Indonesian Journal of Educational Development (IJED)
Volume 6, Issue 3, 2025, pp. 1116-1130
ISSN: 2722-1059 (Online); ISSN: 2722-3671 (Print)
DOI: https://doi.org/10.59672/ijed.v6i3.4929

Self-efficacy as a moderator of the effect of techno-pedagogical competence on economics teachers' readiness

Silvana Shirly Alice Oroh*)[1], I Kadek Satria Arsana[2], Herman Philips Dolonseda[3]
[1]Universitas Negeri Manado, Tondano, Indonesia; silvanashirlyaliceoroh@gmail.com
[2]Universitas Negeri Manado, Tondano, Indonesia; satriaarsana28@gmail.com
[3]Universitas Negeri Manado, Tondano, Indonesia; hermandolonseda@unima.ac.id
*)Corresponding author: Silvana Shirly Alice Oroh; E-mail addresses: silvanashirlyaliceoroh@gmail.com

Article Info

Article history:
Received June 12, 2025
Revised September 5, 2025
Accepted September 14, 2025
Available online November 21, 2025

Keywords: Digital era, Self-efficacy, Teaching readiness, Techno-pedagogical competence

Abstract. Teachers' readiness to teach in the digital era presents a strategic challenge for 21st-century education. This study examines the effect of TPC on economics teachers' TR, with SE as a moderating variable. Using a quantitative explanatory design, data were collected via questionnaires from 204 senior and vocational high school economics teachers in Minahasa Regency, who were purposively selected. The data were analyzed with SEM-PLS. The results confirm that TPC significantly influences both SE and TR. SE also has a significant positive effect on TR and demonstrates a moderating role, strengthening the relationship between TPC and TR. The model shows moderate to substantial predictive power, with R^2 values of 0.468 for SE and 0.597 for TR. These findings highlight that teacher development programs should not only prioritize technical competence but also foster self-efficacy as a psychological resource for effective digital teaching readiness. The study is limited by its focus on one region and subject area, as well as its reliance on self-reported quantitative data. Future research should adopt a longitudinal approach and expand to other contexts to better capture the complexity of teachers' readiness in the digital era.

Introduction

The ongoing digital transformation in education has catalyzed the emergence of a new learning paradigm (Mohamed Hashim et al., 2022). In this context, the primary challenge for teachers is no longer access to technology, but their ability to integrate it into teaching in reflective, contextual, and meaningful ways (Maphosa, 2021; Ramdhani et al., 2025; Voogt et al., 2013). Teachers are now expected to serve not just as users of technology but as architects of adaptive digital learning environments responsive to students' evolving needs (Dominic & Francis, 2015; Kem, 2022).

To meet this challenge, techno-pedagogical competence has become an essential skill for 21st-century educators. This competence involves the integration of technological, pedagogical, and content knowledge, as outlined in the TPACK framework (Koehler et al., 2013). With this competency, teachers are expected to be able to design, select, and implement technology in learning according to student characteristics and curriculum objectives (Koh & Chai, 2016). However, studies by Sarwa et al. (2020) and Tømte et al. (2015) indicate that competence alone does not always translate into effective digital teaching practices. Randall et al. (2022) found that, even with training, teachers often struggle to develop TPACK-based lesson plans or to adapt their

teaching to meet student needs, highlighting a gap between the technical competence acquired through training and its classroom implementation.

Based on the GTK Kemendikbud survey, only 40% of non-ICT teachers are prepared to use technology (Sekretariat GTK, 2018). The average teacher competency score in Indonesia in 2019 was only 50.64 points, indicating a need to improve teachers' Technological Pedagogical Content Knowledge (TPACK) (Hari Santhi Dewi et al., 2024). Insufficient support for teachers transitioning to digital learning has made adaptation difficult, with limited access and low-quality training being major obstacles in the adoption of educational technology (UNICEF, 2021). These conditions demonstrate that research examining the moderating role of self-efficacy in the effect of techno-pedagogical competence on teaching readiness is both highly important and urgent.

A central psychological factor affecting teaching readiness is self-efficacy, defined as an individual's belief in their ability to execute the actions required to achieve specified performance goals (Shengyao et al., 2024; Widana et al., 2021). According to Bandura's Social Cognitive Theory, self-efficacy affects how individuals apply their knowledge and strategies in challenging situations (Johnston et al., 2019). Teachers with high self-efficacy tend to be more reflective, innovative, and autonomous in instructional decision-making, even in complex digital environments (Grewal, 2023). In contrast, teachers with low self-efficacy often revert to traditional methods despite having technical skills (Değirmencioğlu, 2021). Research by Al-Hattami (2025) indicates that technological self-efficacy can serve as a moderating variable, strengthening the relationship between digital competence and learning outcomes. Although this study was conducted in the context of digital accounting education, its findings underscore the potential importance of self-efficacy as a moderator in other educational settings, including teaching readiness among economics teachers, highlighting the critical role of developing self-efficacy to enhance instructional effectiveness (Widana et al., 2019).

In Indonesia, teacher training programs tend to emphasize skill acquisition at the expense of confidence development. Furthermore, most academic studies examining the link between techno-pedagogical competence and teaching readiness do so in a linear fashion. Very few consider self-efficacy a moderating variable in this relationship, especially within the Merdeka Curriculum framework. This reveals a theoretical and methodological gap in understanding how technical skills and psychological factors interact in shaping teacher readiness.

While several studies have emphasized the importance of techno-pedagogical competence for teaching effectiveness (Prates et al., 2025; Widodo & Akbar, 2024; Srijayanti et al., 2023), they often overlook the influence of psychological variables. Similarly, although the role of self-efficacy in educational decision-making has been acknowledged (Santos et al., 2018; Suhardita et al., 2024), its link to technology integration in teaching remains underexplored.

Therefore, this study aims to investigate the effect of techno-pedagogical competence on instructional readiness and to examine self-efficacy as a moderating variable. It proposes a conceptual model that evaluates both direct and interactive effects, contributing to a more comprehensive understanding of teaching readiness in technology-rich contexts.

