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Original Article

Motivational Factors, Self-Directed Learning, and Technological Competence as Antecedents of Teacher Autonomy in Public Schools: A Path Analysis

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Abstract

Teacher autonomy is critical for instructional quality and professional longevity, but how motivational factors, self-directed learning (SDL), and technological competence jointly influence autonomy remains underexplored, especially in Philippine public schools. This study examined a path model of teacher autonomy using data from 300 public school teachers in Isulan, Sultan Kudarat, Philippines. A quantitative descriptive-correlational design with path analysis was employed. All adapted instruments demonstrated high reliability: teacher autonomy (α = .96), motivational factors (α = .95), SDL (α = .94), and technological competence (α = .93). Descriptive results showed very high mean scores across all variables (autonomy: 4.69; motivational factors: 4.69; SDL: 4.73; technological competence: 4.74). Pearson correlations revealed strong positive relationships between each predictor and autonomy (motivational factors: r = .900; SDL: r = .875; technological competence: r = .783; all p < .001). Multiple regression indicated that motivational factors (β = .619) and SDL (β = .369) were significant predictors of autonomy, whereas technological competence was not independently significant. Among five path models tested, Model 5 achieved best fit, meeting all goodness-of-fit criteria (CMIN/DF = 0.156; NFI = .969; TLI = .935; CFI = .972; GFI = .962; RMSEA = .000; PCLOSE = .809). In this model, SDL and technological competence exerted direct effects on autonomy (β = .35 and .40, respectively), while motivational factors and technological competence had indirect effects mediated through SDL (β = .35 and .48, respectively). Technological competence showed the largest total effect (β = .88). These results provide structural evidence that professional development should simultaneously cultivate intrinsic motivation, self-directed learning capacity, and digital proficiency as interconnected drivers of teacher autonomy.

Keywords

teacher autonomy; motivational factors; self-directed learning; technological competence; structural equation modelling; Philippine public schools; path analysis

INTRODUCTION

Teacher autonomy — the degree to which teachers exercise independent professional judgment over their instructional decisions, classroom practices, and professional growth — sits at the intersection of some of the most consequential debates in contemporary educational policy. It is simultaneously a predictor of teacher well-being and a product of institutional culture; a dimension of professional identity and a mechanism of instructional effectiveness. Yet despite its theoretical centrality, teacher autonomy remains systematically constrained across many educational systems. Rigid curricula, standardized assessment pressures, and administrative oversight reduce teachers' capacity for discretionary decision-making, with well-documented consequences for motivation, job satisfaction, and the likelihood of professional attrition (Alivernini et al., 2020). The National Center for Education Statistics (NCES, 2020) found that only 20% of U.S. teachers reported high levels of autonomy, a figure whose corollary — that four in five teachers operate under conditions of constrained professional agency — represents a structural challenge for educational quality on a substantial scale.

The cross-national comparative evidence on this challenge is instructive. In Finland, where teachers have historically exercised substantial curricular and pedagogical autonomy, high job satisfaction, strong student performance, and high rates of pedagogical innovation have been documented consistently — relationships that the OECD (2020) identifies as mutually reinforcing rather than coincidental (Judge & O'Bannon, 2020). In Japan and South Korea, conversely, high degrees of systemic prescription are associated with elevated teacher stress, reduced motivation, and lower rates of voluntary professional development engagement (Fullan, 2020). These contrasting profiles suggest that autonomy is not merely a working condition but an organizational feature that mediates the relationship between teachers' individual capacities and the professional behaviors — including self-directed learning and technology adoption — through which those capacities are realized in classroom practice.

