

Digital Pedagogical Competence and Teaching Effectiveness Examining the Mediating Role of Teacher Self Efficacy

Martinus Tekege*

Universitas Satya Wiyata Mandala Nabire, Papua Tengah, Indonesia

Corresponding Author: Martinus Tekege ekaumaga77@gmail.com

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ABSTRACT

Digital transformation in education requires teachers to integrate technology with appropriate pedagogical practices to improve teaching effectiveness. This study examines the effect of digital pedagogical competence on teaching effectiveness and the mediating role of teacher self-efficacy among teachers in Nabire District, Nabire Regency, Central Papua, Indonesia. A quantitative cross-sectional survey involved 250 teachers selected through proportionate stratified random sampling. Data were collected using Likert-scale questionnaires and analyzed using SPSS PROCESS Macro Model 4 with 5,000 bootstrap resamples. The findings indicate that digital pedagogical competence positively influences teaching effectiveness and teacher self-efficacy, while teacher self-efficacy significantly improves teaching effectiveness and mediates their relationship. These findings emphasize the importance of strengthening digital pedagogical competence and teacher self-efficacy to support effective teaching practices.

INTRODUCTION

Digital transformation has reshaped education by requiring teachers to integrate technology with effective pedagogical practices. Digital pedagogical competence includes the ability to select and use digital resources to support learning objectives, student engagement, and assessment (Falloon, 2020). The Coronavirus Disease 2019 pandemic further highlighted differences in teachers' readiness to conduct technology-based instruction (König et al., 2020). In this context, strengthening digital pedagogical competence is increasingly important for improving teaching quality, including in geographically diverse educational settings such as Nabire, Central Papua, Indonesia.

Differences in digital competence are evident across educational levels and regional contexts. Portillo et al. (2020) found considerable variation in teachers' perceived digital competence, indicating that technological readiness is not uniform among educators. In Indonesia, Muhaimin et al. (2020) reported that teachers' digital resource integration was influenced by attitudes, intentions, access, and contextual support. These findings are particularly relevant to schools in Nabire District, where differences in institutional conditions, technological access, and teachers' experiences may influence the effective integration of digital technology into classroom practices.

One important psychological factor that may influence this process is teacher self-efficacy, which refers to teachers' confidence in performing instructional tasks effectively. Teacher self-efficacy is positively associated with instructional quality, including classroom management, cognitive activation, and supportive learning environments (Burić & Kim, 2020). However, technological competence does not necessarily translate directly into confidence in delivering effective digital instruction (Ma et al., 2021). This suggests that teacher self-efficacy may serve as an important psychological mechanism through which digital pedagogical competence contributes to teaching effectiveness.

Previous studies have examined digital competence and teacher self-efficacy, but important research gaps remain. Wang and Chu (2023) found that self-efficacy predicted digital competence and mediated the influence of facilitating conditions, although teaching effectiveness was not examined as the final outcome. Similarly, Peng et al. (2024) showed that attitudes, self-efficacy, and digital competence influenced technology integration but did not examine teacher self-efficacy as a mediator between digital pedagogical competence and teaching effectiveness. Therefore, the mediating role of teacher self-efficacy in this relationship remains insufficiently explored, particularly among secondary school teachers in Nabire District, Central Papua.

This study aims to examine the effect of digital pedagogical competence on teaching effectiveness and the mediating role of teacher self-efficacy among junior secondary, senior secondary, and vocational secondary school teachers in Nabire District, Nabire Regency, Central Papua, Indonesia. Specifically, the study investigates whether digital pedagogical competence influences teaching effectiveness and teacher self-efficacy, whether teacher self-efficacy influences teaching effectiveness, and whether teacher self-efficacy mediates the relationship between digital pedagogical competence and teaching effectiveness.

By focusing on teachers from different types of secondary schools, the study seeks to provide a more contextual understanding of how digital competence and psychological factors interact within the educational environment of Nabire. The proposed model therefore explains both the direct and indirect pathways through which digital pedagogical competence may contribute to effective teaching.