Based on gaps identified in the literature and field conditions, this study aims to examine the relationships among techno-pedagogical competence, self-efficacy, and teaching readiness among economics teachers. The research questions include: to what extent does techno-pedagogical competence influence teachers' self-efficacy, to what extent does self-efficacy affect teaching readiness, and whether self-efficacy moderates the effect of techno-pedagogical competence on economics teachers' teaching readiness.

In line with these questions, the study proposes the following hypotheses: H1: Techno-pedagogical competence (TPC) has a positive and significant effect on teachers' self-efficacy (SE). H2: Self-efficacy (SE) has a positive and significant effect on economics teachers' teaching readiness (TR). H3: Techno-pedagogical competence (TPC) is expected to have a direct effect on economics teachers' teaching readiness (TR), which is also moderated by self-efficacy, such that teachers with higher self-efficacy can apply their technical competence more effectively to achieve optimal instructional readiness.

By formulating comprehensive research questions and hypotheses, this study aims to provide an in-depth understanding of how technical and psychological factors interact to shape economics teachers' teaching readiness. In practice, the findings can guide policymakers and teacher-training developers in designing programs that not only emphasize technology mastery but also foster psychological preparedness.

Method

Research methods & design

This study employed an explanatory quantitative approach using a non-experimental ex post facto design (Asenahabi, 2019). The primary objective was to examine the effect of techno-pedagogical competence on teachers' teaching readiness and to analyze the moderating role of self-efficacy in this relationship. This approach was chosen to empirically explain causal relationships between variables without manipulating them.

Population and Sampling Technique

The population consisted of all high school teachers (SMA and SMK) in Minahasa Regency, North Sulawesi Province, totaling 1.419 teachers. Among them, 419 were economics teachers, including civil servant teachers (PNS) from ranks II, III, and IV, as well as non-civil servant teachers. To focus the study on the target group, a purposive sampling technique was employed, selecting 204 economics teachers as the study sample. This sample size was calculated using Slovin's formula with a 95% confidence level and a 5% margin of error. The selected teachers represented various sub-districts proportionally, ensuring a balanced coverage across the region.

Research Setting and Time

This study was conducted in Minahasa Regency, North Sulawesi Province, Indonesia, which has the second-largest number of senior and vocational high schools after Manado City. Administratively, Minahasa borders directly on Manado, yet a significant part of its territory lies in mountainous areas. This creates diverse school conditions across urban and rural settings, with varying levels of access to technology and learning resources, making the region highly relevant for examining teachers' techno-pedagogical competence and readiness. Data collection was carried out from March to May 2025, coinciding with the second semester of the academic year.

Data Collection Techniques and Research Instruments

Data were collected through a closed-ended questionnaire using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The research instrument was developed based on validated theoretical indicators from previous studies. Techno-pedagogical competence was measured using 14 items adapted from the dimensions of Technological Pedagogical Content Knowledge (TPACK) as developed by Mishra & Koehler (2016), which include technological knowledge, pedagogical knowledge, content knowledge, technological content knowledge, technological pedagogical knowledge, pedagogical content knowledge, and TPACK (integrated knowledge). Teacher self-efficacy was measured using 15 items covering three dimensions: efficacy

in instructional strategies, classroom management, and student engagement (Tschannen-Moran & Hoy, 2001). Teaching readiness was assessed with 18 items based on three dimensions: technological readiness, pedagogical readiness, and contextual readiness (Phan & Dang, 2017).

Instrument Validity and Reliability Testing

The research instrument underwent expert judgment to establish content validity, involving three senior education researchers who reviewed item clarity, relevance, and alignment with theoretical constructs. A pilot test with 30 economics teachers was also conducted to refine the items. Reliability and construct validity were further assessed in the main study using PLS-SEM, including tests for convergent validity (factor loading > 0.70), Average Variance Extracted (AVE > 0.50), and construct reliability (Cronbach's Alpha and Composite Reliability > 0.70). This was followed by an assessment of the structural model (inner model) to determine the strength and direction of relationships among variables, using path coefficients, significance levels (t-statistics and p-values), and the coefficient of determination (R^2) to assess the explanatory power of the predictors (Hair et al., 2019).

Data Analysis Techniques and Criteria

Data were analyzed using the Partial Least Squares–Structural Equation Modeling (PLS-SEM) technique, which is well-suited for testing latent constructs and moderating effects within complex models. The moderating effect of self-efficacy was analyzed by creating an interaction term between techno-pedagogical competence and self-efficacy. This moderating effect was tested using a bootstrapping technique with 5,000 subsamples to obtain stable parameter estimates and statistically valid inferences. Through this approach, the study aims to provide a comprehensive understanding of the role of self-efficacy in enhancing or attenuating the influence of techno-pedagogical competence on teachers' readiness to implement technology-integrated learning in the digital era.

Results and Discussion

Reliability and Convergent Validity

The evaluation of the measurement model confirms that all constructs in this study meet the recommended criteria for reliability and convergent validity, as outlined in the quantitative methodology literature. As shown in Table 1, the values for Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) for each construct exceed the minimum recommended thresholds.

Table 1. Evaluation of Convergent Reliability and Validity

Construct	Cronbach's Alpha	Composite Reliability (ρc)	Average Variance Extracted (AVE)	Number of Items
TPC	0.959	0.963	0.652	14
SE	0.952	0.957	0.600	15
TR	0.963	0.966	0.615	18

The results show high internal consistency for all constructs, with Cronbach's Alpha values ranging from 0.952 to 0.963, well above the commonly accepted minimum of 0.70. This indicates that the indicators within each construct consistently measure the same underlying concept.

Additionally, the Composite Reliability (CR) values range from 0.957 to 0.966, confirming strong construct reliability. The AVE values (TPC = 0.652, SE = 0.600, TR = 0.615) all exceed the recommended threshold of 0.50, indicating that each construct explains more than 50% of the

variance in its respective indicators. This establishes convergent validity and confirms that the indicators validly and consistently represent their respective latent constructs.