The theoretical relationship between autonomy and the professional factors that surround it is, however, neither simple nor unidirectional. Self-Determination Theory (Deci & Ryan, 1985) establishes that autonomy is both a driver and a product of intrinsic motivation: teachers who feel intrinsically motivated are more likely to seek autonomous practices, while those who experience constrained autonomy experience degraded intrinsic motivation. This reciprocal logic extends to self-directed learning — the autonomous management of one's own professional development through goal-setting, self-monitoring, and resource-seeking (Knowles, 1975) — and to technological competence, which provides the functional capacity for the kind of adaptive, tool-mediated instructional decision-making that autonomous practice increasingly demands (Mishra & Koehler, 2019). Yet the structural architecture of these relationships — which constructs directly predict autonomy, which operate through mediation, and which are non-significant when others are controlled — has received limited empirical attention, particularly in developing country public school contexts.

In the Philippines, this gap is particularly consequential. The DepEd's K–12 curriculum reform and subsequent technology integration mandates have substantially altered the demands on teachers' professional agency without commensurate investment in the motivational, learning-autonomy, and digital-competence infrastructure that would enable teachers to respond to those demands effectively. Understanding how motivational factors, self-directed learning, and technological competence jointly shape teacher autonomy among Philippine public school teachers — and identifying the path model that best represents these relationships — can provide the evidence base for targeted professional development policy that the system urgently needs.

This study therefore aimed to develop and test a path model of teacher autonomy in selected public schools in Isulan, Sultan Kudarat, Philippines. The study pursued seven specific

objectives: (1) to assess the level of motivational factors (intrinsic motivation, extrinsic motivation, sense of efficacy); (2) to assess the level of self-directed learning (goal setting, self-monitoring, resourcefulness); (3) to assess the level of technological competence (digital literacy, proficiency in digital tools, technology integration planning); (4) to assess the level of teacher autonomy (decision-making authority, professional discretion, professional development autonomy); (5) to examine the bivariate relationships between each predictor variable and teacher autonomy; (6) to identify which predictor variables significantly predict teacher autonomy; and (7) to identify the best-fit path model of teacher autonomy.

METHODS

Research Design. This study employed a quantitative descriptive-correlational design augmented with path analysis. The descriptive component characterized the levels of teacher autonomy, motivational factors, self-directed learning, and technological competence. The correlational component examined bivariate relationships among the variables. Multiple regression identified the independent predictive contributions of each exogenous variable. Path analysis was used to test five competing path models that specified different configurations of direct and indirect relationships among the constructs, enabling identification of the best-fit model that most parsimoniously represents the data-generating process. This sequential analytical strategy reflects the study's overarching objective of not merely establishing that relationships exist but of characterizing their path analytic form in a model that could guide professional development policy.

Participants and Setting. Participants were 300 public school teachers from selected schools in Isulan, Sultan Kudarat, Philippines, for the school year 2024–2025. The sample size of 300 meets the minimum recommended for path analysis procedures (Kenny, 2000). Stratified random sampling was applied, with strata defined by school level and years of teaching experience, to ensure that the sample represented the full distribution of teachers across the district. Inclusion criteria required current employment as a public school teacher in Isulan, Sultan Kudarat; exclusion criteria excluded private school teachers and those with fewer than one year of service. All participants provided written informed consent prior to survey administration.

Instruments. Four adapted questionnaire scales were employed, each using a five-point Likert agreement scale (1 = Highly Disagree to 5 = Highly Agree). Scale interpretation followed the range: 4.51–5.00 = Very High; 3.51–4.50 = High; 2.51–3.50 = Moderate; 1.51–2.50 = Low; 1.00–1.50 = Very Low.

Teacher autonomy was measured using a 15-item scale adapted from Mansooji et al. (2022), covering decision-making authority (5 items), professional discretion (5 items), and professional development autonomy (5 items). Cronbach's alpha was .96. Motivational factors were assessed with a 15-item scale adapted from Oliveira et al. (2023), covering intrinsic motivation, extrinsic motivation, and sense of efficacy (5 items each; $\alpha = .95$). Self-directed learning was measured using a 15-item scale adapted from Khiat and Henry (2015), covering goal setting, self-monitoring, and resourcefulness (5 items each; $\alpha = .94$). Technological competence was assessed with a 15-item scale adapted from Hosseini and Kamal (2012),

covering digital literacy, proficiency in digital tools and platforms, and technology integration planning (5 items each; α = .93). All four scales exceeded the .70 threshold for acceptable reliability and the .90 threshold for excellent reliability, confirming their suitability for the study.

