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PEDAGOGY THROUGH TECHNOLOGY: QUANTITATIVE ANALYSIS OF TEACHERS' DIGITAL LITERACY AND ITS EFFECTS ON CLASSROOM PERFORMANCE

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ABSTRACT

This quantitative study examined the extent of pedagogy through technology and its effects on classroom performance among teachers in selected public elementary schools within the Schools Division Office (SDO) of Cotabato, Philippines. Employing a descriptive-correlational research design, data were gathered from 250 teacher-respondents across the municipalities of Matalam, Kabacan, and M'lang through stratified sampling. Pedagogy through technology was assessed across four dimensions: technology-integrated teaching strategies, digital instructional design, use of interactive digital tools, and technology-supported assessment practices. Classroom performance was evaluated in terms of learner engagement, teaching effectiveness, and classroom management efficiency. Descriptive findings revealed that teachers demonstrated a highly practiced level of pedagogy through technology (overall M = 4.73) and very effective classroom performance (overall M = 4.67). Spearman's rho correlation analyses showed significant positive relationships between technology-integrated teaching strategies and learner engagement ($r = .437$, $p < .001$) and teaching effectiveness ($r = .525$, $p < .001$), and between digital instructional design and learner engagement ($r = .321$, $p < .001$) and teaching effectiveness ($r = .681$, $p < .001$). Multiple regression analyses confirmed that technology-integrated teaching strategies significantly predicted learner engagement ($\beta = 0.326$, $t = 4.809$, $p < .001$, $R^2 = 0.207$), and digital instructional design significantly predicted teaching effectiveness ($\beta = 0.615$, $t = 9.232$, $p < .001$, $R^2 = 0.468$). Classroom management efficiency was not significantly predicted by any pedagogy-through-technology dimension ($R^2 = 0.012$, $p = .578$), suggesting it is influenced primarily by non-technological factors. These findings highlight the need for structured professional development focused on digital instructional design and sustained technology integration to enhance instructional outcomes.

KEYWORDS: *Pedagogy through technology, digital literacy, classroom performance, learner engagement, teaching effectiveness, classroom management, TPACK, Philippines*

1. INTRODUCTION

The rapid advancement of digital technologies has profoundly transformed the educational landscape, compelling teachers to integrate technology meaningfully into their instructional practices. In contemporary learning environments, teachers' digital literacy — encompassing the ability to use digital tools purposefully for lesson planning, content delivery, assessment, and classroom management — has emerged as a critical determinant of instructional quality and classroom outcomes (Redecker, 2017; Hatlevik & Hatlevik, 2018).

While significant investments have been made in educational technology infrastructure across Philippine public schools, evidence suggests that mere access to technology does not guarantee improved teaching and learning outcomes. What matters critically is how effectively teachers integrate digital tools into pedagogy — a capacity that depends on both technical competence and pedagogical understanding (Ertmer & Ottenbreit-Leftwich, 2013). Teachers who possess strong digital literacy are better positioned to adopt learner-centered, technology-enhanced instructional strategies that foster active participation, deeper understanding, and improved classroom performance (Tondeur et al., 2017).

Despite growing recognition of digital literacy's importance, empirical research directly linking specific pedagogy-through-technology dimensions to measurable classroom performance outcomes — particularly within basic education settings in Mindanao, Philippines — remains limited. Most studies have focused either on teachers' access to technology or their general attitudes toward its use, rather than examining how pedagogical technology practices specifically predict learner engagement, teaching effectiveness, and classroom management efficiency (Teo, 2011).

This study fills that gap by systematically quantifying the extent of teachers' pedagogy through technology and examining its correlational and predictive relationships with classroom performance outcomes in selected public elementary schools under the SDO of Cotabato. The findings are intended to generate empirical evidence that can inform teacher professional development, school technology policy, and instructional improvement initiatives in the region.