Discriminant Validity

Discriminant validity was assessed using three widely accepted SEM-PLS criteria: the Heterotrait-Monotrait ratio (HTMT), the Fornell-Larcker criterion, and cross-loading analysis. The results are summarized in Table 2.

Table 2. Discriminant Validity Evaluation

Evaluation Method	SE-TPC	SE-TR	TPC-TR	Threshold	Status
HTMT	0.712	0.726	0.745	< 0.85	✓ Achieved
Fornell-Larcker	0.684	0.699	0.718	< √AVE	✓ Achieved

The HTMT values (ranging from 0.712 to 0.745) fall below the conservative threshold of 0.85 (Henseler et al., 2015), suggesting that the constructs Self-Efficacy (SE), Techno-Pedagogical Competence (TPC), and Teaching Readiness (TR) are sufficiently distinct from one another.

The Fornell-Larcker criterion supports this, with inter-construct correlations lower than the square roots of their respective AVE values: SE = 0.775, TPC = 0.807, and TR = 0.784. This indicates that each construct accounts for more variance among its indicators than among those of other constructs.

Cross-loading analysis further confirms discriminant validity. All indicators load highest on their respective constructs, as shown in Table 3.

Table 3. Summary of Cross-Loadings Between Constructs

Construct	Min Loading on Own Construct	Max Loading on Other Constructs
SE	0.752	0.591
TPC	0.789	0.644
TR	0.734	0.625

All indicators exhibit higher loadings on their respective constructs than on others, with own-construct loadings above 0.70 and cross-construct loadings well below this value. This confirms strong discriminant validity, supporting the use of the constructs in the structural model.

Indicator Loadings and Multicollinearity

The quality of the indicators was assessed via factor loadings and Variance Inflation Factor (VIF) values. Results are summarized in Table 4.

Table 4. Loading Factors and VIF Values

Construct	Number of Indicators	Loading Range	VIF Range
Techno-Pedagogical Competence (TPC)	14	0.789 - 0.827	2.412 - 2.898
Self-Efficacy (SE)	15	0.752 - 0.802	2.095 - 2.546
Teaching Readiness (TR)	18	0.734 - 0.806	2.064 - 2.735

All indicators exhibit loading values above the recommended threshold of 0.70 (Hair et al., 2019), indicating strong item contributions to their respective constructs. Conceptually, this suggests the indicators effectively represent the latent variables they are intended to measure.

The VIF values, ranging from 2.064 to 2.898, fall below the critical value of 3.0, indicating no multicollinearity issues among indicators. Each item contributes unique information, supporting the model's internal validity. These results provide strong evidence of indicator reliability and confirm the absence of measurement redundancy, validating the model for further structural analysis.

Model Fit Indices

The structural model exhibits a good fit to the data based on standard model fit indices. Results are summarized in Table 5.

Table 5. Structural Model Fit Evaluation

Fit Index	Value	Threshold	Interpretation
SRMR	0.041	< 0.08	Good Fit
NFI	0.854	> 0.80	Acceptable Suitability

The Standardized Root Mean Square Residual (SRMR) value of 0.041 is well below the 0.08 threshold (Henseler et al., 2015), suggesting excellent fit. A low SRMR indicates minimal discrepancy between observed and predicted data, supporting the model's accuracy. The Normed Fit Index (NFI) of 0.854 exceeds the minimum acceptable level of 0.80 (Hair et al., 2014), confirming that the proposed model significantly outperforms the null model. Taken together, these indices indicate that the model is both theoretically sound and empirically valid, providing a robust foundation for hypothesis testing in the structural model.

The figure below presents the structural model estimated using the Partial Least Squares (PLS) method, displaying relationships between latent constructs, path coefficients, and the R^2 values for endogenous variables. Estimation was based on 5000 bootstrap subsamples.

