine technology, teaching methods, and subject knowledge, while the SAMR model shows how technology is used in learning. However, few studies have used both frameworks together in island-based education contexts. This study investigates the implementation of digital learning in Ternate, Indonesia, through an integrated TPACK-SAMR perspective and proposes a contextual transformation model. A qualitative case study was conducted in three secondary schools involving 12 informants (eight teachers and four students). Data were collected through semi-structured interviews, classroom observations, documentation analysis, and a systematic literature review (2015–2025). Thematic analysis following Miles et al.'s interactive model was employed, supported by triangulation and member checking to enhance credibility. Teachers demonstrated strong content and pedagogical knowledge but limited technological pedagogical integration, resulting in low TPACK competency. Digital learning practices were predominantly situated at the Substitution and Augmentation levels of the SAMR model, indicating limited pedagogical transformation. Four interconnected barriers were identified: digital inequality, insufficient teacher digital competence, weak instructional design, and academic integrity challenges. Based on these findings, the Digital Learning Transformation Model (DLTM) was developed by integrating TPACK and SAMR within an input-process-output-outcome framework. Meaningful digital transformation requires simultaneous enhancement of teacher competence, instructional design, institutional support, and equitable digital access. The proposed DLTM offers a contextual framework to guide sustainable digital learning transformation in island and other geographically disadvantaged educational settings.

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1. INTRODUCTION

The urgency of digitalizing education has intensified in the aftermath of the COVID-19 pandemic, which compelled educational institutions worldwide to adopt online learning systems on an unprecedented scale. This phenomenon reveals two contradictory realities: on one hand, technology has proven capable of maintaining educational continuity in times of crisis; on the other hand, significant digital divides continue to obstruct the equitable distribution of educational quality (Pokhrel & Chhetri, 2021). Critically, the gap is not merely a matter of access to devices or internet connectivity; it extends to dimensions of digital competence, pedagogical readiness, and learning environment support, all of which determine whether technology genuinely transforms learning or simply replicates conventional practices in digital form.

In Indonesia, the digitalization of education has been reinforced through various national policies, including the *Merdeka Belajar* program, the *Merdeka Mengajar* Platform (PMM), and the *Merdeka Curriculum*. However, implementation at the school level continues to face significant structural challenges, particularly in regions outside major educational centers. Limited network infrastructure, low technological-pedagogical competence among teachers, and an underdeveloped digital learning culture remain the primary obstacles to meaningful transformation. (Mailizar. et al., 2020) These conditions suggest that policy-level commitments to digitalization have yet to translate into substantive pedagogical change at the classroom level.

In the local context, Ternate City in North Maluku presents a particularly compelling case for studying digital learning implementation. As an archipelagic region with diverse and challenging geographical conditions, Ternate faces compounding barriers related to network accessibility, uneven device distribution, and varying levels of institutional readiness in adopting technology. These conditions generate disparities in digital learning implementation that are not merely technical but also pedagogical and socio-economic in nature. As such, field-based empirical research is essential to understand how digitalization actually unfolds and where it falls short in such constrained real-world contexts (Pernantah, 2024).

Two theoretical frameworks are central to diagnosing the gap between technology use and pedagogical transformation. The Technological Pedagogical Content Knowledge (TPACK) framework, developed by (Mishra & Koehler, 2006), asserts that effective digital teaching requires the simultaneous and integrated mastery of content knowledge, pedagogical knowledge, and technological knowledge. Separately, the SAMR model (Puentedura, 2014) offers a hierarchical framework for evaluating the depth of technology integration in learning, spanning from Substitution and Augmentation, where technology enhances but does not transform, to Modification and Redefinition, where technology enables fundamentally new learning experiences. While each framework provides valuable diagnostic tools, their analytical separation limits explanatory power: TPACK reveals what teachers know, while SAMR reveals what teachers do. It is precisely the gap between knowledge and practice that demands their integrated application.

Despite their complementary strengths, existing studies have rarely integrated TPACK and SAMR empirically, and this limitation is especially pronounced in educationally disadvantaged and geographically marginalized regions. Most prior research applies these frameworks in isolation, remains largely descriptive, and is concentrated in urban or well-resourced settings (Fitriani, 2020; Mailizar. et al., 2020; Singun, 2025). Studies that examine the gap between digitalization concepts and classroom implementation practices in island regions such as Ternate are virtually absent from the literature. This represents a significant empirical and contextual gap, one that weakens the evidentiary basis for educational policy and teacher development in precisely the regions that stand to benefit most from targeted intervention.

