

Associations of Digital Learning Strategy Management and Digital Tool Utilization with Teachers' Teaching Performance

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ABSTRACT

Purpose of the study: This study examines the individual and joint associations of digital learning strategy management and digital tool utilization with teachers' self-reported teaching performance at public senior high school XY, an anonymized public senior high school in Purwakarta Regency, Indonesia.

Methodology: A quantitative cross-sectional correlational survey was conducted using a five-point Likert-scale questionnaire. Complete responses from 37 teachers were analyzed using multiple linear regression in SPSS. The design examines statistical associations and does not establish causality.

Main Findings: Digital learning strategy management was not statistically associated with teaching performance after accounting for digital tool utilization ($t = -1.482$, $p = 0.147$). Digital tool utilization showed a positive association after accounting for strategy management ($t = 2.618$, $p = 0.013$). The overall model was statistically significant ($F = 3.453$, $p = 0.043$), with $R^2 = 0.169$ and adjusted $R^2 = 0.120$. These findings apply to the teachers analyzed at the study site.

Novelty/Originality of this study: The study examines managerial perceptions and perceived digital resource quality and support within one regression model of self-reported teaching performance at an anonymized public senior high school. Its contribution is context-specific, exploratory evidence concerning these associations.

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1. INTRODUCTION

Digital transformation has positioned the management of technology-based learning strategies as the primary lever for improving instructional quality at various levels of education [1]. The development of adaptive learning systems and interactive platforms is redefining pedagogical possibilities on a global scale [2]. The accelerated integration of technology demands comprehensive institutional readiness so that digital potential can be translated into effective teaching practices [3]. These changes position teachers' instructional performance as the linchpin linking technological investment to students' learning outcomes [4].

At the national level, developing countries face structural challenges in aligning digitization policies with the readiness of school resources [5]. Infrastructure and competency gaps remain persistent barriers that limit the effectiveness of digital strategies in resource-constrained environments [6]. Similar conditions are reflected in the perceptions of science teachers in Indonesia, whose adoption of technology is influenced by

demographic factors [7]. Digital participation disparities are also documented in educational programs serving vulnerable groups [8].

The local context of secondary schools shows that the success of digitization depends not only on the procurement of devices but also on the governance of coherent strategies [9]. The digital leadership of school principals plays a crucial role in fostering a culture of instructional innovation [10]. Organizational support has been shown to strengthen the pathway from teachers' digital literacy to pedagogical innovation [11]. Instructional leadership practices also help institutionalize digital innovation in school quality assurance.

Several previous studies have confirmed that the use of interactive digital tools enhances student engagement and academic achievement [12]. Teachers' digital competencies and self-efficacy mediate the effectiveness of these tools. A social-cognitive perspective suggests that teachers' technological self-efficacy is related to students' learning aspirations [13]. Mediation analyses reinforce the role of motivation in the use of digital resources in secondary education. Previous research has examined digital teaching from various organizational and individual perspectives. Pettersson's review links teachers' digital competencies to school policies, infrastructure, leadership, and teaching practices [14]. Scherer, Siddiq, and Tondeur summarize teachers' acceptance of technology, thereby providing insights into the conditions associated with technology adoption [15]. These perspectives help distinguish organizational support for digital learning from teachers' use of digital tools in their teaching activities.

This distinction is also evident in recent empirical evidence and reviews. Rasdiana et al. examined online instructional supervision, technology leadership, and school digital culture in relation to teachers' professional digital competencies in Indonesian high schools [16]. Claro et al. identified differences in how the digital competencies of practicing teachers are operationalized across various quantitative studies [17]. Amemasor et al. examined school digital readiness, professional development, and professional learning communities in relation to the integration of digital teaching [9]. These studies examine related digital education processes, but their outcome constructs differ from self-reported teaching performance. The specific gap discussed here is the need for contextual evidence that distinguishes the management of digital learning strategies from the use of digital tools when both are included as predictors of self-reported teaching performance. This study does not claim that digital leadership or technology integration has never been researched. Rather, it focuses on a distinct combination of predictors and outcomes at public senior high school XY, an anonymized public high school in Purwakarta Regency. The uniqueness of this study lies in its contextual comparison within a single model.