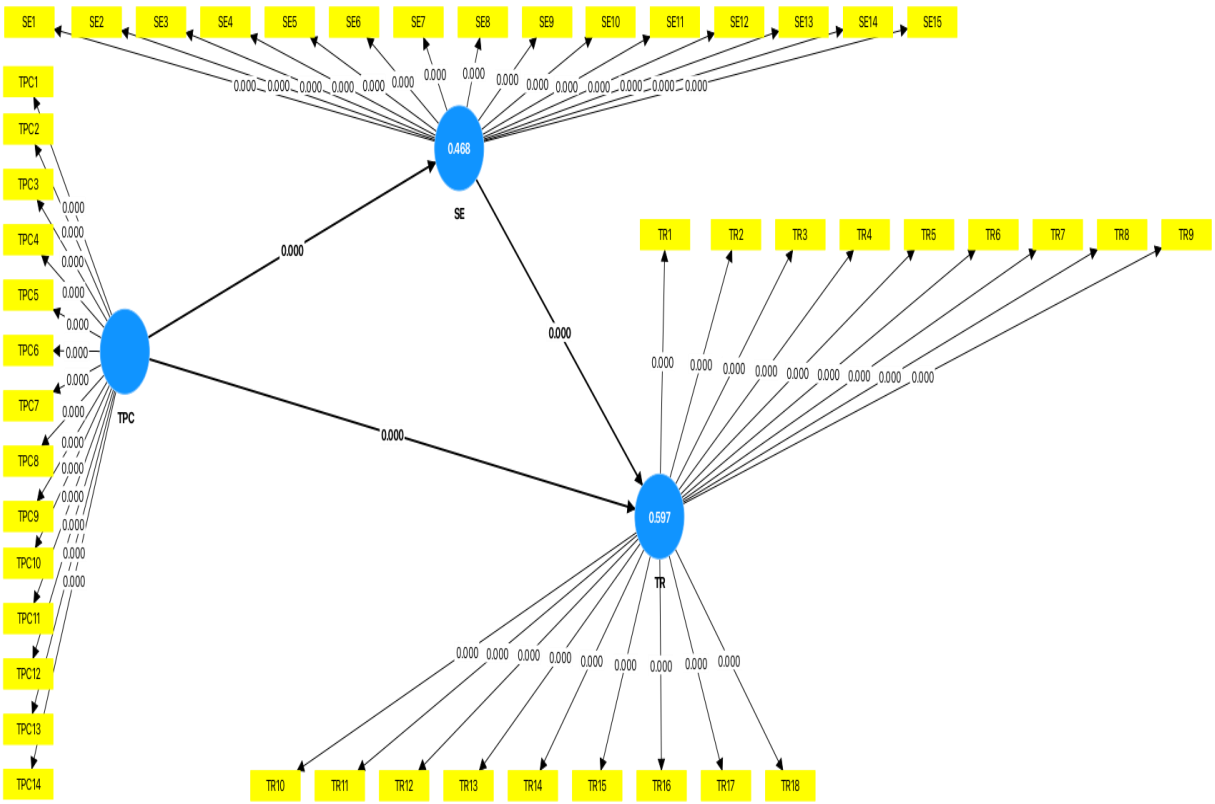

Image 1. SEM-PLS Model

Coefficient of Determination (R^2)

Table 6. Evaluation of Explained Variance

Endogenous Constructs	R^2	Adjusted R^2	Effect Size
Self-Efficacy (SE)	0.468	0.465	Medium
Teaching Readiness (TR)	0.597	0.593	Moderate to Substantial

The analysis results indicate that the research model explains 46.8% of the variance in the Self-Efficacy (SE) construct and 59.7% of the variance in the Teaching Readiness (TR) construct. According to the proposed interpretation guidelines, an R^2 value of 0.75 indicates a substantial effect, 0.50 a moderate effect, and 0.25 a weak effect (Hair et al., 2019). Based on this framework, the model demonstrates moderate to near-substantial predictive power. For the SE construct, the R^2 of 0.468 indicates that nearly half of the variance in SE is accounted for by Techno-Pedagogical Competence (TPC), providing empirical support for TPC as a significant predictor of teacher self-efficacy. Nonetheless, this also highlights the opportunity to explore other contributing factors. In contrast, the R^2 value of 0.597 for the TR construct shows that the combined influence of SE and TPC accounts for over half of the variance in teaching readiness. This supports the theoretical premise that both constructs are critical in shaping teachers' preparedness for instructional implementation, and it also confirms the model's conceptual relevance and explanatory strength.

Effect Size (f^2)

The effect size (f^2) evaluates the relative contribution of independent variables to the dependent variable in the model. As a rule of thumb, an f^2 value above 0.02 indicates a small effect, above 0.15 a medium effect, and above 0.35 a significant effect (Hair et al., 2019).

Table 7. Effect Size Evaluation

Path	Value of f^2	Effect Size
Techno-Pedagogical Competence (TPC) → Self-Efficacy (SE)	0.879	Large
Self-Efficacy (SE) → Teaching Readiness (TR)	0.201	Small
Techno-Pedagogical Competence (TPC) → Teaching Readiness (TR)	0.268	Small to Medium

The results show that the path from TPC to SE has an f^2 value of 0.879, which falls into the large category. This suggests that TPC is a dominant predictor of teacher self-efficacy, reflecting that improvements in techno-pedagogical competence significantly enhance teachers' confidence in managing learning. Meanwhile, the effect of SE on TR has an f^2 of 0.201, and the direct effect of TPC on TR is 0.268. Both are within the small-to-medium range, indicating that, while the effects are statistically significant, their practical contribution to changes in TR is smaller than the effect of TPC on SE. These findings highlight the complexity of relationships in the model, where statistically significant effects may not always equate to large practical impacts. Thus, effect-size analysis provides critical insight into the relative strength of each path in supporting the structural model's validity.

Direct Effects

Direct path analysis assesses the strength and direction of causal relationships among constructs. The hypothesis testing results are presented below.

Table 8. Direct Path Analysis Results

Hypothesis	Path	β	t-value	p-value	Decision	Effect Size
H1	TPC → SE	0.684	18.989	0.000	Supported	Large
H2	SE → TR	0.390	6.264	0.000	Supported	Medium

H3	TPC → TR	0.451	7.245	0.000	Supported	Medium

The hypothesis testing confirms that all direct relationships proposed in the model are strongly supported by empirical data. All path coefficients have p-values < 0.001, suggesting that the observed effects are statistically robust.

H1 (TPC → SE): The path coefficient of 0.684 and a t-value of 18.989 indicate a strong and significant positive influence of TPC on SE. This supports the theoretical assumption that enhancing teachers' techno-pedagogical competence increases their self-efficacy in instructional contexts. H2 (SE → TR): The path coefficient of 0.390 with a t-value of 6.264 suggests that SE significantly contributes to TR. While smaller than the TPC → SE effect, it remains both theoretically and practically relevant. H3 (TPC → TR): The coefficient of 0.451 with a t-value of 7.245 shows that TPC also directly influences TR, beyond its mediated effect through SE. This underlines TPC's foundational role in shaping teaching readiness. Overall, the findings reinforce the theoretical framework positing that both technopedagogical competence and self-efficacy are key determinants of teaching readiness in digital learning environments.

Indirect Effects and Mediation Analysis

Mediation analysis was conducted to evaluate the role of SE as an intermediary between TPC and TR.

Table 9. Mediation Analysis Results

Mediation Path	Indirect Effect (β)	t-value	p-value	95% CI	Type of Mediation
TPC → SE → TR	0.267	6.090	0.000	[0.181, 0.353]	Partial Mediation

The results demonstrate that SE partially mediates the relationship between TPC and TR. The indirect effect (β = 0.267) is statistically significant (p < 0.001), with a confidence interval of [0.181, 0.353]. Since the direct path TPC → TR (β = 0.451) also remains significant, the mediation is classified as partial. This implies a dual influence mechanism: TPC affects TR directly and indirectly through SE. The total effect of TPC on TR is β = 0.718, with the indirect effect accounting for approximately 37.2% of the total. From a theoretical standpoint, this underscores SE as a critical cognitive mechanism linking TPC to TR. Practically, it suggests that enhancing TPC not only boosts SE but also directly prepares teachers for digital teaching challenges. Therefore, professional development programs should be designed to leverage both pathways for maximum impact.