Based on this background, this study addresses three interrelated research questions: (1) what are the conceptual characteristics of learning digitalization in the context of modern education?; (2) how is learning digitalization implemented in Ternate schools when analyzed through the integrated lens of TPACK and SAMR?; and (3) what challenges, implications, and conceptual models can be offered to

optimize digital learning transformation in island-based educational contexts? In responding to these questions, this study makes two primary contributions. Theoretically, it proposes the Digital Learning Transformation Model (DLTM) a novel integrative framework that synthesizes TPACK and SAMR within a systemic input-process-output-outcome structure, developed from and grounded in empirical evidence from island educational contexts. Practically, it offers context-specific findings to inform teacher professional development programs and educational policy design in marginalized regions across Indonesia and the broader Global South.

2. METHODS

This study employs a qualitative approach with a case study design, aimed at developing a deep understanding of digital learning implementation within real educational contexts. This approach was selected because the study prioritizes contextual and interpretive exploration of phenomena examining the meanings, experiences, and practices of digital learning from the perspective of research subjects rather than testing causal relationships statistically (Creswell & Poth, 2016).

The study was conducted at three educational institutions in Ternate, North Maluku: MAN 1 Ternate, MTsN 1 Ternate, and SMA Negeri 8 Kota Ternate. These locations were selected purposively to capture variation in the level of digital learning implementation, thereby enabling a comprehensive picture of digital learning practices across different school conditions and resource levels. Fieldwork was conducted over a period of three months, from January to March 2026, encompassing interview sessions, classroom observations, and documentation collection across all three sites.

The research subjects consisted of 12 informants: 8 teachers and 4 students actively involved in digital learning, drawn proportionally from across the three schools. Informants were selected based on two criteria: direct involvement in the use of learning technology, and a minimum of one year of experience in digital-based learning. The number of informants was determined by the principle of data saturation, the point at which additional informants yielded no substantially new information or perspectives (Creswell & Poth, 2016). In practice, thematic patterns became consistent and repetitive by the tenth informant, confirming that 12 informants constituted a sufficient and adequate sample for this study.

Data were collected through three complementary techniques. Semi-structured interviews were the primary instrument, conducted individually with each informant to explore their experiences, perceptions, and practices related to digital learning. Interview questions were organized around three thematic areas: (1) understanding and conceptualization of digital learning, (2) actual practices and platforms used in classroom technology integration, and (3) perceived challenges and barriers in implementing digital learning. Representative examples of interview questions include: *"How do you currently use technology in your teaching and learning activities?"* and *"What challenges do you face in integrating technology into your classroom practice?"* Direct classroom observations were carried out to verify and contextualize interview data by examining digital learning processes as they occur in practice. Documentation analysis supplemented field data through examination of lesson plans, digital media, and learning platforms employed across the schools (Mukhlash Abrar, 2024). Field data collection was further strengthened by a systematic literature review of nationally and internationally accredited scientific journals published between 2015 and 2025, which served as the theoretical foundation for analyzing findings within the TPACK and SAMR frameworks.

Data analysis followed the interactive model of (Miles et al., 2014), comprising three iterative stages: data reduction, data display, and conclusion drawing. During the data reduction stage, a thematic coding strategy was applied. Initial open coding was conducted on all interview transcripts and observation notes, generating descriptive codes from the raw data. These codes were subsequently organized into broader thematic categories through axial coding, guided deductively by the TPACK and SAMR frameworks. Specifically, codes related to teacher knowledge and competence were clustered under TPACK dimensions (CK, PK, TK, TPK, TCK, TPACK), while codes related to the nature and depth of technology use in practice were categorized according to SAMR levels (Substitution,

Augmentation, Modification, Redefinition). A third category captured cross-cutting themes related to contextual challenges, including infrastructural barriers, socioeconomic factors, and issues of academic integrity. This coding process was conducted iteratively and reflexively, with categories reviewed and refined across multiple analytical cycles to ensure consistency and analytical depth.

