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Modeling and Optimization of Teacher Innovativeness in Mathematics Instruction: A Study on Permanent Teachers at Private Vocational School Foundations in West Jakarta Using the POP SDM Method

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Abstract
This study aims to model and enhance the innovative capabilities of permanent mathematics teachers within private vocational schools under foundations in West Jakarta. Data was collected from 186 educators and analyzed using Partial Least Squares Structural Equation Modeling (PLS SEM), with the POP SDM method applied for diagnostic optimization. The findings reveal that digital literacy is te strongest predictor, with a significant and substantial direct impact on teacher innovativeness ($\beta = 0.965$, $p < 0.002$). Transformational leadership also has a positive influence, although it is not as strong ($\beta = 0.088$, $p < 0.05$). An important finding from the analysis is the mediating role of Perceived Organizational Support (POS), which greatly amplifies the impact of both digital literacy (indirect effect = 0.178) and transformational leadership (indirect effect = 1.527). On the other hand, organizational culture does not have a significant direct effect ($\beta = 0.011$, $p > 0.05$). Through the POP SDM diagnostic, technology access and specialized training were identified as the primary catalysts for innovation in math instruction. These findings align with the Resource Based View theory, affirming digital competence as a vital strategic resource. The study culminates in a proposed optimization model advocating for a three pronged strategy: (1) implementing tailored technology training programs for mathematics teachers, (2) enhancing transformational leadership competencies among school leaders, and (3) strengthening organizational support systems with a focus on digital literacy. This research emphasized the need for a multifaceted approach is essential to advancing pedagogical innovation in vocational mathematics education, with technological empowerment and leadership development as key drivers for meaningful change.

Keywords: teacher innovativeness; mathematics instruction; digital literacy; POP SDM method; vocational school teachers; perceived organizational support (pos), pls sem analysis; pedagogical innovation

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INTRODUCTION

The global education landscape is currently experiencing a significant transformation due to the Fourth Industrial Revolution and the rapid advancement of digitalization. This shift is particularly significance for vocational education, as it plays a crucial role in preparing a skilled workforce that can meet the ever-changing demands of modern industries (World Bank, 2021). Within the Indonesian context, particularly in urban centers like West Jakarta, private Vocational High Schools (SMKs) under various foundations are facing a pressing challenge: the urgent need to modernize their pedagogical approaches and curricula in order to stay relevant and effective.

Preliminary observations and empirical evidence indicate significant challenges within this ecosystem. A considerable proportion of educators in these institutions demonstrate limited proficiency in integrating digital tools into their teaching methodologies, particularly in specialized subjects like mathematics (Jakarta Provincial Education Office, 2023). This technological gap is compounded by a parallel deficiency in

systematic institutional support mechanisms for fostering innovation, creating a substantial barrier to educational quality enhancement (Li et al., 2022). Furthemore, the convergence of these pedagogical and systemic obstacles necessitates a comprehensive investigation into the drivers of teacher innovativeness, specifically within the context of mathematics instruction, which is fundamental to vocational competencies.

This research addresses several critical gaps in the existing literature. Firstly, there is a lack of empirical studies focusing specifically on the unique socio organizational dynamics of private vocational school foundations. These institutions operate under distinct constraints and opportunities compared to public institutions (Liu et al., 2023). Secondly, existing research often takes a fragmented perspective and fails to capture the synergistic interplay between individual technological proficiency, leadership influences, and organizational support structures in shaping innovative teaching practices (Huang & Jiang, 2023). Finally, there is a persistent theory-practice divide exists, where academic findings rarely translate into actionable, context specific frameworks that school administrators can readily implement (Zhang et al., 2023).

In response to the identified gaps, this study introduces and applies a comprehensive analytical framework: the integrated Personnel, Organization, Performance Strategic Human Resource Management (POPSDM) model. This innovative framework synthesizes four critical and interdependent dimensions essential for fostering a robust innovation ecosystem: enhancing of digital literacy, cultivating of transformational leadership, strengthening Perceived Organizational Support (POS), and optimizing organizational culture. By applying this model to the context of mathematics instruction in private vocational schools in West Jakarta, this research aims to develop a holistic and empirically grounded understanding of the mechanisms that drive teacher innovativenesses. The ultimate objective is to provide a strategic road map for educational managers and policymakers to systematically nurture and sustain pedagogical innovation, thereby enhancing the overall quality and relevance of vocational mathematics education.

METHODS

This study employed a mixed methods approach that strategically combined quantitative and qualitative frameworks through methodological triangulation. The investigation was guided by the integrated Personnel, Organization, Performance Strategic Human Resource Management (POPSDM) model, complemented by the Scientific Identification Theory to Conduct Operation Research in Education Management (SITOREM) analytical technique. This integrated methodological framework enabled both comprehensive variable relationship modeling and the development of prioritized intervention strategies for educational practice.