The practical question is whether teachers' perceptions of digital strategy management and their reported use of digital tools show a similar relationship with teaching performance at the study site. Analyzing these two dimensions separately and together provides a foundation for local reflection on support for digital learning. This analysis is an initial diagnostic step; it does not evaluate an intervention or identify a proven order of investment priorities. The resource-based view provides a broad rationale for considering managerial capabilities and technological resources together, because organizational performance is linked conceptually to the resources an organization can mobilize [18]. Applied to the school context, this perspective motivates examining digital strategy management alongside the support available through digital resources. The present study does not measure competitive advantage or test the full resource-based model.

The questionnaire translates the strategic management perspective of David and David into school-level indicators of goal formulation, implementation support, monitoring, and evaluation [19]. The digital resource scale draws conceptually on the information systems success perspective of DeLone and McLean, which distinguishes system, information, and service quality [20]. In this study, the scale labeled digital tool utilization primarily represents teachers' perceptions of digital resource availability, functionality, and support. Teaching performance is represented by self-reported instructional practices informed by Danielson's Framework for Teaching [21]. The locally developed items operationalize these ideas for digital teaching and are not the original instruments supplied by the theorists. These perspectives support examining whether digital strategy management and perceived digital resource quality and support are associated with self-reported teaching performance. The study estimates each association after accounting for the other predictor and evaluates the overall two-predictor model. It does not test the mechanisms linking organizational resources to teaching performance or establish causal effects.

2. RESEARCH METHOD

2.1. Research Design

This study used a quantitative cross-sectional correlational survey to examine associations among digital learning strategy management (X1), digital tool utilization (X2), and teachers' self-reported teaching performance (Y) at public senior high school XY in Purwakarta Regency, West Java, Indonesia. Multiple linear regression estimated the association of each predictor with the outcome while accounting for the other predictors

[19]. The predictors were not manipulated, and their temporal ordering relative to teaching performance was not established. The estimates are therefore interpreted as statistical associations.

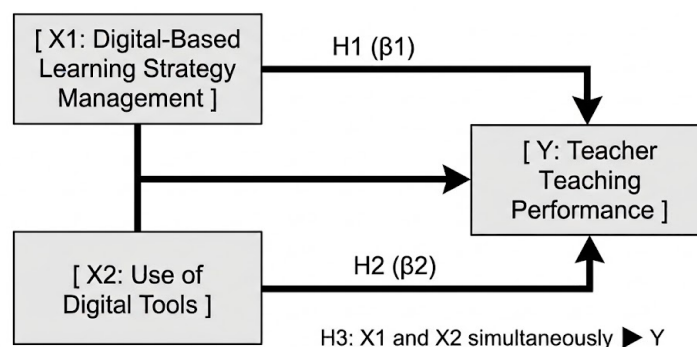


Figure 1. Conceptual model of associations among the study variables

The model specifies X1 and X2 as statistical predictors of Y. H1 refers to the coefficient of X1, H2 to the coefficient of X2, and H3 to the overall two-predictor model. The arrows show the direction of model specification and do not establish causal relationships.

2.2. Population and Sample

The study was conducted at one public senior high school in Purwakarta Regency, West Java, Indonesia. The school is identified as public senior high school XY to protect its institutional identity. The research plan specified a target population of 38 teachers and proposed a total population sampling. The dataset available for analysis contained 37 complete teacher responses, equivalent to 97.4% of the planned target population. The study is therefore described as an attempted census rather than a completed census of all 38 teachers.

The regression analysis included cases with complete scores for X1, X2, and Y using listwise handling of missing values. All 37 records in the supplied dataset contained complete responses to the 24 questionnaire items. The available data do not identify the participation status of the remaining teacher. Table 1 distinguishes the planned population from the cases analyzed. The designation public senior high school XY is used consistently throughout the manuscript.