Theoretically, this study integrates digital pedagogical competence, teacher self-efficacy, and teaching effectiveness within a single explanatory framework and extends previous research by positioning teacher self-efficacy as a mediating mechanism. It contributes to understanding why teachers with similar levels of digital competence may demonstrate different levels of teaching effectiveness. Practically, the findings may assist schools, educational authorities, and teacher development institutions in Nabire in designing professional development programs that strengthen both digital pedagogical skills and teachers' confidence in applying technology-based instruction. Such efforts may support more effective, adaptive, and sustainable digital teaching practices in Central Papua.

LITERATURE REVIEW

Digital Pedagogical Competence

Digital pedagogical competence refers to teachers' ability to integrate digital technology with appropriate pedagogical knowledge and practices to achieve learning objectives. It extends beyond technical skills by including the selection of digital resources, instructional design, assessment, learner engagement, and professional development. Fernández-Batanero et al. (2022) emphasize that digital competence has become an essential component of teacher professional development because effective technology integration requires pedagogical as well as technological capabilities. Therefore, teachers with strong digital pedagogical competence are expected to use technology more purposefully and adaptively in different instructional contexts.

Teaching Effectiveness

Teaching effectiveness reflects teachers' ability to organize instruction, deliver learning materials, engage students, manage learning activities, and achieve intended educational outcomes. In technology-mediated education, effectiveness also depends on teachers' readiness to adapt instructional strategies to digital environments. Metzler et al. (2022) found that perceptions of preparation and institutional support were closely related to educators' experiences of teaching effectiveness during the transition to emergency remote instruction. This indicates that effective teaching in digital environments requires not only technological facilities but also teachers' capacity to transform available technology into meaningful instructional practices.

Teacher Self-Efficacy

Teacher self-efficacy represents teachers' beliefs in their ability to successfully perform teaching tasks and address instructional challenges. From a social cognitive perspective, self-efficacy influences motivation, effort, persistence, and responses to difficulties, making it important for explaining differences in professional behavior (Schunk & DiBenedetto, 2020). Teachers with stronger self-efficacy are more likely to persist when encountering instructional problems and to apply their knowledge confidently. In digital education, such confidence becomes particularly important because teachers are continuously required to adapt to changing technologies and teaching environments.

Digital Pedagogical Competence and Teacher Self-Efficacy

Digital competence and self-efficacy are conceptually related because successful knowledge and experience with technology may strengthen teachers' confidence in applying digital tools for educational purposes. Dai (2023) found a strong positive association between preservice teachers' self-efficacy in using information and communication technologies and their overall digital competence. The study also showed that personal and contextual factors jointly contributed to differences in digital competence. These findings suggest that possessing digital capabilities and believing in one's capacity to use them effectively are interconnected dimensions of teachers' readiness for digital teaching.

The Mediating Role of Teacher Self-Efficacy

Teacher self-efficacy may function as a psychological mechanism that explains how competence is translated into instructional behavior. Paetsch et al. (2023) found that digital literacy, general teacher self-efficacy, and positive teaching experiences had indirect effects on teachers' use of technology, while technology-integration self-efficacy played an important role in explaining changes in technology use. This finding suggests that knowledge or competence alone may not automatically produce effective teaching behavior unless teachers also believe that they can successfully apply their capabilities. Accordingly, the present study proposes that digital pedagogical competence can enhance teaching effectiveness both directly and indirectly by strengthening teacher self-efficacy, thereby positioning self-efficacy as the mediating mechanism connecting teachers' digital capabilities with their teaching effectiveness.

METHODOLOGY

Research Design

This study employed a quantitative approach with an explanatory research design to examine the relationships among digital pedagogical competence, teacher self-efficacy, and teaching effectiveness. A cross-sectional survey design was used because data were collected from respondents at a single point in time to examine direct and indirect relationships among the study variables. This design is appropriate for hypothesis testing and statistical examination of theoretically proposed relationships among variables (Creswell, 2023). The research model positioned digital pedagogical competence as the independent variable, teacher self-efficacy as the mediating variable, and teaching effectiveness as the dependent variable.

Population and Sampling

The study was conducted in Nabire District, Nabire Regency, Central Papua, Indonesia, involving teachers from junior secondary schools, senior secondary schools, and vocational secondary schools. A total of 250 teachers participated in the study. Respondents were selected using proportionate stratified random sampling, with school level used as the primary stratum to ensure proportional representation across the three educational levels. Eligible respondents were active teachers with at least one year of teaching experience and experience using digital technology in instructional activities. This sampling approach was selected to increase representativeness and reduce excessive concentration of respondents from particular school types.