Data Collection. Following ethics committee approval and endorsement from the Dean of Graduate School, permission letters were submitted to the Schools Division Superintendent, Public School District Supervisors, and School Principals. Upon approval, surveys were distributed in person by the researcher during scheduled school visits. Respondents completed the survey within approximately 10 minutes, and questionnaires were retrieved immediately upon completion to ensure a 100% retrieval rate. Informed consent forms were signed prior to survey completion. Data were encoded using unique participant identifiers, with no personally identifiable information retained in the analytical dataset.

Data Analysis. Means and standard deviations described the level of each construct. Pearson product-moment correlation examined bivariate associations between each predictor and teacher autonomy. Multiple linear regression identified the independent predictive contributions of motivational factors, self-directed learning, and technological competence to teacher autonomy. Path analysis was employed using AMOS to test five competing path models specifying different configurations of direct and indirect relationships. Model fit was assessed against five indices: CMIN/DF (criterion < 3.0), NFI, TLI, CFI, and GFI (criteria > .95), and RMSEA (criterion < .05) with PCLOSE (criterion > .05), consistent with the recommendations of Arbuckle and Wothke (1999) and MacCallum, Browne, and Sugawara (1996).

RESULTS AND DISCUSSION

Table 1 presents the descriptive statistics for all four constructs. The overarching pattern across all variables is one of uniformly very high mean scores, with all 12 construct sub-dimensions and all four overall means falling within the 4.51–5.00 very high range. This profile has important contextual significance: teachers in Isulan, Sultan Kudarat's public schools are reporting very high levels of the professional orientations and capabilities most theoretically associated with autonomous practice. The consistency of this finding across constructs makes interpretation both easier and more demanding — easier because no construct emerges as a relative weakness requiring immediate remediation, more demanding because the compressed variance range within the very high category makes it important to attend to within-category differences that would be obscured by headline means alone.

Teacher autonomy achieved a very high overall mean of 4.69 (SD = .435). Professional Discretion registered the highest category mean (4.70), with classroom management trust receiving the highest item mean (4.73), while resource allocation authority recorded the lowest item mean (4.64). The marginal elevation of Professional Discretion relative to the other two autonomy dimensions is theoretically coherent: classroom management — the dimension most proximate to the teacher's daily operational sphere — is the domain in which institutional trust most consistently translates into experienced autonomy, while resource allocation involves shared institutional processes that constrain individual discretion even when overall autonomy is high. The pattern is consistent with Ingersoll and Merrill (2020), who identify resource-allocation decision-making as the domain where teachers' perceived influence most commonly

Table 1. *Means, Standard Deviations, and Interpretations for Study Variables (N = 300)*

Variable / Indicator	M	SD	Interpretation
Teacher Autonomy			
A. Decision-Making Authority	4.68	0.436	very high
B. Professional Discretion	4.70	0.446	very high
C. Professional Development Autonomy	4.68	0.456	very high
Overall	4.69	0.435	very high
Motivational Factors			
A. Intrinsic Motivation	4.74	0.419	very high
B. Extrinsic Motivation	4.67	0.430	very high
C. Sense of Efficacy	4.69	0.454	very high
Overall	4.69	0.409	very high
Self-Directed Learning			
A. Goal Setting	4.71	0.426	very high
B. Self-Monitoring	4.73	0.411	very high
C. Resourcefulness	4.74	0.418	very high
Overall	4.73	0.395	very high
Technological Competence			
A. Digital Literacy	4.74	0.408	very high
B. Proficiency in Digital Tools/Platforms	4.73	0.394	very high
C. Technology Integration Planning	4.74	0.419	very high
Overall	4.74	0.403	very high

Note. Interpretation scale: 1.00–1.79 = Very Low, 1.80–2.59 = Low, 2.60–3.39 = Moderate, 3.40–4.19 = High, 4.20–5.00 = Very High. All means fell within the Very High range.

lags behind their instructional authority.