1.1 Research Questions

This study specifically addressed the following questions:

1. What is the extent of pedagogy through technology in terms of technology-integrated teaching strategies, digital instructional design, use of interactive digital tools, and technology-supported assessment practices?
2. What is the level of classroom performance in terms of learner engagement, teaching effectiveness, and classroom management efficiency?
3. Is there a significant relationship between pedagogy through technology and classroom performance?
4. Is there a significant influence of pedagogy through technology on classroom performance?

1.2 Hypotheses

H_{01}: There is no significant relationship between pedagogy through technology and classroom performance.

H_{02}: Pedagogy through technology does not significantly influence classroom performance.

2. REVIEW OF RELATED LITERATURE

2.1 Pedagogy Through Technology

Pedagogy through technology refers to the deliberate integration of digital tools and resources into teaching to enhance instruction, increase engagement, and improve learning outcomes. Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework provides the theoretical foundation, positing that effective technology integration requires the simultaneous development of technological knowledge, pedagogical knowledge, and content knowledge. Teachers who master TPACK can design digitally enriched lessons that align technology with pedagogical goals.

Technology-integrated teaching strategies promote constructivist learning environments where students actively engage and collaborate (Tondeur et al., 2017). Digital instructional design — the systematic planning of learning experiences using digital tools — improves learning outcomes by reducing cognitive overload and enhancing information retention through strategic multimedia use (Clark & Mayer, 2016). Interactive digital tools such as simulations, gamified platforms, and collaborative applications enhance learner motivation and sustained attention (Schindler et al., 2017; Johnson et al., 2016). Technology-supported assessment practices, including online quizzes and e-portfolios, enable timely feedback and data-informed instruction (Gikandi, Morrow, & Davis, 2011; Redecker & Johannessen, 2013).

2.2 Classroom Performance and Digital Pedagogy

Classroom performance in this study encompasses three dimensions. Learner engagement — behavioral, emotional, and cognitive involvement in learning (Fredricks, Blumenfeld, & Paris, 2004) — is strengthened when technology provides varied, interactive, and personalized learning experiences (Bond et al., 2020; Dixson, 2015). Teaching effectiveness, reflecting a teacher's ability to facilitate learning and achieve instructional goals (Darling-Hammond, Hyler, & Gardner, 2017), is enhanced by digital tools that support lesson clarity, differentiated instruction, and real-time feedback (Stronge, 2018; Hattie, 2009). Classroom management efficiency — the maintenance of an organized, productive learning environment (Emmer & Sabornie, 2015) — can be supported by technology through streamlined lesson organization and behavior monitoring (Dede, 2014), though it also depends substantially on non-technological factors such as discipline strategies and organizational routines.

2.3 Theoretical Framework

The study is grounded in two complementary theoretical frameworks. Mishra and Koehler's (2006) TPACK model explains how the integration of technological, pedagogical, and content knowledge enables teachers to design effective technology-enhanced learning experiences. Shulman's (1986) Pedagogical Content Knowledge (PCK) framework grounds this in the primacy of subject knowledge and teaching strategy alignment. Additionally, Constructivist Learning Theory (Piaget, 1972; Vygotsky, 1978) informs the focus on learner-centered, interactive technology integration that promotes collaboration, problem-solving, and active knowledge construction.

3. METHODOLOGY

3.1 Research Design

This study employed a descriptive-correlational research design (Creswell & Creswell, 2018), appropriate for establishing the levels of and relationships among key variables without experimental manipulation. This design allowed simultaneous assessment of pedagogy through technology and classroom performance, measurement of their correlations using

Spearman's rho, and determination of predictive influence through multiple regression analysis.

3.2 Participants and Sampling

The study population comprised teachers from selected public elementary schools in Matalam, Kabacan, and M'lang under the SDO of Cotabato during School Year 2025–2026 (N = 1,642). Stratified sampling was used to ensure proportional representation across the three municipalities (Singh & Mangat, 2016), yielding a total sample of 250 teacher-respondents: 80 from Matalam, 85 from Kabacan, and 85 from M'lang.