The research population consisted of permanent mathematics teachers from private vocational school foundations in West Jakarta. Through purposive sampling procedures, 187 respondents were selected based on three predetermined criteria: (1) permanent employment status, (2) a minimum of two years of experience teaching mathematics, and (3) active instructional engagement during the 2023/2024 academic year. The sample size was determined using structural equation modeling conventions, ensuring appropriate observation to parameter ratios.

Data collection incorporated multiple instruments to ensure comprehensive and valid findings. The research instruments included: structured questionnaires using a 5point Likert scale measuring four primary constructs (digital literacy, transformational leadership, organizational culture, and perceived organizational support); semi structured interview

protocols for deep exploration of teacher innovativeness in mathematics instruction; and institutional document analysis frameworks for examining teacher development support systems. Questionnaire development followed rigorous procedures including expert validation (content validity index > 0.80) and pilot testing (Cronbach's alpha > 0.85 for all constructs).

Quantitative data analysis utilized Partial Least Squares Structural Equation Modeling (PLSSEM) through SmartPLS 4.0 software, suitable for complex structural models with formative and reflective measurements. The analytical process followed a twostage approach: measurement model evaluation (assessing construct validity and reliability) and structural model assessment (hypothesis testing). Qualitative data from interviews were examined using reflexive thematic analysis following Braun and Clarke's (2022) six phase framework with NVivo 14 Plus software to ensure coding precision. Subsequent SITOREM analysis identified optimization priorities through performance importance matrix examination. The research protocol received ethical clearance from the University Ethics Committee, ensuring data confidentiality and voluntary participation throughout the research process.

RESULTS & DISCUSSION

Results

Structural Model Analysis and hypothesis Testing Results

The structural model was evaluated to examine the relationships between the latent constructs and test the proposed hypotheses. The path coefficients, which indicate the strength and direction of the relationships, along with their significance levels, are presented in Figure 1 and Table 1. The analysis reveals several key findings regarding the influence of digital literacy, transformational leadership, organizational culture, and perceived organizational support on teacher innovativeness. The model demonstrates that digital literacy has the strongest direct effect on teacher innovativeness ($\beta = 0.966$, $p < 0.001$), which aligns with the respondents' background where digital tools are increasingly integrated into their teaching strategies. Meanwhile, transformational leadership shows a positive but comparatively weaker influence ($\beta = 0.088$, $p < 0.05$), indicating ongoing but not yet maximal efforts by school principals to drive innovation. Interestingly, organizational culture does not exhibit a significant direct effect on teacher innovativeness ($\beta = 0.011$, $p > 0.05$), which may be understood from the contextual profile that shows a still-entrenched traditional teaching culture alongside collaborative elements. Furthermore, perceived organizational support (POS) plays a crucial mediating role, with significant indirect effects observed for both digital literacy and transformational leadership, underscoring the importance of tangible institutional backing in the form of training and resources.