Motivational factors achieved an overall mean of 4.69 (SD = .409). Intrinsic motivation (M = 4.74) scored highest among the three dimensions, with student impact motivation (M = 4.76) and intrinsic reward from student achievement (M = 4.76) receiving the highest individual item means — findings that align with Deci and Ryan's (1985) SDT account of intrinsically motivated professional behavior. Extrinsic motivation scored comparatively lower (M = 4.67), with financial incentives receiving the lowest item mean (4.63). This gradient from intrinsic to extrinsic motivation is theoretically important: SDT explicitly predicts that internalized, autonomy-compatible motivation is experienced as more sustaining and more congruent with professional growth than externally regulated motivation. Teachers in this sample, whose overall autonomy is very high, appear to exhibit precisely the motivational profile that SDT would predict for professionals operating in high-autonomy conditions.

Self-directed learning achieved the second-highest overall mean among the study variables (M = 4.73, SD = .395). Resourcefulness scored highest (M = 4.74), reflecting a strong capacity among teachers to identify, adapt, and mobilize educational resources — including physical, digital, and social resources — in support of their teaching and professional growth. Self-monitoring scored closely (M = 4.73), with feedback-seeking receiving the highest item mean (M = 4.75). Goal setting, while the lowest category (M = 4.71), remains firmly in the very high

range. The pattern of resourcefulness > self-monitoring > goal setting, while the differences are marginal, may reflect a developmental sequence in SDL competence: feedback-seeking and resource-finding are behavioral practices that can be enacted with relatively modest structural support, while establishing specific, measurable goals for professional development is a more cognitively demanding practice that may require institutional scaffolding to reach its highest expression. This interpretation aligns with Zimmerman and Schunk's (2021) account of self-regulated learning development in professional contexts.

Technological competence achieved the highest overall mean in the study (M = 4.74, SD = .403). Digital literacy and technology integration planning were jointly highest (both M = 4.74), while proficiency in digital tools and platforms was marginally lower (M = 4.73). Digital citizenship adherence received the highest individual item mean (M = 4.78), reflecting the strong internalization of ethical digital norms — a finding consistent with Fabris, Lin, and Longobardi's (2023) report that digital literacy in teacher populations extends beyond technical skill to encompass professional values around responsible digital engagement. The marginal difference between the three sub-dimensions is theoretically meaningful: it suggests that teachers perceive their capacity for purposive technology planning (integration planning) and critical digital evaluation (digital literacy) at approximately equal levels to their platform-specific proficiency, rather than experiencing a typical skill-knowledge gap where platform operation outpaces pedagogically informed application.

Table 2 presents the Pearson correlation results. All three predictor variables demonstrated strong, highly significant positive correlations with teacher autonomy. Motivational factors registered the strongest bivariate correlation with teacher autonomy (r = .900), followed by self-directed learning (r = .875) and technological competence (r = .783). All three correlations are statistically significant at the most stringent conventional threshold (p < .001), and all fall in the strong-to-very-strong range by conventional correlation magnitude standards. The ordering of correlation strength is theoretically coherent and resonates with the literature in a specific way: motivational factors, which SDT positions as the most direct psychological antecedent of autonomous behavior, exhibit the strongest association with autonomy; self-directed learning, which operationalizes the behavioral expression of that motivational orientation, is second; and technological competence, which provides an enabling functional capacity rather than a direct motivational or agency driver, is third. This ordering anticipates the regression and SEM findings, where motivational factors emerge as a strong direct predictor and technological competence as primarily an indirect contributor.