Table 1. Planned Population and Analytical Sample

Component	n	Description
Target population in the research plan	38	Teachers at the study school
Complete records available for analysis	37	Complete responses for all 24 items
Target population not represented in the analytical dataset	1	Participation status and reason are not documented in the available records
Analytical coverage of the planned population	97.4%	$37/38 \times 100$; not a verified questionnaire return rate

2.3. Data Collection Techniques and Instruments

Data were collected using a closed-ended questionnaire containing 24 positively worded statements, with eight items for each variable. Responses were coded from 1 (strongly disagree) to 5 (strongly agree), with the midpoint labeled less agreement/uncertain in the questionnaire plan. Scale scores were calculated by summing the eight items for each variable, giving a possible range of 8–40. No reverse scoring was applied.

Digital learning strategy management (X1) was operationalized as teachers' perceptions of school support for planning, organizing, implementing, monitoring, and evaluating digital teaching. Digital tool utilization (X2) was operationalized through perceived network quality, hardware readiness, access to work devices and digital materials, platform reliability, technical support, assessment application support, and data security. Consequently, X2 primarily captures the quality and support of the digital resources available for teaching rather than the frequency of teachers' tool use.

Teachers' teaching performance (Y) was operationalized as self-reported lesson planning, classroom management, instructional delivery, time management, assessment, feedback, media innovation, and support for students' learning mastery. The indicators were developed locally with reference to David and David for X1, DeLone and McLean for X2, and Danielson for Y [19]–[21]. The questionnaire is a contextual operationalization of these perspectives, not a verbatim reproduction of the original frameworks. Table 2 presents the item grid.

Table 2. Operational Indicators and Questionnaire Item Codes

Scale	Operational indicator	Item code	Items
X1	Goal formulation	X1.1	1
X1	Policies and guidelines	X1.2	1
X1	Scheduling and organization	X1.3	1
X1	Teacher capacity development	X1.4	1
X1	Support for instructional methods	X1.5	1
X1	Curriculum and digital material alignment	X1.6	1
X1	Supervision and monitoring	X1.7	1
X1	Evaluation and follow-up	X1.8	1
X2	Network quality	X2.1	1
X2	Hardware readiness	X2.2	1
X2	Access to teachers' work devices	X2.3	1
X2	Access to digital repositories	X2.4	1
X2	Platform reliability	X2.5	1
X2	Technical support	X2.6	1
X2	Assessment application support	X2.7	1
X2	System data security	X2.8	1
Y	Lesson planning	Y.1	1
Y	Classroom climate management	Y.2	1
Y	Instructional delivery	Y.3	1
Y	Teaching time management	Y.4	1
Y	Assessment practices	Y.5	1
Y	Feedback provision	Y.6	1
Y	Teaching media innovation	Y.7	1
Y	Students' learning mastery	Y.8	1
Total	Three scales	24 items	24

A supplementary item analysis was conducted on the 37 complete records used in the regression. Pearson item–total correlations were calculated against each eight-item scale total, which included the item being assessed. With $n = 37$, $df = 35$, and a two-sided significance level of 0.05, the critical correlation was 0.3246. Corrected item–total correlations were also calculated against the sum of the other seven items to avoid including an item in its own comparison score [19]. These coefficients provide item-level association evidence and do not establish construct validity. Cronbach's alpha was calculated for each eight-item scale. This analysis used the main study sample rather than an independent validation sample.

Table 3. Supplementary Item Analysis and Internal Consistency

Scale	Items	n	Pearson item–total r range	Corrected item–total r range	Cronbach's α
X1	8	37	0.116–0.657	–0.067–0.492	0.537
X2	8	37	0.449–0.668	0.207–0.519	0.662
Y	8	37	0.160–0.643	–0.109–0.374	0.298

The item–total criterion was not met by X1.1, X1.3, X1.5, Y.5, Y.7, and Y.8. Cronbach's alpha was below the manuscript's stated threshold of 0.70 for all three scales, particularly the outcome scale. The measures, therefore, cannot be described as having demonstrated adequate internal consistency under this criterion. The original eight-item totals were retained to reproduce the reported regression, and the results are interpreted as exploratory associations affected by measurement limitations.