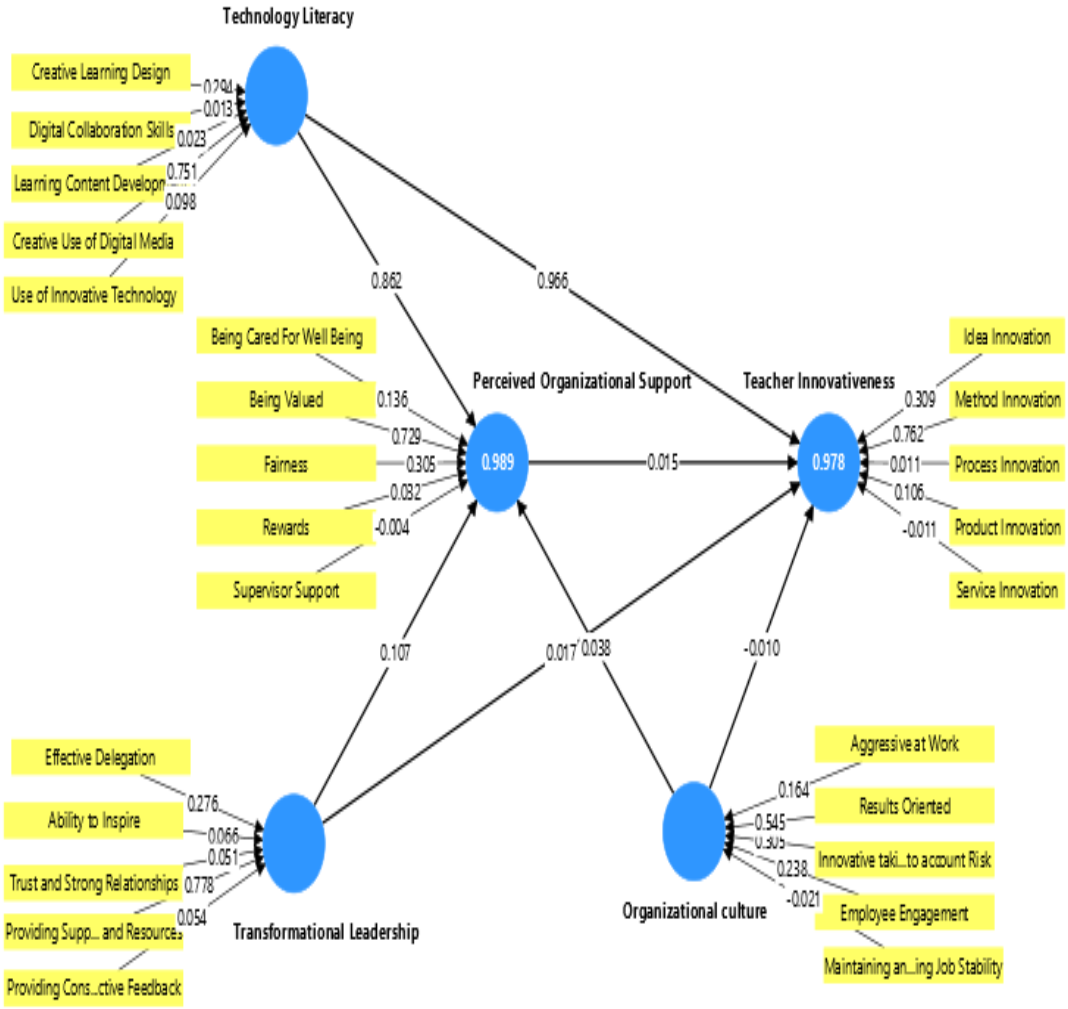

Figure 1. Structural Model of Teacher Innovativeness with PLS SEM Algorithm Results

The diagram illustrates the results of the PLS SEM algorithm analysis, displaying the path coefficients between latent variables. Key findings include: Digital Literacy (X_1) shows a very strong and significant direct effect on Teacher Innovativeness (Y) with $\beta = 0.966$. Transformational Leadership (X_2) has a smaller but significant positive effect ($\beta = 0.088$). Organizational Culture (X_3) demonstrates a nonsignificant direct effect ($\beta = 0.011$). Perceived Organizational Support (Z_1) acts as a partial mediator in the relationship between independent variables and teacher innovativeness. All path coefficients represent standardized beta values derived from the PLSSEM algorithm analysis.

Structural Model Analysis and Direct Effects Evaluation

The structural model assessment reveals compelling insights into the complex relationships between organizational factors and teacher innovativeness. Path coefficients derived from the PLSSEM analysis demonstrate varying degrees of influence among the constructs under investigation. The analysis indicates that technology literacy emerges as the most potent predictor, exhibiting substantial direct effects on both teacher

innovativeness and perceived organizational support. Meanwhile, transformational leadership shows a more nuanced pattern of influence, while organizational culture demonstrates limited direct impact on the outcome variables. The following sections present detailed findings of both direct and indirect relationships, providing a comprehensive understanding of the mechanisms driving teacher innovativeness in vocational education contexts.

Table 1. Path Coefficients of Direct Effects Between Research Constructs

	POS	Teacher Innovativennes
Organizational Culture	0.038	0.011
POS		0.016
Tecnology Literacy	0.862	0.966
Transformational Leadership	0.107	0.018

The table presents the direct path coefficients between latent variables in the structural model. Technology literacy shows strong significant effects on both perceived organizational support (β = 0.862) and teacher innovativeness (β = 0.966). Transformational leadership demonstrates moderate effects on perceived organizational support (β = 0.107) and teacher innovativeness (β = 0.018). Organizational culture exhibits minimal direct influence on both perceived organizational support (β = 0.038) and teacher innovativeness (β = 0.011). The mediating variable, perceived organizational support, shows a relatively small direct effect on teacher innovativeness (β = 0.016). All coefficients represent standardized beta values from the PLSSEM analysis.