Predictive Relevance Evaluation

Table 10. Evaluation of Predictive Relevance

Construct	Q^2 Value	Predictive Relevance
SE	0.276	Small
TR	0.358	Medium

The predictive relevance of the model was assessed using Stone-Geisser's Q^2 value. A Q^2 above 0 indicates small relevance, above 0.25 indicates moderate relevance, and above 0.50 indicates high relevance (Hair et al., 2019). Positive Q^2 values confirm the model's predictive power. The Q^2 value for SE is 0.276, indicating small but meaningful predictive relevance, suggesting that the model predicts SE better than a baseline average, though there is room for enhancement. The TR construct, with a Q^2 of 0.358, falls into the medium category, showing stronger predictive capability based on TPC and SE. These results support the conclusion that the model is not only statistically robust but also substantively predictive. Moreover, the higher predictive relevance for TR over SE

confirms the direction and logic of the structural model. In the educational landscape of the digital era, the demand for teaching readiness extends beyond pedagogical knowledge to include the integrative ability to manage learning technologies. Mastery of techno-pedagogical competence (TPC) is crucial not merely as a technical skill, but as a foundational component that enhances self-efficacy (SE) and teaching readiness (TR).

This study is grounded in the Social Cognitive Theory developed by Albert Bandura, which highlights the dynamic and reciprocal interplay between personal (cognitive), behavioral, and environmental factors in shaping individual competencies, including those related to teacher professionalism (Devi et al., 2017). Within this framework, learning is conceptualized not as an isolated individual process, but as the outcome of complex social interactions where experience, observational learning, and social reinforcement play a pivotal role in shaping self-efficacy (Hijriyah et al., 2024).

However, this study does not merely replicate Bandura's theoretical model. Instead, it expands upon it through integration with the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2016). TPACK introduces a richer epistemological dimension to the professional demands faced by educators in the digital age by emphasizing the intersectional knowledge required to simultaneously integrate technology, pedagogy, and content (Thyssen et al., 2023). This theoretical integration enables the present study to map how modern techno-pedagogical competencies interact with self-efficacy within the broader context of digital educational transformation.

The Dominance of the TPC → SE Pathway: Epistemic Reconstruction of Self-Efficacy in the Digital Age

The results of the structural model estimation reveal that the path from Techno-Pedagogical Competence (TPC) to Self-Efficacy (SE) exhibits a coefficient of 0.684 (t = 18.989), indicating a highly significant and substantive effect. This finding not only demonstrates a strong causal relationship but also suggests an epistemological shift in how teacher self-efficacy is conceptualized. Theoretically, this finding implies a transformation from Bandura's classical view of self-efficacy, which emphasizes mastery experiences as the primary source of confidence, to a more nuanced construct of digital pedagogical self-efficacy (Wu, 2015). In this new paradigm, self-efficacy is not derived solely from traditional teaching experience but also from mastery in integrating technology into pedagogical practices.

In this context, teaching competence in the digital age can be defined as "a set of professional skills that enable teachers to design learning experiences aligned with 21st-century skill requirements and adaptable to digital technology-driven environments." The empirical evidence suggests that strengthening the techno-pedagogical domain significantly enhances teachers' confidence in designing, delivering, and evaluating digitally mediated learning.

The effect size of 0.684 implies that approximately 46.8% of the variance in teachers' self-efficacy is attributable to their mastery of techno-pedagogical competencies. This indicates a fundamental paradigm shift: from an experiential and observational model to a hybrid epistemology in which technological fluency becomes a core component in shaping professional beliefs in the digital education era.

Partial Mediation of Self-Efficacy: Uncovering the "Confidence Bridge" Phenomenon in Digital Pedagogy

Mediation analysis shows that Self-Efficacy (SE) partially mediates the relationship between Techno-Pedagogical Competence (TPC) and Teaching Readiness (TR), evidenced by a significant

indirect effect of 0.267 ($p < 0.001$), while the direct effect of TPC on TR remains significant ($\beta = 0.451$). This structural configuration gives rise to what can be termed the "confidence bridge" phenomenon. This affective-cognitive pathway facilitates the translation of techno-pedagogical competence into teaching readiness through the mechanism of professional confidence. This finding reveals two simultaneously operating but distinct activation pathways:

Direct Cognitive Pathway (TPC → TR): This pathway suggests that techno-pedagogical competence directly translates into teaching readiness through knowledge internalization and skill application. It is linear and performance-oriented, enabling teachers to gain immediate readiness without requiring affective processing.

Mediated Affective Pathway (TPC → SE → TR): This deeper psychological pathway involves intrapersonal reflection and metacognitive processing. When teachers enhance their techno-pedagogical competence, they also reinforce their belief in their ability to meet the demands of digital instruction. Here, self-efficacy acts as a psychological transformative agent, mediating between capacity and actualization (Stavrou & Piki, 2024).

Theoretical Relevance and Conceptual Novelty

Within Bandura's Social Cognitive Theory, self-efficacy is defined as "one's belief in their capability to organize and execute the courses of action required to manage prospective situations" (Manik et al., 2022; Purnadewi et al., 2023). In the context of digital learning, the present findings expand the theory's applicability by showing that digital competence not only enhances technical efficacy but also strengthens teachers' sense of control and agency in digital instructional settings. Thus, techno-pedagogical competence becomes both an epistemic and affective resource.