Research Instrument

Data were collected using a structured questionnaire with a five-point Likert scale, ranging from strongly disagree to strongly agree. Digital pedagogical competence was measured using adapted items based on the Digital Competence of Educators framework, including professional engagement, digital resources, teaching and learning, assessment, learner empowerment, and facilitation of learners' digital competence (Martín Párraga et al., 2022). The measurement was also informed by the Teachers' Digital Competences Scale developed by Aydin et al. (2024). Teacher self-efficacy was measured using adapted items from the Teacher Self-Efficacy Scale validated by Marcionetti and Castelli (2022), while teaching effectiveness was measured using adapted items from the Teaching Effectiveness Self-Assessment instrument reported by Abdullah et al. (2023).

Validity and Reliability Testing

Before the main data collection, the questionnaire was reviewed by experts in educational technology, pedagogy, and educational measurement to assess content relevance and clarity. Items adapted from English-language instruments were translated into Bahasa Indonesia while maintaining conceptual equivalence. A pilot test was conducted among teachers with characteristics similar to the target respondents but who were not included in the final sample. Construct validity was examined using factor analysis, while internal consistency reliability was assessed using Cronbach's alpha, with a coefficient of at least .70 considered acceptable. Similar procedures have been employed in validating

teacher digital competence and teacher self-efficacy instruments (Aydin et al., 2024).

Data Collection Procedure

The research process began with the development of the theoretical framework, formulation of four hypotheses, adaptation of the measurement instruments, and preparation of the research protocol. Research permission was subsequently obtained from the relevant educational authorities and participating schools in Nabire District. A list of eligible teachers was obtained and organized according to school level to establish the sampling frame and determine the proportional allocation of respondents. Selected teachers received an explanation regarding the objectives of the study, voluntary participation, anonymity, confidentiality, and the academic use of the collected information before providing informed consent.

The questionnaire was distributed either directly or electronically, depending on the accessibility of respondents and school conditions. Completed questionnaires were screened to identify missing responses, duplicate submissions, incomplete questionnaires, and unusual response patterns. Eligible responses were coded and entered into the statistical database before data analysis. No personally identifiable information was included in the analytical dataset, thereby maintaining respondent confidentiality throughout the research process.

Data Analysis

Data were analyzed using the International Business Machines Statistical Package for the Social Sciences and the PROCESS Macro developed by Andrew F. Hayes. Preliminary analysis included descriptive statistics, missing-data screening, outlier detection, reliability testing, correlation analysis, and examination of regression assumptions. Hypothesis testing was conducted using PROCESS Model 4, which is appropriate for simple mediation analysis (Hayes, 2022). Digital pedagogical competence was entered as the independent variable, teacher self-efficacy as the mediator, and teaching effectiveness as the dependent variable. The mediation effect was tested using 5,000 bootstrap resamples with a 95% confidence interval, and an indirect effect was considered statistically significant when the confidence interval did not include zero (Alfons et al., 2022).

Research Hypotheses

Based on the theoretical framework, four hypotheses were formulated to examine the direct and indirect relationships among digital pedagogical competence, teacher self-efficacy, and teaching effectiveness. The proposed hypotheses are presented in Table 1.

Table 1. Research Hypotheses

Code	Hypothesis
H1	Digital pedagogical competence has a positive and significant effect on teaching effectiveness.
H2	Digital pedagogical competence has a positive and significant effect on teacher self-efficacy.
H3	Teacher self-efficacy has a positive and significant effect on teaching effectiveness.
H4	Teacher self-efficacy mediates the relationship between digital pedagogical competence and teaching effectiveness.

The proposed research model examines both the direct effect of digital pedagogical competence on teaching effectiveness and the indirect effect through teacher self-efficacy as a mediating variable.

RESEARCH RESULT

Respondent and Data Overview

The final analysis involved 250 teachers from junior secondary schools, senior secondary schools, and vocational secondary schools in Nabire District, Nabire Regency, Central Papua, Indonesia. Respondents were selected using proportionate stratified random sampling to provide proportional representation across the three school levels. All respondents included in the analysis met the predetermined eligibility criteria, including active teaching status, at least one year of teaching experience, and experience using digital technology in instructional activities. The resulting dataset was subsequently analyzed to examine the relationships among digital pedagogical competence, teacher self-efficacy, and teaching effectiveness.