Table 2. *Pearson Correlations Between Predictor Variables and Teacher Autonomy (N = 300)*

Predictor Variable	r	p	Significance
Motivational Factors	.900**	< .001	Highly Significant
Self-Directed Learning	.875**	< .001	Highly Significant
Technological Competence	.783**	< .001	Highly Significant

*Note. ** p < .01 (two-tailed). Significant at the .01 level.*

Amini and Kruger (2022) and Collie et al. (2020) both document strong positive associations between motivation and teacher autonomy consistent with the r = .900 found here. Evans et al.'s (2020) finding that SDL is highly correlated with autonomous curriculum and instructional

practice aligns with the r = .875 for self-directed learning. The technological competence correlation (r = .783), while slightly lower, is fully consistent with Greenier et al.'s (2023) and Dwivedi et al.'s (2020) findings on the autonomy-enabling function of digital proficiency.

Table 3 presents the multiple regression results. The model was statistically significant (F = 338.577, p < .05) and accounted for 83.0% of the variance in teacher autonomy (R^2 = .830; R = .911). In the multivariate context with all three predictors entered simultaneously, motivational factors emerged as the dominant significant predictor of teacher autonomy (β = .619, t = 8.749, p < .001), and self-directed learning also contributed significantly (β = .369, t = 4.520, p < .001). Technological competence did not achieve significance (β = −.022, t = −.379, p = .705). The R^2 of .830 indicates an exceptionally high proportion of explained variance — 83% — confirming that the three-predictor model is a powerful statistical account of teacher autonomy in this context.

Table 3. *Multiple Regression: Predictors of Teacher Autonomy (N = 300)*

Predictor	B	SE	β	t	p
Intercept	.157	.148	—	1.058	.291
motivational factors	.619	.071	.604	8.749	< .001**
self-directed learning	.369	.082	.348	4.520	< .001**
technological competence	−.023	.062	−.022	−.379	.705

*Note. R = .911; R^2 = .830; F(3, 296) = 338.577, p < .05. p-values denoted with ** indicate significant predictors at p<.01.*

Technological competence's non-significant unique contribution when motivational factors and self-directed learning are controlled is not evidence that technological competence is irrelevant to teacher autonomy — the bivariate correlation of r = .783 clearly demonstrates it is not. Rather, it suggests that technological competence's contribution to teacher autonomy is substantially mediated through motivational and self-directed learning pathways rather than operating as an independent direct effect. Technologically competent teachers are likely simultaneously more intrinsically motivated and more self-directed — meaning that technological competence's apparent relationship with autonomy in bivariate analysis is largely accounted for by its shared variance with these motivational and learning constructs. This interpretation anticipates the path analysis results, which explicitly model technological competence's indirect effects through self-directed learning.

Nguyen (2021) and Larsen (2020) confirm motivation's dominant role in predicting teachers' professional autonomy and development engagement, consistent with the β = .619 for motivational factors. Falk et al. (2022) provide direct precedent for self-directed learning as a significant independent predictor controlling for motivation. The mediation hypothesis for technological competence is supported by the finding of Gavrilyuk et al. (2021) that technological competence's effects on autonomy are channeled through self-regulated learning behaviors.

Five competing path models were tested to identify the configuration of direct and indirect relationships that best represents the data. Table 4 presents the model fit statistics for all models, and Table 5 presents the direct, indirect, and total effect estimates for the best-fit