The study's theoretical novelty lies in the formulation and empirical validation of a dual-pathway activation model. Here, teacher competence functions both directly through instructional capacity and indirectly by shaping the psychological structures of professional confidence. This model reconceptualizes digital-era competence as a multidimensional construct requiring an integrative understanding of both technical expertise and psychological empowerment. The concept of the "confidence bridge" demonstrates that without self-efficacy, even robust competence may fail to yield transformative instructional impact.

Predictive Relevance Asymmetry and the Construct Complexity Paradox

Predictive evaluation using Q^2 values revealed theoretically intriguing results: $Q^2 = 0.276$ for SE, and $Q^2 = 0.358$ for TR. Although one might assume that the psychological construct (SE) would exhibit higher predictive power than a behavioral outcome (TR), the data indicate the opposite, which we term a relevance asymmetry reflecting an epistemic paradox.

The Complexity Paradox suggests that TR, despite its multidimensionality, is more predictable because of its behavioral concreteness. According to the behavioral convergence hypothesis, behavioral constructs are more stable representations of internal processes and are therefore more reliably predicted. Conversely, SE is influenced by fluctuating intrapersonal dynamics, making it less predictable despite its central psychological role.

This asymmetry aligns with findings from recent literature, where even technically competent teachers report feeling "overwhelmed and unprepared to use online or remote teaching strategies" (Whalen, 2020). Competence does not necessarily equate to confidence, and confidence is inherently unstable in evolving digital environments. This underscores the need for dual calibration between what teachers can do (objective competence) and what they believe they can do (subjective self-perception).

Digital Pedagogical Readiness Framework

This study introduces a new conceptual model, the Digital Pedagogical Readiness Framework (DPRF), which offers an integrative and transformative approach to understanding digital teaching readiness. DPRF consists of three interconnected layers:

The technical competence base is the foundational epistemic structure that anchors pedagogical readiness in digital skills. As Chounta et al. (2024) emphasize, "Digital readiness entails a broad spectrum of dimensions, including not only access to and proficiency with digital tools, but also the ability to integrate them meaningfully into teaching and learning practices". This highlights the epistemic centrality of digital competence as the ontological basis of instructional readiness.

Confidence Amplification Layer, the psychological domain where pedagogical confidence is constructed and strengthened. According to Chounta et al. (2024), digital readiness also involves "the beliefs and attitudes of individuals toward the use of digital tools and their confidence in using them effectively in educational contexts", underscoring the critical role of affective constructs in shaping professional self-assurance.

Readiness Synthesis Zone, a hermeneutic space where cognitive and affective dimensions converge to form holistic readiness. The framework draws on the understanding that "a comprehensive model of digital readiness should capture the interplay between technical infrastructures, organizational strategies, and pedagogical innovation" (Chounta et al., 2024), thereby recognizing the transdisciplinary synthesis necessary for digital pedagogical preparedness.

DPRF fills an epistemological gap in the fragmented digital competence literature and provides a comprehensive lens for designing teacher-training programs, shaping educational policy, and advancing professional development in the digital age.

Self-Efficacy Recalibration Theory

This study further proposes the Self-Efficacy Recalibration Theory (SERT), which challenges conventional paradigms by demonstrating how digital environments reshape the sources and formation of teacher efficacy. The theory introduces three major recalibration shifts:

From Experience-Based to Competence-Based: In contrast to traditional views that emphasize tenure and prior experience, SERT posits that "individuals' digital readiness depended more on their perceived competence in applying digital tools than on their prior teaching experience" (Chounta et al., 2024). This represents a critical epistemological transition, where digital competence becomes the new locus of efficacy (Huang, 2022).

From Static to Dynamic: Efficacy is no longer seen as a fixed attribute but as "an evolving capacity that reflects the changing demands of educational ecosystems" (Chounta et al., 2024). SERT conceptualizes efficacy as a fluid, adaptable construct that must be continuously renegotiated in light of technological shifts.

From Individual to Integrative: SERT also repositions efficacy as a socially constructed phenomenon, not merely an individual belief. Chounta et al. affirm that "readiness is a shared, socially-constructed condition" (Chounta et al., 2024), highlighting the role of collaborative practices, peer interaction, and institutional ecosystems in shaping self-efficacy.

SERT enriches the Technological Pedagogical Content Knowledge (TPACK) model by incorporating a psychological mediation axis. This results in a new variant: TPACK-SE, a comprehensive framework that interlinks competence, belief, and performance in digital teaching

contexts. TPACK-SE accommodates the dynamic, socially embedded nature of teacher efficacy in digitally mediated instructional environments.

Limitations of the Study

This study has several limitations that should be acknowledged. First, the research was conducted exclusively in Minahasa Regency and focused only on economics teachers at the senior and vocational high school levels, which may limit the generalizability of the findings to other subjects, educational levels, or regional contexts. Second, the study employed a quantitative ex post facto design relying on self-reported survey data, which may not fully capture the complex psychological and contextual dynamics underlying techno-pedagogical competence and self-efficacy. Third, the model examined only three core constructs (TPC, SE, and TR). At the same time, other potentially influential factors, such as institutional support, access to digital infrastructure, or organizational culture, were not included. Finally, the data collection was limited to a single semester, which may limit the generalizability of the findings to long-term changes in teachers' readiness in rapidly evolving digital educational environments.

Conclusion

This study was motivated by the low level of teacher readiness to meet the challenges of digital learning. It confirms that techno-pedagogical competence significantly enhances both teachers' self-efficacy and their teaching readiness. Self-efficacy also plays a crucial mediating role, strengthening the link between competence and readiness. These findings imply that teacher development programs should not only emphasize technical skills but also foster psychological resilience by cultivating self-efficacy. Without this balance, improvements in techno-pedagogical competence may not translate into meaningful gains in teaching readiness. Theoretically, this study extends Bandura's Social Cognitive Theory to digital education by highlighting the mediating role of self-efficacy between competence and readiness. Practically, the findings suggest that policymakers and educational institutions should design more holistic professional development programs that integrate both technical training and psychological empowerment. Despite these contributions, the study has certain limitations. It was conducted only in the Minahasa Regency with economics teachers, and it relied solely on quantitative self-report data. Future research should expand the scope to other regions and subjects, adopt a longitudinal approach, and explore contextual factors such as organizational culture and access to digital infrastructure to provide a more comprehensive understanding of teachers' readiness in the digital era.