2.4. Research Hypotheses

The hypotheses concern the conditional associations of the two predictors with self-reported teaching performance and the statistical significance of the overall regression model. They do not imply causal effects.

- H1: Digital learning strategy management is positively associated with teachers' self-reported teaching performance after accounting for digital tool utilization.
- H2: Digital tool utilization is positively associated with teachers' self-reported teaching performance after accounting for digital learning strategy management.
- H3: The two-predictor regression model accounts for variation in teachers' self-reported teaching performance, with at least one nonzero predictor coefficient.

2.5. Data Analysis Techniques

The original analysis used multiple linear regression in SPSS with both predictors entered simultaneously. The model was specified as $Y = b_0 + b_1X_1 + b_2X_2 + \varepsilon$. Individual coefficients were evaluated using two-sided t-tests, and the overall model was evaluated using an F-test at $\alpha = 0.05$. Unstandardized coefficients, standard errors, standardized coefficients, p-values, R^2 , and adjusted R^2 were reported. The dependent variable was analyzed using the eight-item total score.

The original SPSS output provided the residual probability plot, residual scatterplot, and Durbin–Watson statistic. A supplementary reanalysis of the same 37 complete records reproduced the descriptive statistics and regression estimates and added numerical diagnostics: tolerance and VIF for collinearity, the Shapiro–Wilk test of regression residuals for normality, and the Glejser test by regressing absolute unstandardized residuals on X_1 and X_2 . Item–total correlations, corrected item–total correlations, and Cronbach’s alpha were also calculated as supplementary measurement checks. Numerical tests and plots were interpreted together; nonsignificant diagnostic tests were not treated as proof that the assumptions held.

The Durbin–Watson statistic was retained for transparency, but the dataset consisted of cross-sectional teacher responses without a documented temporal or substantive ordering. Its value was therefore not used as definitive evidence of independent errors. The model’s findings were interpreted within the single-school context and in light of the instrument reliability results.

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistics

Descriptive statistics provide an overview of the distributions of the three research variables based on responses from 37 teachers. Table 4 presents the mean and standard deviation for each variable.

Table 4. Descriptive Statistics of Research Variables

Variable	Mean	Standard Deviation	N
Teacher Teaching Performance (Y)	35.51	2.231	37
Digital Strategy Management (X1)	35.11	2.767	37
Utilization of Digital Tools (X2)	35.46	3.202	37

Among the 37 teachers analyzed, the mean self-reported teaching performance score was 35.51 (SD = 2.231), the mean digital strategy management score was 35.11 (SD = 2.767), and the mean digital tool utilization score was 35.46 (SD = 3.202). Each score was the sum of eight five-point items, with a possible range of 8–40. The observed ranges were 31–40 for Y, 28–39 for X_1 , and 30–40 for X_2 . These values describe the scores in this sample. Similar raw means do not establish equivalence between constructs or uniformity of teachers’ perceptions.

3.2. Regression Diagnostics

Regression diagnostics were examined using the original SPSS plots and supplementary numerical analyses of the same 37 complete records. Table 5 reports the diagnostic statistics. These checks address the regression residuals and predictor relationships; they do not remedy low scale reliability.