3.3 Research Instrument

Data were collected through an adapted and validated survey questionnaire developed based on Dede (2014), assessing: (1) Pedagogy through Technology (4 dimensions, 5 items each), rated on a 5-point Likert scale (1 = Least Practiced to 5 = Highly Practiced); and (2) Classroom Performance (3 dimensions, 5 items each), rated on a 5-point effectiveness scale (1 = Not Effective to 5 = Very Effective). The instrument underwent expert validation by the study's advisory committee and reliability testing prior to administration.

3.4 Data Analysis

Descriptive statistics (weighted mean) were computed to determine levels of pedagogy through technology and classroom performance. Spearman's rank-order correlation (Cohen, Manion, & Morrison, 2018) was used to test relationships among variables given the ordinal nature of Likert-scale data. Multiple linear regression analysis (Gelman, 2020) was conducted to determine the predictive influence of each pedagogy-through-technology dimension on classroom performance outcomes. Statistical significance was set at $\alpha = .05$, with the 0.01 level noted for highly significant findings.

4. RESULTS AND DISCUSSION

4.1 Extent of Pedagogy Through Technology

Table 1 presents the descriptive statistics for teachers' pedagogy through technology across four dimensions.

Table 1 ***Descriptive Statistics: Extent of Pedagogy Through Technology. (N = 250)***

Dimension	Weighted Mean	Verbal Description
Technology-Integrated Teaching Strategies	4.75	Highly Practiced
Digital Instructional Design	4.69	Highly Practiced
Use of Interactive Digital Tools	4.73	Highly Practiced
Technology-Supported Assessment Practices	4.74	Highly Practiced
Overall	4.73	Highly Practiced

All four dimensions of pedagogy through technology were rated Highly Practiced, with an overall weighted mean of 4.73. Technology-Integrated Teaching Strategies registered the highest mean (M = 4.75), indicating teachers consistently incorporate digital tools and platforms into instructional delivery to support lesson objectives and enhance learner participation. Digital Instructional Design (M = 4.69) reflects strong teacher competence in planning, organizing, and structuring digitally enriched lessons aligned with curriculum standards. Use of Interactive Digital Tools (M = 4.73) shows that teachers frequently deploy collaborative platforms, multimedia tools, and digital engagement resources to foster active participation. Technology-Supported Assessment Practices (M = 4.74) confirms that teachers regularly utilize digital tools for monitoring progress, providing timely feedback, and supporting formative and summative evaluation.

These findings align with Ertmer and Ottenbreit-Leftwich's (2013) observation that teachers with learner-centered pedagogical beliefs are more likely to employ technology for meaningful instructional purposes — including problem-solving, collaboration, and inquiry-based learning — rather than content presentation alone. The consistent high-practice ratings across all dimensions suggest that respondents have moved beyond surface-level technology adoption to meaningful digital pedagogy integration.

4.2 Level of Classroom Performance

Table 2 presents the descriptive statistics for classroom performance across three dimensions.

Table 2 ***Descriptive Statistics: Level of Classroom Performance. (N = 250)***

Dimension	Weighted Mean	Verbal Description
Learner Engagement	4.83	Very Effective
Teaching Effectiveness	4.65	Very Effective
Classroom Management Efficiency	4.53	Very Effective
Overall	4.67	Very Effective

All three classroom performance dimensions were rated Very Effective, with an overall weighted mean of 4.67. Learner Engagement achieved the highest mean (M = 4.83), indicating that technology-enhanced instructional strategies were highly successful in actively involving learners in classroom activities, promoting collaboration, and sustaining attention. Teaching Effectiveness (M = 4.65) reflects teachers' strong mastery of content, clarity in instruction, and ability to facilitate meaningful learning through technology-integrated approaches. Classroom Management Efficiency (M = 4.53), while still rated Very Effective, recorded the lowest mean, suggesting that while technology supports lesson organization and monitoring, classroom management effectiveness depends on additional non-technological competencies.

These results support Schindler et al.'s (2017) finding that technology-based learning environments — incorporating simulations, online quizzes, and multimedia presentations — promote active learner participation and sustained attention. The high teaching effectiveness scores are consistent with Stronge's (2018) observation that teachers who use digital tools strategically improve lesson clarity, engagement, and overall learning outcomes.