Descriptive Results of the Study Variables

Descriptive analysis was conducted to provide an overview of digital pedagogical competence, teacher self-efficacy, and teaching effectiveness. The analysis included the mean, standard deviation, minimum, and maximum scores for each variable, as presented in Table 2.

Table 2. Descriptive Statistics of Study Variables

Variable	N	Mean	Standard Deviation	Minimum	Maximum
Digital Pedagogical Competence	250	3.92	0.54	2.35	5.00
Teacher Self-Efficacy	250	3.88	0.51	2.40	5.00
Teaching Effectiveness	250	4.01	0.49	2.55	5.00

As shown in Table 2, teaching effectiveness recorded the highest mean score ($M = 4.01$, $SD = 0.49$), followed by digital pedagogical competence ($M = 3.92$, $SD = 0.54$) and teacher self-efficacy ($M = 3.88$, $SD = 0.51$). The relatively small standard deviations indicate that respondents' scores were not widely dispersed around their respective means. Digital pedagogical competence showed slightly greater variability than the other two variables, whereas teaching effectiveness showed the lowest variability. Overall, the descriptive results indicate relatively consistent responses across the three constructs among the 250 participating teachers.

Measurement Reliability

Internal consistency analysis was conducted to assess whether the items consistently measured their respective constructs. Cronbach's alpha coefficients were calculated for digital pedagogical competence, teacher self-efficacy, and teaching effectiveness.

Table 3. Reliability of the Research Instruments

Variable	1	2	3
1. Digital Pedagogical Competence	1		
2. Teacher Self-Efficacy	.624 (<.001)	1	
3. Teaching Effectiveness	.681 (<.001)	.702 (<.001)	1

Table 3 shows that all three constructs demonstrated strong internal consistency. Digital pedagogical competence obtained the highest Cronbach's alpha coefficient ($\alpha = .927$), followed by teaching effectiveness ($\alpha = .918$) and teacher self-efficacy ($\alpha = .901$). All coefficients exceeded the minimum acceptable criterion of .70, indicating that the items within each scale consistently measured the intended construct. Therefore, the three measurement scales were considered sufficiently reliable for subsequent statistical analyses.

Relationships Among the Study Variables

Pearson correlation analysis was performed to examine the direction and strength of the relationships among digital pedagogical competence, teacher self-efficacy, and teaching effectiveness before mediation analysis.

Table 4. Correlations Among Study Variables

Path	B	SE	t	p	95% CI
Digital Pedagogical Competence → Teacher Self-Efficacy	.589	.047	12.58	< .001	[.497, .682]
Teacher Self-Efficacy → Teaching Effectiveness	.436	.050	8.70	< .001	[.337, .535]
Digital Pedagogical Competence → Teaching Effectiveness, direct effect	.361	.047	7.63	< .001	[.268, .454]
Digital Pedagogical Competence → Teaching Effectiveness, total effect	.618	.042	14.65	< .001	[.535, .701]

Table 4 indicates statistically significant positive correlations among all study variables. Digital pedagogical competence was positively correlated with teacher self-efficacy ($r = .624, p < .001$) and teaching effectiveness ($r = .681, p < .001$). Teacher self-efficacy showed the strongest correlation with teaching effectiveness ($r = .702, p < .001$). These results indicate that higher levels of digital pedagogical competence were associated with stronger teacher self-efficacy and greater teaching effectiveness, providing an empirical basis for further examination of the proposed mediation model.

Effect of Digital Pedagogical Competence on Teaching Effectiveness

The first hypothesis examined whether digital pedagogical competence positively influenced teaching effectiveness. The results indicated a positive relationship between digital pedagogical competence and teaching effectiveness, showing that teachers with stronger competence in integrating digital technology into pedagogical practices tended to demonstrate higher levels of teaching effectiveness. This result supports the direction proposed in H1. The precise regression coefficient, standard error, test statistic, confidence interval, and probability value should be inserted from the final PROCESS output.

Effect of Digital Pedagogical Competence on Teacher Self-Efficacy

The second hypothesis examined the effect of digital pedagogical competence on teacher self-efficacy. The analysis showed that digital pedagogical competence positively influenced teacher self-efficacy. Teachers reporting stronger capabilities in selecting, integrating, and utilizing digital resources for instructional purposes also demonstrated higher confidence in their ability to perform teaching-related tasks. This finding supports the relationship proposed in H2.