Table 5. Regression Diagnostic Results

Diagnostic	Numerical result	Interpretation
Collinearity: X_1	Tolerance = 0.598; VIF = 1.671	Tolerance > 0.10 and VIF < 10; no indication of severe predictor collinearity
Collinearity: X_2	Tolerance = 0.598; VIF = 1.671	Tolerance > 0.10 and VIF < 10; no indication of severe predictor collinearity
Residual normality	Shapiro–Wilk $W = 0.962$; $p = 0.240$	The test did not detect a departure from normality at $\alpha = 0.05$
Glejser: X_1	$B = 0.083$; $t = 0.928$; $p = 0.360$	The test did not detect an association with absolute residuals at $\alpha = 0.05$
Glejser: X_2	$B = -0.068$; $t = -0.875$; $p = 0.387$	The test did not detect an association with absolute residuals at $\alpha = 0.05$
Durbin–Watson	1.239	No definitive inference without a justified ordering of observations

Both predictors had tolerance values of 0.598 and VIF values of 1.671, indicating no severe collinearity under the stated criteria. The Shapiro–Wilk test did not detect a departure from residual normality ($W = 0.962$, $p = 0.240$). The Glejser test did not detect significant associations between absolute residuals and either X_1 ($p =$

0.360) or X^2 ($p = 0.387$). These findings are compatible with the visual diagnostics, although the small sample size limits the sensitivity of the numerical tests. The Durbin–Watson value of 1.239 is reported without asserting that independence of errors has been established.

The Normal P–P Plot of regression standardized residuals was inspected alongside the numerical normality test. Figure 2 presents this visual diagnostic. The plotted points broadly follow the diagonal reference line. Together with the nonsignificant Shapiro–Wilk result, this provides no clear indication of a major departure from residual normality in this sample. The visual pattern does not prove that the residual distribution is exactly normal.

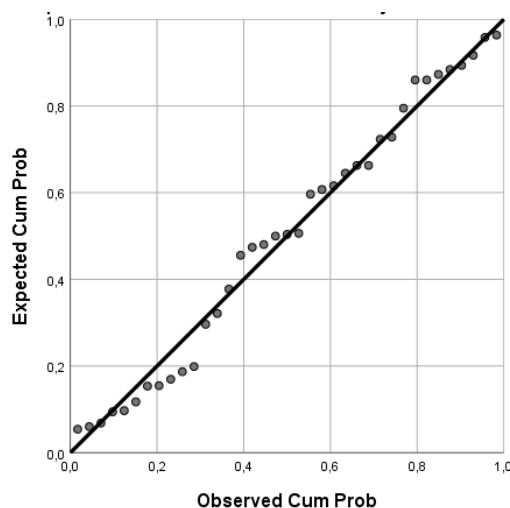


Figure 2. Normal P-P Plot of Regression Standardized Residuals

Figure 2 shows that the data points are scattered around the diagonal line and generally follow it. This scatter plot indicates that the regression model's residuals are normally distributed; therefore, the normality assumption is satisfied, and the model is suitable for further analysis.

The heteroscedasticity test was conducted by examining the scatterplot of standardized predicted values against studentized residuals. Figure 3 presents the results of the heteroscedasticity test for the regression model.

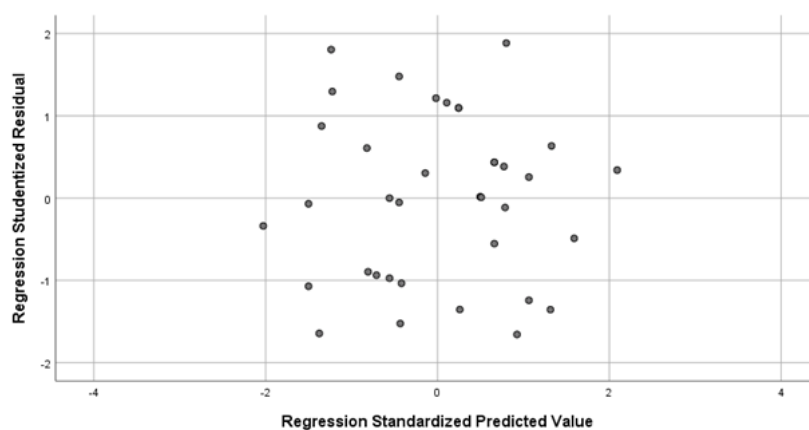


Figure 3. Scatterplot for the Heteroscedasticity Test

Figure 3 shows that the data points are randomly scattered above and below the zero line on the Y-axis without forming any specific, regular pattern, such as undulating, widening, and then narrowing. This random distribution of data points indicates that there is no heteroscedasticity; therefore, the assumption of homoscedasticity is satisfied, and the variance of the residuals is constant.