To ensure data validity, this study employed source triangulation and technique triangulation, cross-checking data obtained through interviews, observations, and documentation to verify consistency across sources and methods. Member checking was also conducted with informants upon completion of the analysis, presenting key findings and interpretations to research subjects to confirm alignment between the data interpretation and the realities they experienced (Creswell & Poth, 2016). These procedures collectively strengthen the credibility and trustworthiness of the findings. The results of this analytical process were used to identify patterns in digital learning implementation and to formulate the Digital Learning Transformation Model (DLTM) as the primary theoretical contribution of this research.

3. FINDINGS AND DISCUSSION

3.1 Concept and Characteristics of Digital Learning

Digitalization of learning can be defined as the process of transforming the education system through the integration of digital technology into all aspects of teaching and learning activities, institutional management, assessment, and educational policies (Selwyn, 2012). In the Indonesian context, this transformation is understood not as mere substitution of conventional media, but as a fundamental shift in learning design, pedagogical interaction, and evaluation strategy (Lexi Jalu Aji.dkk, 2024; Darmawan, 2014)

However, field findings across all three schools MAN 1 Ternate, MTsN 1 Ternate, and SMAN 8 Ternate reveal a consistent and significant gap between this ideal concept and actual classroom practice. In all three institutions, digitalization is still understood primarily as the use of digital media to support conventional learning activities, rather than as a comprehensive pedagogical transformation. Technology is used instrumentally: platforms such as Google Classroom and WhatsApp are deployed mainly for distributing materials and collecting assignments, with little evidence of interactive, collaborative, or student-centered learning design. As one teacher at MAN 1 Ternate stated, *"We have been using Google Classroom, but mostly just to send assignments there are rarely any discussions or direct interactions with students."*

From the students' perspective, this instrumental use of technology has resulted in learning experiences that lack adequate guidance and interaction. A recurring pattern across informants was the experience of receiving materials without explanation, leaving students to learn independently without pedagogical support. Technical barriers including unstable internet connections and shared device access further compound these challenges, particularly for students from lower socioeconomic backgrounds.

This pattern indicates that the characteristics of digital learning as theorized in the literature, including flexibility, high interactivity, personalized learning, and virtual collaboration (Means et al., 2009; Basilaia & Kvavadze, 2020), have not yet been realized in practice. The digitalization of learning at these three schools remains at an operational level and has not yet constituted a genuine pedagogical transformation.

3.2 Analysis of Implementation Based on the TPACK Model

The TPACK framework developed by (Mishra & Koehler, 2006) posits that effective digital teaching requires the simultaneous integration of Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). Based on field findings, the teacher competency profile across the three schools can be summarized in Table 1.

Table 1. Digital Teacher TPACK Competency Profile in Digital Learning

TPACK Component	Indicator	Field Findings	Level
Content Knowledge (CK)	Mastery of subject matter	Teachers demonstrate strong subject mastery	High
Pedagogical Knowledge (PK)	Teaching strategies and methods	Teachers are proficient in conventional methods	High
Technological Knowledge (TK)	Ability to use technology	Moderate: able to use basic digital platforms	Moderate
TPK	Integration of technology & pedagogy	Weak: technology used only for task distribution	Low
TCK	Integration of technology & content	Limited to slide/presentation display	Low
TPACK (Integrated)	Full integration of all three domains	Not yet achieved at any of the three schools	Very Low

Source: Field Data Analysis, Ternate 2026

A consistent pattern emerges across all three schools: teachers demonstrate strong mastery of content (CK) and conventional pedagogy (PK), but remain significantly weak in integrating technology with pedagogical strategies (TPK, TCK, and TPACK). Technological knowledge (TK) is at a moderate level teachers are able to operate basic digital platforms but this operational familiarity has not translated into purposeful pedagogical integration (Mishra & Koehler, 2006). At the planning stage, technology is added without structured instructional design; at the implementation stage, it has not been used to promote collaborative or constructive learning; and at the evaluation stage, digital-based authentic assessment has not been adopted.