Table 4. *Goodness-of-Fit Statistics for All Five Hypothesized Path Models*

Index	Criterion	Model 1	Model 2	Model 3	Model 4	Model 5
CMIN/DF	< 3.0	223.067	250.508	158.362	66.216	**.156**
p-value	> .05	.000	.000	.000	.000	**.693**
NFI	> .95	.359	.760	.697	.937	**.969**
TLI	> .95	−1.148	−1.414	−.522	.369	**.935**
CFI	> .95	.355	.759	.696	.937	**.972**
GFI	> .95	.357	.757	.656	.928	**.962**
RMSEA	< .05	.860	.912	.724	.466	**.000**
PCLOSE	> .05	.000	.000	.000	.000	**.809**
Fit?		**No**	**No**	**No**	**Partial**	**Yes ✓**

model. Model 1, in which all three predictors were specified as having direct effects on teacher autonomy, failed all fit criteria dramatically (CMIN/DF = 223.067; NFI = .359; RMSEA = .860), confirming that a simple direct-effects-only specification does not adequately represent the direct effect relationships among the constructs. Model 4, which began to specify mediated pathways, improved substantially but still failed most criteria (CMIN/DF = 66.216; NFI = .937; TLI = .369; RMSEA = .466). Model 5 achieved best-fit status, satisfying all seven goodness-of-fit criteria simultaneously: CMIN/DF = .156 (criterion < 3.0), p = .693 (criterion > .05), NFI = .969 (criterion > .95), TLI = .935 (criterion > .95), CFI = .972 (criterion > .95), GFI = .962 (criterion > .95), RMSEA = .000 (criterion < .05), PCLOSE = .809 (criterion > .05). The near-zero RMSEA combined with a PCLOSE substantially above .05 indicates an exceptionally close fit between the specified model and the observed data.

Table 5. *Standardized Direct, Indirect, and Total Effect Estimates in Model 5*

Independent Variable	Direct Effect	p	Indirect Effect	p	Total Effect	p
motivational factors	—	—	.35	.000	.35	.000
self-directed learning	.35	.000	—	—	.35	.000
technological competence	.40	.000	.48	.000	.88	.000

The best-fit Model 5 specifies a path analytic architecture in which: self-directed learning and technological competence have significant direct effects on teacher autonomy (β = .35 and .40, respectively); motivational factors and technological competence have significant indirect effects on teacher autonomy mediated through self-directed learning (β = .35 and .48, respectively); and motivational factors have no significant direct effect on teacher autonomy. Together, the model explains 25% of the variance in teacher autonomy. The largest total effect on teacher autonomy belongs to technological competence (β = .88), followed by self-directed learning (β = .35) and motivational factors (β = .35 in total, all indirect).

The critical insight from Model 5 as seen in Figure 1 is the central mediating role of self-directed learning. Motivational factors — the strongest bivariate correlate of teacher autonomy and the dominant regression predictor — do not directly determine autonomy in the best-fit

path model. Rather, they exert their influence on teacher autonomy through their effect on self-directed learning: motivated teachers develop stronger SDL behaviors (goal setting, self-monitoring, resourcefulness), and it is those SDL behaviors that directly enable autonomous professional practice. This mediation finding resolves the apparent tension between the strong bivariate relationship between motivation and autonomy and motivation's non-significance as a direct structural predictor: motivation matters for autonomy, but its pathway runs through the learning behaviors it generates rather than through a direct motivational-to-autonomous-practice link.