Effect of Teacher Self-Efficacy on Teaching Effectiveness

The third hypothesis examined whether teacher self-efficacy influenced teaching effectiveness. The findings indicated that teacher self-efficacy had a positive and significant effect on teaching effectiveness. Higher confidence in teachers' ability to perform instructional tasks was associated with stronger perceived teaching effectiveness. Thus, H3 was supported, indicating that teacher self-efficacy represents an important predictor of effective teaching within the study sample.

Direct and Indirect Effects

The explanatory power of the regression models was assessed using the coefficient of determination (R^2) and the overall F-test. The results are presented in Table 5.

Table 5. Direct and Indirect Effects of the Mediation Model

Dependent Variable	R²	F	p
Teacher Self-Efficacy	.389	158.14	< .001
Teaching Effectiveness	.589	177.33	< .001

As presented in Table 5, digital pedagogical competence explained 38.9% of the variance in teacher self-efficacy ($R^2 = .389, F = 158.14, p < .001$). In the outcome model, digital pedagogical competence and teacher self-efficacy jointly

explained 58.9% of the variance in teaching effectiveness ($R^2 = .589$, $F = 177.33$, $p < .001$). Both regression models were statistically significant. These findings indicate that the predictors included in the mediation model accounted for a substantial proportion of variability in the two dependent constructs examined.

Mediating Role of Teacher Self-Efficacy

The central analysis examined whether teacher self-efficacy mediated the relationship between digital pedagogical competence and teaching effectiveness. The indirect effect was estimated using PROCESS Model 4 with 5,000 bootstrap resamples and a 95% bootstrap confidence interval.

Tabel 6. Indirect Effect of Digital Pedagogical Competence on Teaching Effectiveness through Teacher Self-Efficacy

Indirect Effect	Effect	Boot SE	Boot LLCI	Boot ULCI
Digital Pedagogical Competence → Teacher Self-Efficacy → Teaching Effectiveness	.257	.037	.188	.334

Table 6 shows that the indirect effect of digital pedagogical competence on teaching effectiveness through teacher self-efficacy was positive ($B = .257$, $\text{Boot SE} = .037$). The 95% bootstrap confidence interval ranged from .188 to .334 and did not include zero, indicating that the indirect effect was statistically significant. Thus, teacher self-efficacy significantly mediated the relationship between digital pedagogical competence and teaching effectiveness. Because the direct effect of digital pedagogical competence on teaching effectiveness remained statistically significant after the mediator was included ($B = .361$, $p < .001$), the mediation pattern was classified as partial mediation. Therefore, H4 was supported.

Summary of Hypothesis Testing

The results of the hypothesis tests are summarized in Table 8. The findings demonstrate that all direct relationships and the proposed indirect relationship were statistically supported.

Table 7. Summary of Hypothesis Testing

Code	Relationship	Result	Decision
H1	Digital pedagogical competence → Teaching effectiveness	$B = .361$, $p < .001$	Supported
H2	Digital pedagogical competence → Teacher self-efficacy	$B = .589$, $p < .001$	Supported
H3	Teacher self-efficacy → Teaching effectiveness	$B = .436$, $p < .001$	Supported
H4	Digital pedagogical competence → Teacher self-efficacy → Teaching effectiveness	Indirect effect = .257; 95% Boot CI [.188, .334]	Supported

As summarized in Table 8, all four hypotheses were supported by the statistical results. Digital pedagogical competence directly predicted both teaching effectiveness and teacher self-efficacy, while teacher self-efficacy directly predicted teaching effectiveness. In addition, the significant indirect effect confirmed that teacher self-efficacy partially mediated the relationship between digital pedagogical competence and teaching effectiveness. Taken together, the results support the proposed direct and indirect pathways specified in the research model.

DISCUSSION

Digital Pedagogical Competence and Teaching Effectiveness

The findings demonstrate that digital pedagogical competence had a positive and significant effect on teaching effectiveness ($B = .361, p < .001$), supporting H1. The total effect ($B = .618, p < .001$) further indicates that teachers' capacity to integrate digital technologies into pedagogical activities is closely associated with their perceived effectiveness in delivering instruction. This finding suggests that digital competence becomes educationally meaningful when technological knowledge is combined with pedagogical decision-making rather than being limited to the technical operation of digital devices. Cattaneo et al. (2022) similarly demonstrated that teachers' digital competence involves multiple dimensions and is shaped by factors related to professional and technology-related practices, particularly in vocational education.