This finding extends the work of (Mailizar. et al., 2020), who identified that technology use among Indonesian teachers is predominantly substitutive rather than integrative. The present study adds empirical depth to that claim by demonstrating that the weakness is not in content or pedagogical knowledge independently, but specifically in their intersection with technology the TPK and TPACK domains. This finding also confirms (Fitriani, 2020), who found that most teachers remain at the stage of technology adoption without reaching pedagogical integration. Critically, however, this study contextualizes these findings within an island region, where infrastructural constraints compound the pedagogical gap in ways that urban-focused studies have not fully captured.

3.3 Analysis of Implementation Based on the SAMR Model

The SAMR model (Puentedura, 2014) distinguishes technology integration into two broad categories: enhancing (Substitution and Augmentation) and transforming (Modification and Redefinition). Based on field data analysis across the three schools, the implementation pattern is summarized in Table 2.

Table 2. Analysis of Digital Learning Implementation Based on the SAMR Model

SAMR Level	Category	Field Findings	Pedagogical Implications
Substitution	Enhancing	PDF replaces textbooks; slides replace the blackboard	No change in pedagogical function
Augmentation	Enhancing	Google Classroom, WhatsApp Group, Google Form	Improved efficiency in distributing and collecting assignments
Modification	Transforming	Emerging: some schools beginning to use Padlet & Jamboard	Initial asynchronous digital collaboration observed
Redefinition	Transforming	Not yet achieved at any school	No global collaboration or AR/VR learning implemented

Source: Field Data Analysis, Ternate 2026

Across all three schools, a dominant and consistent pattern is evident: digital learning implementation is concentrated at the Substitution and Augmentation levels, with no school having achieved systematic practice at the Redefinition level. At the Substitution level, technology functions as a direct replacement for conventional media PDFs replace textbooks; presentation slides replace blackboards without any change in pedagogical function. At the Augmentation level, platforms such as Google Classroom, WhatsApp Group, and Google Form have improved administrative efficiency in material distribution and assignment collection, but have not substantively altered the quality of learning interaction.

Isolated instances of Modification-level practice were observed, with some teachers beginning to experiment with tools such as Padlet and Jamboard. However, these practices have not been systematically integrated into instructional design and remain peripheral rather than transformative. This finding confirms (Sahronih et al., 2023), who similarly found that most digital learning practices in Indonesia remain at the Augmentation stage. More critically, this finding extends the argument of (Hamilton et al., 2016), who cautioned that the hierarchical nature of SAMR can be misleading if not accompanied by pedagogical readiness. The present study demonstrates that the ceiling of SAMR achievement is directly constrained by the weakness of TPACK integration teachers who lack TPK and TPACK competence are structurally unable to design learning at the Modification or Redefinition levels, regardless of technological availability. This contradicts the assumption that providing more technology will naturally elevate SAMR levels; rather, it is pedagogical competence, not technological access alone, that determines the depth of digital integration (Romrell et al., 2014)

3.4 Challenges of Learning Digitalization

Field data analysis identified four main categories of challenges that are consistent across all of three schools and mutually reinforcing in their impact on digital learning quality. First, the digital divide. Defined by (Colom, 2020) as the disparity in access to and use of information technology among social groups, the digital divide manifests in this context not only as infrastructural inequality but also as socioeconomic barrier. Students reported unstable network conditions and shared device access as recurring obstacles to participation in digital learning conditions that disproportionately affect students from lower-income households.

Second, uneven teacher digital competence. Consistent with the TPACK analysis above, teachers across all three schools remain at a basic level of technology use, primarily for material distribution and assignment collection. This finding reinforces (Mailizar. et al., 2020) and confirms that the competence gap is not uniform but structured teachers possess strong domain knowledge yet lack the integrative competence to deploy technology pedagogically.

Third, misalignment in instructional design. A pervasive pattern across the three schools is the adoption of technology without systematic instructional planning. Technology is used as a formality rather than as a purposeful pedagogical tool. This finding extends Angeli and Valanides (2015), who argued that effective technology integration must be grounded in deliberate pedagogical design a condition that has clearly not yet been met in the schools studied. (Utari et al., 2025)

Fourth, supervision and academic integrity. Digital learning environments have introduced new challenges related to student monitoring and academic honesty. Teachers reported difficulty in verifying the authenticity of student work submitted through digital platforms. In the context of Islamic education, this challenge carries additional weight, as academic integrity is directly linked to the values of trust and moral character that are central to Islamic educational goals (Pokhrel & Chhetri, 2021).