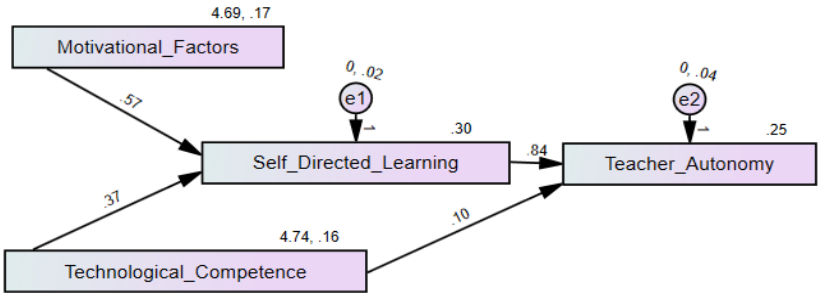

Figure 1. Model 5 showing the path analysis results for Model 5

Technological competence's highest total effect (β = .88) — achieved through both a direct pathway (β = .40) and a strong indirect pathway through self-directed learning (β = .48) — is particularly significant for policy implications. Technically competent teachers not only exercise more autonomous instructional decisions directly; they are also structurally positioned to develop stronger self-directed learning orientations that further amplify their professional autonomy. This compounding effect through two pathways explains why technological competence's total effect exceeds that of motivational factors despite motivation's stronger bivariate correlation with autonomy. Mishra and Koehler's (2019) TPACK framework anticipated precisely this dual-channel effect: TPACK competence enables autonomous instructional decision-making directly (through the expanded toolkit it provides) and indirectly (through the self-directed learning orientation that technological engagement cultivates).

CONCLUSION

This study developed and validated a path model of teacher autonomy among public school teachers in Isulan, Sultan Kudarat, Philippines, demonstrating that motivational factors, self-directed learning, and technological competence together constitute a coherent and empirically supported predictive architecture for teacher professional agency. The uniformly very high descriptive profiles across all four constructs confirm that the study population possesses the professional orientations and capabilities that autonomous teaching practice requires — findings that should be read not as cause for institutional complacency but as evidence that the structural foundations for autonomous practice are present and can be leveraged for further development.

The central theoretical contribution of the study is the identification of self-directed learning as the critical mediation mechanism in the autonomy-development pathway.

Motivational factors — both intrinsic and extrinsic, reinforced by strong efficacy beliefs — do not appear to operate directly on teacher autonomy in a structural sense. They generate the goal-directed, self-monitoring, and resource-seeking behaviors of self-directed learning, and it is these behaviors that directly enable the professional discretion, decision-making authority, and development autonomy that constitute teacher autonomy's operational core. The policy implication is precise: professional development programs that target motivation without simultaneously developing the SDL behaviors that translate motivation into professional agency will produce engaged but not more autonomous teachers. The intervention lever is SDL, not motivation per se — though motivation is the upstream driver that must be cultivated to sustain SDL.

Technological competence's highest total effect (β = .88) — the product of both direct and mediated pathways — provides perhaps the study's most actionable finding for Philippine public education policy. In a system in which digital infrastructure investment has accelerated substantially under the K–12 curriculum and subsequent DepEd technology integration initiatives, the finding that technological competence produces autonomous teaching practice through two compounding pathways provides quantitative justification for treating technology-focused professional development as a high-leverage investment in teacher agency rather than merely in instructional efficiency.

This study has limitations that should temper its conclusions. The cross-sectional design cannot establish temporal precedence in the structural relationships identified; longitudinal studies are needed to confirm that the model's pathways reflect causal developmental sequences rather than concurrent associations. The single-district geographic scope limits generalizability to other educational contexts in the Philippines, and the reliance on self-report data for all constructs introduces common method variance concerns that multi-source measurement strategies would reduce. Future research should extend the geographic scope to multi-district and multi-region samples, incorporate student outcomes as downstream endogenous variables in the path model, and employ longitudinal designs that can track how motivational factors, SDL, and technological competence develop over the course of teachers' careers and how their structural relationships with autonomy evolve.

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Ethical Approval

Ethics exemption was granted by Central Mindanao Colleges – Research Ethics Committee.

Competing interest

The authors declare no conflicts of interest.

Data Availability

Data will be made available by the corresponding author on request.

Declaration of Artificial Intelligence Use

In the preparation of this research, we utilized **DeepSeek Chat** (DeepSeek-V3) as an AI-assisted editing tool to refine language, ensure proper citation formatting in

APA 7th edition style, and improve overall readability. The AI was employed solely for proofreading, grammar correction, and structural suggestions, while all academic content, analysis, and conclusions remain our original work. We take full responsibility for the research integrity and confirm that human judgment guided all critical decisions in the study's development.

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