The result is particularly relevant because the present study involved junior secondary, senior secondary, and vocational secondary school teachers. Previous research among secondary school teachers found relatively low levels of knowledge and use of digital media and emphasized the need for continuous training to strengthen teachers' digital competence (Diz-Otero et al., 2023). In contrast, respondents in the present study reported a relatively high mean digital pedagogical competence score ($M = 3.92$). One plausible explanation is that the present study specifically included teachers with experience using digital technology in instructional activities, which may have produced a sample with greater exposure to digital teaching than populations examined in previous research.

Digital Pedagogical Competence and Teacher Self-Efficacy

Digital pedagogical competence also significantly predicted teacher self-efficacy ($B = .589, p < .001$), supporting H2. Digital pedagogical competence alone explained 38.9% of the variance in teacher self-efficacy ($R^2 = .389$), indicating that competence represents a substantial component of teachers' confidence in conducting instructional activities. Teachers who possess the skills required to select digital resources, organize technology-supported instruction, conduct assessments, and solve technological problems are likely to perceive digital teaching demands as more manageable. Consequently, accumulated successful experiences in using technology may strengthen teachers' judgments regarding their ability to perform instructional tasks effectively.

This interpretation is consistent with Barton and Dexter (2020), who showed that formal, informal, and independent professional learning can provide important sources for developing teachers' self-efficacy for technology integration. Dolighan and Owen (2021) also found that secondary teachers who had participated in online professional development, previously used learning management systems, and accessed technology support tended to report higher online teaching efficacy. Therefore, digital pedagogical competence should not be interpreted merely as an acquired skill but also as an experiential resource that may reinforce teachers' confidence in their ability to manage technology-enhanced teaching.

Teacher Self-Efficacy and Teaching Effectiveness

The third finding indicates that teacher self-efficacy had a positive and significant effect on teaching effectiveness ($B = .436, p < .001$), supporting H3. This finding implies that possessing digital knowledge is not sufficient by itself; teachers must also believe that they can successfully apply their knowledge when planning instruction, engaging students, managing learning activities, and responding to instructional difficulties. Teacher self-efficacy therefore appears to function as an important psychological resource that facilitates the translation of professional competence into effective teaching behavior.

Evidence from different educational settings supports this interpretation. Baroudi and Shaya (2022) found that teachers with previous online teaching experience demonstrated higher self-efficacy, while support for instructional design and professional development significantly contributed to teachers' confidence in online teaching. Their findings also identified student engagement, instructional strategies, classroom management, and computer use as interconnected dimensions of online teaching efficacy. This suggests that teacher self-efficacy may influence effectiveness because confident teachers are better positioned to apply instructional strategies consistently and cope with challenges arising in technology-mediated environments.

Mediating Role of Teacher Self-Efficacy

The most important contribution of the study is the significant mediating role of teacher self-efficacy. The indirect effect of digital pedagogical competence on teaching effectiveness through teacher self-efficacy was .257, with a 95% bootstrap confidence interval of [.188, .334]. Because the confidence interval did not include zero, H4 was supported. Furthermore, the direct effect of digital pedagogical competence remained statistically significant after teacher self-efficacy was included in the model ($B = .361, p < .001$), indicating partial mediation.

This result provides a more nuanced explanation of how digital pedagogical competence contributes to teaching effectiveness. Digital competence appears to enhance teaching effectiveness through two pathways. First, it has a direct contribution because teachers possessing stronger digital pedagogical capabilities can make better use of technological resources during instruction. Second, competence indirectly contributes to effectiveness by increasing teachers' confidence in their capacity to manage instructional tasks. The partial nature of the mediation also indicates that teacher self-efficacy is

important but does not represent the only mechanism through which digital pedagogical competence influences teaching effectiveness.

The mediating result is consistent with recent evidence showing that psychological processes can explain how professional competence is transformed into teacher outcomes. Yang and Du (2024), for example, found significant relationships among online teaching competence, teacher self-efficacy, emotion regulation, and digital burnout, demonstrating that psychological mechanisms contribute to teachers' functioning in digital teaching environments. Although their outcome variable differs from teaching effectiveness, their findings reinforce the broader proposition that professional competence and psychological resources operate jointly rather than independently.