Bibliography

Al-Hattami, H. M. (2025). Understanding how digital accounting education fosters innovation: The moderating roles of technological self-efficacy and digital literacy. *The International Journal of Management Education*, *23*(2), 101-131. https://doi.org/https://doi.org/10.1016/j.ijme.2025.101131

Asenahabi, B. M. (2019). Basics of research design: A guide to selecting appropriate research design. *International Journal of Contemporary Applied Researches*, *6*(5), 76–89. https://surl.li/nypful

Chounta, I. A., Ortega-Arranz, A., Daskalaki, S., Dimitriadis, Y., & Avouris, N. (2024). Toward a data-informed framework for the assessment of digital readiness of higher education institutions. *International Journal of Educational Technology in Higher Education*, *21*(1). https://doi.org/10.1186/s41239-024-00491-0

Değirmencioğlu, Ü. L. (2021). The impact of teacher self-efficacy on teaching techniques: Traditional or contemporary? *European Journal of English Language Teaching*, *6*(3). https://doi.org/http://dx.doi.org/10.46827/ejel.v6i3.3662

Devi, B., Khandelwal, B., & Das, M. (2017). Application of bandura's social cognitive theory in the

technology enhanced, blended learning environment. *International Journal of Applied Research*, *3*(1),721–724. https://www.allresearchjournal.com/archives/?year=2017&vol=3&issue=1&part=J&ArticleId=3115

Dominic, M., & Francis, S. (2015). An adaptable e-learning architecture based on learners' profiling. *International Journal of Modern Education and Computer Science*, *7*(3), 26–31. https://doi.org/10.5815/ijmecs.2015.03.04

Grewal, T. K. (2023). *Elementary school teachers' pedagogical digital competency and self-efficacy during the covid-19 pandemic: A Multiple Case Study*. https://digitalcommons.liberty.edu/doctoral/4545

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM): An emerging tool in business research. *European Business Review*, *26*(2), 106–121. https://doi.org/10.1108/EBR-10-2013-0128

Hari Santhi Dewi, K., Sudiatmika, I. P. G. A., Rahardian Rifky Lana, & Pradipta, I. M. (2024). Pengaruh kompetensi technological pedagogical content knowledge (tpack) terhadap keterampilan guru smk dalam merancang perangkat pembelajaran berbasis digital (The influence of technological pedagogical content knowledge (TPACK) competency on vocational school teachers' skills in designing digital-based learning devices). *Journal on Education*, *6*(2 SE-Articles), 13943–13953. https://doi.org/10.31004/joe.v6i2.5249

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

Hijriyah, A. L., Putri, A. H., Setiyawan, A., & Badrisya, A. H. (2024). The social cognitive theory by albert bandura and its implementation in arabic language learning. *Mantiqu Tayr: Journal of Arabic Language*, *4*(2), 626–639. https://doi.org/https://doi.org/10.25217/mantiqutayr.v4i2.4564

Huang, Y. (2022). The role of digital readiness innovative teaching methods in music art e-learning students' satisfaction with entrepreneur psychological capital as a mediator: Evidence from music entrepreneur training institutes. *Frontiers in Psychology*, *13*, 979628. https://doi.org/10.3389/fpsyg.2022.979628

Johnston, T. M., Brezina, T., & Crank, B. R. (2019). Agency, self-efficacy, and desistance from crime: An application of social cognitive theory. *Journal of Developmental and Life-Course Criminology*, *5*, 60–85. https://doi.org/https://doi.org/10.1007/s40865-018-0101-1

Kem, D. (2022). Personalised and adaptive learning: Emerging learning platforms in the era of digital and smart learning. *International Journal of Social Science and Human Research*, *5*(2), 385–391. https://doi.org/10.47191/ijsshr/v5-i2-02

Koehler, M. J., Mishra, P., Akcaoglu, M., & Rosenberg, J. M. (2013). The technological pedagogical content knowledge framework for teachers and teacher educators. *ICT Integrated Teacher Mducation Models*, 1–8. http://cemca.org.in/ckfinder/userfiles/files/ICT teacher education Module 1 Final_May 20.pdf

Koh, J. H. L., & Chai, C. S. (2016). Seven design frames that teachers use when considering technological pedagogical content knowledge (TPACK). *Computers & Education*, *102*, 244–257. https://doi.org/https://doi.org/10.1016/j.compedu.2016.09.003

Manik, S., Sembiring, M., Padang, I., & Manurung, L. (2022). Theory of bandura's social learning in the process of teaching at sma methodist berastagi kabupaten karo. *Jurnal Visi Pengabdian Kepada Masyarakat*, *3*(2), 85–96. https://doi.org/https://doi.org/10.51622/pengabdian.v3i2.729

Maphosa, V. (2021). Teachers' perspectives on remote-based teaching and learning in the COVID-19 era: Rethinking technology availability and suitability in Zimbabwe. *European Journal of*

Interactive Multimedia and Education, *2*(1), e02105. https://doi.org/https://doi.org/10.30935/ejimed/9684

Mishra, P., & Koehler, M. J. (2016). *Handbook of technological pedagogical content knowledge (tpack) for educators*. Routledge.