3.3. Associations with Teaching Performance

Multiple linear regression examined the conditional associations of digital learning strategy management and digital tool utilization with teachers' self-reported teaching performance. Table 6 presents the coefficients. The estimates reproduce the original analysis using the eight-item totals, and their interpretation is qualified by the reliability findings reported in Section 2.3.

Table 6. Regression Coefficients and Partial Tests (t-Tests)

Term	B	SE	β	t	p
Constant	30.923	4.646	—	6.656	< 0.001
Digital learning strategy management (X1)	-0.242	0.163	-0.300	-1.482	0.147
Digital tool utilization (X2)	0.369	0.141	0.529	2.618	0.013

Digital learning strategy management was not statistically associated with self-reported teaching performance after accounting for X2 ($B = -0.242$, $\beta = -0.300$, $t = -1.482$, $p = 0.147$). H1 was therefore not supported. The negative coefficient does not demonstrate that strategy management reduces teaching performance. The sample did not provide sufficient statistical evidence for the proposed positive conditional association, and the measurement limitations further constrain this interpretation.

This result is not directly comparable to research on different outcomes. Rasdiana et al. examined organizational digital practices in relation to teachers' professional digital competence [16]. Amemasor et al. examined professional development and learning communities in relation to digital instructional integration [9]. The present outcome was self-reported teaching performance. Digital competence and professional learning pathways were not measured in the regression, so possible indirect relationships remain questions for further research.

Digital tool utilization was positively associated with self-reported teaching performance after accounting for X1 ($B = 0.369$, $\beta = 0.529$, $t = 2.618$, $p = 0.013$), supporting H2 within the fitted model. A one-point higher X2 total corresponded to an estimated 0.369-point higher Y total at the same X1 score. Given the item content, this is an association with perceived digital resource quality and support. It should not be interpreted as the gain caused by increasing teachers' frequency of technology use.

This interpretation is conceptually consistent with examining the conditions that support teachers' digital practice. Technology acceptance research addresses teachers' adoption of digital technology [15], whereas reviews of digital competence show differences in how such constructs are measured [17]. The current study did not independently measure technology acceptance, classroom instructional quality, or student achievement. The significance of X2 and the non-significance of X1 also do not establish a statistically significant difference between the two coefficients.

Table 7. Overall regression model

Statistic	Value	Interpretation
F(2, 34)	3.453	Overall model test
p	0.043	At least one predictor coefficient differs from zero at $\alpha = 0.05$
R	0.411	Multiple correlation coefficient
R ²	0.169	16.9% of observed variance explained by the fitted model
Adjusted R ²	0.120	Explained variance adjusted for predictor count and sample size
Standard error of the estimate	2.093	Residual standard error in total-score units

The fitted equation was $\hat{Y} = 30.923 - 0.242X_1 + 0.369X_2$. The overall model was statistically significant, $F(2, 34) = 3.453$, $p = 0.043$, supporting H3 as an overall model hypothesis. This indicates that at least one predictor contributed statistically to the model; it does not mean that both individual coefficients were significant or positive. The model accounted for 16.9% of observed variation in Y ($R^2 = 0.169$), with adjusted $R^2 = 0.120$.

The remaining variance was not explained by the fitted model and cannot be assigned specifically to factors that were not measured. Measurement error and other unexplained variation may contribute. The findings describe different association patterns among the analyzed teachers at public senior high school XY. They do not support statistical generalization to all senior high school teachers in Purwakarta or Indonesia, and the low internal consistency of the outcome scale warrants particular caution.