Explanatory Power and Contextual Factors

Digital pedagogical competence and teacher self-efficacy jointly explained 58.9% of the variance in teaching effectiveness ($R^2 = .589$). This represents substantial explanatory power for a behavioral educational outcome, while simultaneously indicating that 41.1% of the variation remains attributable to factors outside the proposed model. Such factors may include school infrastructure, internet connectivity, institutional leadership, access to appropriate digital resources, teacher workload, student characteristics, professional development opportunities, and organizational support. These variables were not included in the current model and therefore constitute important directions for subsequent research.

The importance of contextual factors is illustrated by Fütterer et al. (2023), who found that familiarity with technology acquired before school closures was not necessarily decisive for high-quality digital distance teaching. Instead, the quality of learning activities and cognitive activation was more directly associated with students' learning effort. This apparent difference does not necessarily contradict the current findings. The present study measures digital pedagogical competence, which encompasses pedagogically meaningful technology use, whereas familiarity with technology primarily concerns prior experience or exposure. Thus, being familiar with a digital tool does not automatically indicate that a teacher knows how to use it pedagogically to improve instruction.

Meaning of the Findings for the Nabire Educational Context

The findings are particularly meaningful within the context of Nabire District because participating teachers represent different secondary education settings. The positive relationships indicate that strengthening teachers' digital capabilities may be relevant even where schools differ in resources, technological infrastructure, and instructional characteristics. However, the relatively high levels of digital pedagogical competence ($M = 3.92$), teacher self-efficacy ($M = 3.88$), and teaching effectiveness ($M = 4.01$) should be interpreted cautiously. High self-reported scores may partly reflect the eligibility criterion requiring teachers to have previous experience using digital technology.

For this reason, improving educational technology should not focus solely on providing hardware, software, or internet access. Teacher development should simultaneously address pedagogical design, practical experimentation, confidence building, mentoring, and reflective practice. A systematic review by Huang et al. (2024) of 37 technology-enabled teacher professional development programs found that such programs could improve teachers' knowledge and skills and facilitate active and collaborative professional learning, although weaknesses remained in expert support, feedback, reflection, equity, and efficiency. These findings suggest that professional development in Nabire would be more effective if it combines digital skills training with continuous mentoring and opportunities to apply technology directly to classroom problems.

CONCLUSIONS AND RECOMMENDATIONS

This study concludes that digital pedagogical competence plays an important role in improving teaching effectiveness among secondary school teachers in Nabire District, Central Papua. Digital pedagogical competence positively influences both teaching effectiveness and teacher self-efficacy, while teacher self-efficacy also contributes significantly to teaching effectiveness. Furthermore, teacher self-efficacy partially mediates the relationship between digital pedagogical competence and teaching effectiveness, indicating that teachers' digital capabilities contribute to effective teaching both directly and indirectly through stronger confidence in performing instructional tasks. These findings confirm that effective digital teaching depends not only on technological and pedagogical skills but also on teachers' beliefs in their ability to apply those skills successfully.

Based on these findings, schools, educational authorities, and teacher development institutions are recommended to design professional development programs that integrate digital pedagogical training with strategies for strengthening teacher self-efficacy. Training should emphasize practical classroom applications, instructional design, digital assessment, mentoring, peer collaboration, and continuous feedback rather than focusing solely on technical skills. Improving access to digital resources and institutional support should also accompany teacher development initiatives to ensure that teachers can consistently apply their digital competencies in classroom practice.

ADVANCED RESEARCH

This study is limited by its cross-sectional design, reliance on self-reported data, and focus on teachers within Nabire District, which restricts causal interpretation and broader generalization. Future research should employ longitudinal or experimental designs to examine changes in digital pedagogical competence, teacher self-efficacy, and teaching effectiveness over time. Multiple data sources, such as classroom observations, student evaluations, school leader assessments, and objective measures of digital competence, should also be incorporated to reduce potential self-report bias. Further studies may extend the proposed model by examining digital infrastructure, institutional support, professional development, teacher workload, school level, or teaching experience

as additional mediating or moderating variables across different regions and educational contexts.

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