Mohamed Hashim, M. A., Tlemsani, I., & Matthews, R. (2022). Higher education strategy in digital transformation. *Education and Information Technologies*, *27*(3), 3171–3195. https://doi.org/https://doi.org/10.1007/s10639-022-10924-w

Phan, N. T. T., & Dang, T. T. L. (2017). Teacher readiness for online teaching: A critical review. *Journal on Open and Distance E-Learning*, *3*(1), 1–16. https://ijodel.upou.edu.ph/ijodel/article/view/18

Prates, U., Cruz, M., Mascarenhas, D., & Maia-Lima, C. (2025). Technology experiences in initial teacher education: A systematic review. *Open Education Studies*, *7*(1). https://doi.org/10.1515/edu-2024-0059

Purnadewi, G. A. A., Arnawa, N., & Tatminingsih, S. (2023). The influence of school culture, learning interest, and learning motivation on science learning outcomes. *Indonesian Journal of Educational Development (IJED)*, *4*(2), 126-138. https://doi.org/10.59672/ijed.v4i2.3040

Ramdhani, S., Nirmala, S. D., & Nurcahyono, N. A. (2025). Challenges in online mathematics education for elementary schools: A teacher's perspective from Indonesia. *Indonesian Journal of Educational Development (IJED)*, *6*(1 SE-), 109–123. https://doi.org/10.59672/ijed.v6i1.4640

Randall, R., Sukoco, G. A., Heyward, M., Purba, R., Arsendy, S., Zamjani, I., & Hafiszha, D. A. (2022). Studi kesenjangan pembelajaran ii mereformasi kurikulum indonesia: Bagaimana kurikulum merdeka mengatasi learning loss dan meningkatkan hasil belajar dalam literasi dan numerasi (Learning gap study ii reforming the indonesian curriculum: how the independent curriculum addresses learning loss and improves learning outcomes in literacy and numeracy). https://www.inovasi.or.id/wp-content/uploads/2022/06/Studi-Kesenjangan-Pembelajaran-seri-2-IND-1.pdf

Santos, A., Wang, W., & Lewis, J. (2018). Emotional intelligence and career decision-making difficulties: The mediating role of career decision self-efficacy. *Journal of Vocational Behavior*, *107*, 295–309. https://doi.org/https://doi.org/10.1016/j.jvb.2018.05.008

Sarwa, A. S., Hasibuan, N. I., & Priyadi, M. (2020). Teacher readiness in accommodating the TPACK framework to meet teacher competence the 21st Century. *J. Phys. Conf. Ser*, *1511*(1). https://doi.org/doi:10.1088/1742-6596/1511/1/012041

Sekretariat GTK. (2018). *40 persen guru yang siap dengan teknologi* (40 percent of teachers are technology ready). https://gtk.dikdasmen.go.id/read-news/40-persen-guru-yang-siap-dengan-teknologi

Shengyao, Y., Salarzadeh Jenatabadi, H., Mengshi, Y., Minqin, C., Xuefen, L., & Mustafa, Z. (2024). Academic resilience, self-efficacy, and motivation: The role of parenting style. *Scientific Reports*, *14*(1), 5571. https://doi.org/10.1038/s41598-024-55530-7

Srijayanti, N. P. S. ., Kristiantari, M. G. R. ., & Adji, S. S. . (2023). The relationship between teacher pedagogical competence, career expectations, and school infrastructure and learning outcomes of grade VI students. *Indonesian Journal of Educational Development (IJED)*, *4*(2), 219-229. https://doi.org/10.59672/ijed.v4i2.3046

Suhardita, K., Widana, I. W., Degeng, I. N. S., Muslihati, M., & Indreswari, H. (2024). Sharing behavior in the context of altruism is a form of strategy for building empathy and solidarity. *Indonesian Journal of Educational Development (IJED)*, *5*(3), 316-324. https://doi.org/10.59672/ijed.v5i3.4145

Thyssen, C., Huwer, J., Irion, T., & Schaal, S. (2023). From TPACK to DPACK: The "Digitality-related pedagogical and content knowledge"-model in STEM-education. *Education Sciences*, *13*(8), 769. https://doi.org/https://doi.org/10.3390/educsci13080769

Tømte, C., Enochsson, A.-B., Buskqvist, U., & Kårstein, A. (2015). Educating online student

teachers to master professional digital competence: The TPACK-framework goes online. *Computers & Education*, *84*, 26–35. https://doi.org/https://doi.org/10.1016/j.compedu.2015.01.005

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, *17*(7), 783–805. https://doi.org/10.1016/S0742-051X(01)00036-1

UNICEF. (2021). *Situational analysis on digital learning landscape in indonesia*. https://www.unicef.org/indonesia/media/8766/file/Digital Learning Landscape in Indonesia.pdf

Voogt, J., Erstad, O., Dede, C., & Mishra, P. (2013). Challenges to learning and schooling in the digital networked world of the 21st century. *Journal of Computer Assisted Learning*, *29*(5), 403–413. https://doi.org/https://doi.org/10.1111/jcal.12029

Whalen, J. (2020). Should teachers be trained in emergency remote teaching? Lessons learned from the COVID-19 pandemic. *Journal of Technology and Teacher Education*, *28*(2), 189–199. https://doi.org/https://doi.org/10.70725/307718pkpjuu

Widana, I. W., Suarta, I. M., & Citrawan, I. W. (2019). Work motivation and creativity on the teacher's ability to develop HOTS-based assessments. *International Journal of Social Sciences and Humanities*, *3*(3), 188-200. https://doi.org/10.29332/ijssh.v3n3.378

Widana, I. W., Sopandi, A. T., Suwardika, I. G. (2021). Development of an authentic assessment model in mathematics learning: A science, technology, engineering, and mathematics (STEM) approach. *Indonesian Research Journal in Education, 5*(1), 192-209. https://doi.org/10.22437/irje.v5i1.12992

Widodo, Y. B., & Akbar, K. F. (2024). Effectiveness of technology use in indonesian high schools: student engagement, school capacity, teacher performance. *International Journal of Business, Law, and Education*, *5*(1), 615–627. https://doi.org/https://doi.org/10.56442/ijble.v5i1.442

Wu, M. L. (2015). *Teachers' experience, attitudes, self-efficacy and perceived barriers to the use of digital game-based learning: A survey study through the lens of a typology of educational digital games*. Michigan State University.https://www.proquest.com/openview/ec82212fc91fa7e49e01bf9c512f71bd/1?pq-origsite=gscholar&cbl=18750