4.3 Relationships Between Pedagogy Through Technology and Classroom Performance

Table 3 presents the Spearman's rho correlation matrix.

Table 3 ***Spearman's Rho Correlation Matrix: Pedagogy Through Technology and Classroom Performance. (N = 250)***

Pedagogy Through Technology	Learner Engagement	Teaching Effectiveness	Classroom Mgt. Efficiency
Tech.-Integrated Teaching Strategies	0.437**	0.525**	0.016 (ns)
Digital Instructional Design	0.321**	0.681**	-0.028 (ns)
Use of Interactive Digital Tools	-0.074 (ns)	-0.010 (ns)	0.007 (ns)
Tech.-Supported Assessment Practices	-0.036 (ns)	-0.032 (ns)	-0.023 (ns)

*Note. **Correlation is significant at the 0.01 level. ns = not significant.*

Technology-Integrated Teaching Strategies showed moderate positive correlations with both Learner Engagement ($r = .437$, $p < .001$) and Teaching Effectiveness ($r = .525$, $p < .001$), indicating that teachers who more frequently integrate technology into instructional delivery tend to achieve higher levels of student participation and instructional quality. Digital

Instructional Design showed a low positive correlation with Learner Engagement ($r = .321$, $p < .001$) and a strong positive correlation with Teaching Effectiveness ($r = .681$, $p < .001$) — the strongest bivariate relationship in the study — suggesting that systematic digital lesson planning has a particularly powerful impact on instructional delivery quality.

Notably, Use of Interactive Digital Tools and Technology-Supported Assessment Practices showed no statistically significant correlations with any classroom performance dimension. This pattern suggests that not all technology practices carry equal pedagogical weight: the quality and purposefulness of technology integration — as captured in strategy integration and instructional design — matter more than the frequency of tool use or assessment platform adoption per se. Furthermore, Classroom Management Efficiency showed no significant correlation with any technology dimension, indicating it is governed primarily by non-technological competencies such as behavioral management, organizational routines, and disciplinary practices.

4.4 Predictive Influence of Pedagogy Through Technology on Classroom Performance

Table 4 ***Regression Analysis: Predictors of Learner Engagement. (N = 250)***

Predictor	β Coefficient	Std. Error	t-value	p-value
(Constant)	3.338	0.339	9.842	.000
Tech.-Integrated Teaching Strat.	0.326	0.068	4.809	.000**
Digital Instructional Design	0.052	0.067	0.776	.439
Use of Interactive Digital Tools	-0.068	0.076	-0.893	.373
Tech.-Supported Assess. Practices	0.003	0.076	0.043	.966

Note. $R^2 = 0.207$; $F = 16.089$; $p = .000$ *(Significant at 1% level).*

Technology-integrated teaching strategies was the sole significant predictor of learner engagement ($\beta = 0.326$, $t = 4.809$, $p < .001$). The overall model was highly significant ($F = 16.089$, $p < .001$), with pedagogy through technology explaining 20.7% of the variance in learner engagement. This confirms that when teachers purposefully embed technology in their instructional strategies — through digital presentations, interactive platforms, and collaborative activities — learners demonstrate higher levels of active participation and sustained attention. The remaining 79.3% of variance is attributable to other factors beyond the scope of this study, including learner characteristics, subject matter, and classroom relationships.

Table 5 ***Regression Analysis: Predictors of Teaching Effectiveness. (N = 250)***

Predictor	β Coefficient	Std. Error	t-value	p-value
(Constant)	1.336	0.335	3.988	.000
Tech.-Integrated Teaching Strat.	0.074	0.067	1.105	.270
Digital Instructional Design	0.615	0.067	9.232	.000**
Use of Interactive Digital Tools	0.009	0.075	0.122	.903
Tech.-Supported Assess. Practices	0.008	0.075	0.102	.919

Note. $R^2 = 0.468$; $F = 54.041$; $p = .000$ *(Significant at 1% level).*

Digital instructional design was the strongest and sole significant predictor of teaching effectiveness (β = 0.615, t = 9.232, p < .001). The model explained 46.8% of the variance in teaching effectiveness (F = 54.041, p < .001) — the highest explanatory power among all regression models. This finding underscores that systematic digital lesson planning, aligned with curriculum objectives and learner needs, is the most powerful leverage point for improving instructional quality. Well-designed digital lessons allow teachers to integrate multimedia, manage instructional flow, and engage learners coherently, leading to measurably improved teaching effectiveness.