Taken together, these four challenges confirm that the digitalization of learning is a multidimensional phenomenon that cannot be resolved through technological provision alone. Each challenge intersects with the others: infrastructural gaps limit participation, weak teacher competence limits pedagogical quality, poor instructional design limits learning outcomes, and integrity challenges undermine educational values. A systemic and integrative response is therefore necessary.

3.5 Conceptual Model: Digital Learning Transformation Model (DLTM)

Based on the comprehensive analysis of TPACK and SAMR frameworks and empirical findings across the three schools, this study proposes the Digital Learning Transformation Model (DLTM) as its primary theoretical contribution. The model integrates four interconnected dimensions: input, process, output, and outcome, as detailed in Table 3.

Table 3. Components of the Digital Learning Transformation Model (DLTM)

DLTM Dimension	Components	Theoretical Foundation	Success Indicators
Input	Digital infrastructure; Teacher competency; Student readiness	Van Dijk (2020); Mishra & Koehler (2006)	Equitable internet access; Teachers with high TPACK proficiency
Process	TPACK integration; SAMR level application; Instructional design	TPACK + SAMR; Angeli & Valanides (2015)	Practices reaching Modification–Redefinition level
Output	Learning quality; Students' digital competency; Digital literacy	Means et al. (2009); Basilaia & Kvavadze (2020)	Improved learning outcomes & digital literacy
Outcome	Sustainable educational transformation; Healthy digital ecosystem	Selwyn (2019); Mubarak & Hasyim (2021)	Adaptive & equitable education system

Source: Developed from TPACK, SAMR Analysis, and Field Data, Ternate 2026

The DLTM addresses a fundamental limitation identified in this study: that TPACK and SAMR, when applied separately, provide only partial explanations of digital learning quality. TPACK explains the competence dimension what teachers know and are able to integrate while SAMR explains the transformation dimension the depth of pedagogical change that technology enables. By synthesizing both within a systemic input-process-output-outcome structure, DLTM provides a more comprehensive analytical and prescriptive framework than either model offers independently (Pernantah, 2024).

The input dimension highlights that the preconditions for digital transformation equitable infrastructure, teacher TPACK competence, and student readiness are currently unmet across the three schools. Field findings indicate persistent deficits in all three components, which directly constrain the quality of the process dimension. The process dimension, as the core of DLTM, emphasizes that TPACK integration and SAMR-level advancement must be treated as interdependent: improving one without the other produces incomplete transformation (Ahmad et al., 2026). The output dimension reflects the learning quality produced, which in the current context remains suboptimal due to low interactivity and one-way communication patterns. The outcome dimension points toward sustainable educational transformation a condition that, based on field findings, remains distant and requires sustained systemic intervention.

The novelty of DLTM lies in three aspects. First, it integrates TPACK and SAMR into a single cohesive framework, enabling simultaneous analysis of teacher competence and pedagogical transformation depth. Second, it is grounded in empirical evidence from an island educational context that has been largely absent from the existing literature. Third, it incorporates a value dimension derived from Islamic educational principles specifically access justice, academic integrity, and character formation — recognizing that digital transformation must remain anchored in the moral and ethical goals of education, not only its cognitive outcomes

4. CONCLUSION

This study demonstrates that digital learning implementation in three schools in Ternate remains instrumental and has not yet achieved meaningful pedagogical transformation. TPACK analysis

reveals persistent weakness in technology-pedagogy integration, while SAMR analysis confirms that practices are concentrated at the Substitution and Augmentation levels. Four compounding challenges the digital divide, uneven teacher competence, misaligned instructional design, and academic integrity concerns collectively explain this condition.

The primary theoretical contribution of this study is the Digital Learning Transformation Model (DLTM), which synthesizes TPACK and SAMR within a systemic input-process-output-outcome structure grounded in empirical evidence from an island educational context. DLTM advances existing literature by demonstrating that pedagogical transformation requires the integrated development of teacher competence and technology use depth, not technological provision alone. Practically, professional development programs should be reoriented toward TPACK-based instructional design, supported by systemic institutional and policy frameworks. This study is limited by its geographical scope and cross-sectional design. Future research should pursue comparative studies across island regions and longitudinal tracking of teacher TPACK development, alongside quantitative validation of the DLTM framework.

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