3.4. Discussion

3.4.1. The Effect of Digital Learning Strategy Management on Teachers' Teaching Performance

The test results show that the management of digital-based learning strategies does not have a significant effect on teachers' teaching performance [22]. This finding differs from studies that emphasize the role of digital leadership in driving teaching innovation [10]. This discrepancy can be explained by the possibility that the impact of managerial strategies is indirect and mediated by the variable of teacher competence [11]. Previous studies have also noted that strategies not operationalized at the classroom level tend to have a weak impact. Thus, managerial dimensions require operational translation to have an impact on teaching practices [23].

3.4.2. The Effect of Digital Tool Utilization on Teacher Teaching Performance

The use of digital tools has a positive and significant effect on teachers' teaching performance, consistent with evidence of the benefits of interactive digital tools [12]. These findings reinforce research on the relationship between the quality of learning systems and academic achievement [24]. Consistent results are also evident in meta-analyses of technology's impact on learning. The effectiveness of these digital tools is supported by infrastructure readiness and platform usability [25]. The consistency of this direction of influence reinforces the argument that the availability of technical resources is a prerequisite for digital-based teaching performance [23].

3.4.3. Simultaneous Effects on Teacher Performance

Simultaneously, both variables have a significant effect, contributing 16.9% to teachers' teaching performance. The magnitude of this contribution indicates that other factors outside the model also determine teaching performance [26]. The theoretical implication is the importance of integrating managerial and technical determinants into a single analytical framework [27]. The practical implication is that schools need to prioritize strengthening digital resources without neglecting the development of teachers' competencies [28]-[30]. The study's limitations include a small sample size and a single-location scope, which limit the generalizability of the findings [8].

3.4.4 Implications and Limitations

Public senior high school XY may use the findings as one input when reviewing support for digital teaching. The association involving X2 suggests examining the availability, functionality, and support of digital resources alongside the management of digital learning strategies. Decisions about training, equipment, or technical assistance require additional evidence about teachers' needs and classroom practice. The study does not establish the effectiveness or priority of a particular intervention.

Several limitations constrain interpretation. The analysis involved 37 teachers from one school, limiting the precision and generalizability of the estimates. The cross-sectional design does not establish temporal order or rule out confounding and reverse associations. All variables were measured through the same teacher questionnaire, creating possible common-method and social desirability biases. Internal consistency was below the stated 0.70 threshold for each scale, particularly Y, which limits confidence in the composite-score interpretation. The X2 items mainly captured resource quality and support, and teaching performance was not assessed independently through classroom observation. The participation status of one teacher in the planned population and respondent demographic characteristics were not documented in the available analytical records.

Future research should first strengthen the operational definitions and evaluate the instruments in an independent sample. It should distinguish resource quality and support from actual technology use, include multiple schools, and justify the sample size for the planned analysis. Classroom observations and other independent indicators could complement teacher self-reports. Longitudinal or intervention designs would provide stronger evidence about temporal relationships or causal effects. Digital competence, organizational support, and professional development may be examined as additional variables when their roles are specified theoretically.

4. CONCLUSION

This study examines the individual and combined relationships between the management of digital learning strategies and the use of digital tools with teachers' instructional performance at public senior high school XY, Purwakarta Regency. The use of digital tools is positively correlated with instructional performance after controlling for strategy management, whereas strategy management does not show a statistically significant relationship after controlling for the use of digital tools. The model with two predictors is statistically significant overall, although this does not imply that the two predictors have significant individual relationships. These findings provide contextual evidence from a single school and do not establish a causal effect. The associations should also be interpreted cautiously because the composite measures, especially teaching performance, showed limited internal consistency. For public senior high school XY, these findings can inform a review of the quality and support of digital resources alongside the management of digital learning strategies. Any school improvement measures should be based on these results, accompanied by evidence of local needs and actual teaching practices. Further research should involve multiple schools, stronger performance measures, and a longitudinal or intervention study design to test whether the observed relationship persists and how it is formed.

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