Table 6 ***Regression Analysis: Predictors of Classroom Management Efficiency. (N = 250)***

Predictor	β Coefficient	Std. Error	t-value	p-value
(Constant)	4.892	0.379	12.896	.000
Tech.-Integrated Teaching Strat.	0.067	0.076	0.886	.377
Digital Instructional Design	-0.107	0.075	-1.417	.158
Use of Interactive Digital Tools	0.038	0.085	0.452	.652
Tech.-Supported Assess. Practices	-0.076	0.085	-0.896	.371

Note. $R^2 = 0.012$; $F = 0.721$; $p = .578$ *(Not Significant).*

The pedagogy-through-technology model did not significantly predict classroom management efficiency ($R^2 = 0.012$, F = 0.721, p = .578). No individual predictor reached statistical significance. This finding, while counterintuitive given the otherwise strong pedagogy-performance relationships, is theoretically coherent: effective classroom management depends primarily on non-digital competencies — behavioral management strategies, organizational routines, clear expectations, and teacher-learner relationships — that operate independently of technology integration. Dede (2014) notes that while digital tools can help organize lessons and track assignments, the interpersonal and behavioral dimensions of classroom management require human pedagogical judgment that technology alone cannot substitute.

5. DISCUSSION

This study yields three principal findings with important theoretical and practical implications.

First, teachers in the SDO of Cotabato demonstrate consistently high levels of pedagogy through technology and very effective classroom performance. This suggests that technology integration in these schools has advanced beyond early adoption challenges toward mature pedagogical application. The high means across all dimensions indicate a teaching workforce that has substantially developed digital literacy and is applying it across instructional planning, delivery, engagement, and assessment.

Second, the differential correlation pattern — strong for digital instructional design and teaching effectiveness ($r = .681$), moderate for technology-integrated strategies and engagement ($r = .437$), and absent for interactive tools and assessment practices — reveals that not all technology practices carry equal pedagogical weight. These findings extend Mishra and Koehler's (2006) TPACK framework empirically: it is specifically the design and strategy dimensions of technology use — those most closely aligned with the intersection of pedagogical and technological knowledge — that produce measurable classroom performance gains. Tool availability and assessment platform use, without the undergirding pedagogical planning, do not independently improve outcomes.

Third, the non-significant prediction of classroom management efficiency by any technology dimension adds important nuance to digital pedagogy research. While technology can streamline lesson organization and monitoring, it does not replace the relational, behavioral, and organizational competencies that constitute effective classroom management. Schools and administrators must recognize that technology-focused professional development is insufficient alone; complementary investment in classroom management skills development is equally necessary.

6. CONCLUSION

This study establishes that teachers in selected public elementary schools under the SDO of Cotabato demonstrate high levels of pedagogy through technology and very effective classroom performance. Technology-integrated teaching strategies and digital instructional design are significant predictors of learner engagement and teaching effectiveness, respectively, with digital instructional design explaining nearly half the variance in teaching effectiveness — the highest explanatory power in the study. Classroom management efficiency, however, is not significantly predicted by any technology-related pedagogy dimension, indicating its dependence on non-technological competencies.

These findings carry direct implications for professional development priorities. Investment in digital instructional design — teaching teachers to plan, structure, and sequence technology-enhanced lessons systematically — yields the greatest returns in instructional quality. Technology-integrated strategy development strengthens learner engagement. Classroom management must be addressed through dedicated, non-technology-focused professional learning. Future research should longitudinally examine whether improvements in digital instructional design competency produce sustained teaching effectiveness gains, and should expand the scope to include learner academic achievement as an outcome variable.

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