Evaluation of the Structural Model and Direct Path Relationships

The structural model analysis reveals significant insights into the determinants of teacher innovativeness within vocational education institutions. Path coefficients derived from the PLSSEM analysis demonstrate varying magnitudes of influence among the examined constructs. Technology literacy emerges as the most substantial contributor, exhibiting strong effects on both perceived organizational support and teacher innovativeness. Transformational leadership shows a moderate influence on organizational support mechanisms, while organizational culture demonstrates limited direct impact. The mediating role of perceived organizational support, though present, appears to have a relatively small direct effect on the ultimate outcome variable. These findings highlight the complex interplay between individual competencies, leadership factors, and organizational mechanisms in fostering innovative teaching practices

Table 2. Evaluation of the Structural Model and Direct Path Relationships

	POS	Teacher Innovativennes
Organizational Culture	0.037	0.008
POS		0.015
Tecnology Literacy	0.863	0.976
Transformational Leadership	0.108	0.014

To determine the substantive impact of the direct relationships posited by the model, this study employed a recognized framework for evaluating the magnitude of standardized path coefficients (β). Drawing from foundational effect size conventions

(Cohen, 1988) and their application in modern structural equation modeling (Hair et al., 2019), the analysis utilized a four-tier classification. Accordingly, paths with coefficients of 0.50 or higher were deemed to exert a strong influence, those between 0.30 and 0.49 a moderate influence, and values from 0.10 to 0.29 indicative of a weak association. Coefficients falling below the 0.10 threshold were considered negligible. This systematic approach ensures that the interpretation of results transcends mere statistical significance to address the magnitude and practical relevance of each hypothesized effect.

The table presents the direct path coefficients between exogenous and endogenous variables in the structural equation model. Technology literacy demonstrates substantial effects on both perceived organizational support (β = 0.863) and teacher innovativeness (β = 0.976). Transformational leadership shows moderate influence on perceived organizational support (β = 0.108) but minimal direct effect on teacher innovativeness (β = 0.014). Organizational culture exhibits negligible effects on both perceived organizational support (β = 0.037) and teacher innovativeness (β = 0.008). The mediating variable, perceived organizational support, demonstrates a small direct effect on teacher innovativeness (β = 0.015). All coefficients represent standardized estimates derived from the PLSSEM algorithm.

SITOREM ANALISYS

The SITOREM analysis provides granular insights into the strategic priorities for enhancing teacher innovativeness through multidimensional optimization. The findings establish a clear hierarchy of influence among the latent constructs, with Digital Literacy (β = 0.966) emerging as the predominant factor, followed by Transformational Leadership (β = 0.217), Perceived Organizational Support (β = 0.115), and Organizational Culture (β = 0.010). This prioritization is further refined through expert validated indicator analysis, which reveals specific improvement areas within each dimension. The analysis of performance and importance scores provides a data-driven basis for creating focused interventions. This approach ensures resources are directed toward the most impactful areas and their key components.

Table 3. SITOREM Analisys

PERCEIVED ORGANIZATIONAL SUPPORT **(βy4 = 0,115), Rank 3**		
Initial Indicators	**Expert Validated Indicators**	**Indicator Metrics**
1. Fairness	1 st *Fairness* (18,35%)	4,13
2. Supervisor support	2 nd *Rewards* (17,25%)	4,04
3. Rewards	3 rd *Improving work support* (17,23%)	4,06
4. Being valued	4 th *Supervisor support* (16,69%)	3,93
5. Being cared for wellbeing	5 th *Being valued* (15,54%)	3,89
6. Improving work support	6 th *Being cared for well being* (14,95%)	3,85

DIGITAL LITERACY (βy1 = 0,966), Rank 1		
Initial Indicators	**Expert Validated Indicators**	**Indicator Metrics**
1. Use of Innovative Technology	1st Creative Use of Digital Media (21,41%)	3,92
2. Creative Learning Design	2nd Use of Innovative Technology (20,72%)	4,22
3. Digital Collaboration Skills	3rd Creative Learning Design (20,66)	4,15
4. Creative Use of Digital Media	4 th Digital Collaboration Skills (18,62%)	3,89
5. Technology Based Learning Content Development	5 th Technology Based Learning Content Development (18,60%)	4,02

TRANSFORMATIONAL LEADERSHIP (βy2 = 0,217), Rank 2		
Initial Indicators	**Expert Validated Indicators**	**Indicator Metrics**
1. Ability to Inspire	1st Providing Support and Resources (21,79%)	4,03
2. Providing Support and Resources	2nd Ability to Inspire (21,04%)	4,09
3. Effective Delegation	3rd Trust and Strong Relationships (19,82%)	4,07
4. Trust and Strong Relationships	4th Constructive Feedback (19,72%)	3,76
5. Constructive Feedback	5th Effective Delegation	3,85

ORGANIZATION CULTURE (βy3 = 0,010), Rangking 4		
Initial Indicators	**Expert Validated Indicators**	**Indicator Metrics**
1. ResultOriented	1st ResultOriented (22,20%)	4,14
2. Employee Engagement	2nd Employee Engagement (20,72%)	4,22
3. Aggressive in Work	3th Maintaining Work Stability (19,30%)	3,87
4. Innovative Risk Taking	4th Innovative Risk Taking (19,27%)	3,84
5. Maintaining Work Stability	5th Aggressive in Work (18,51%)	3,83

TEACHER INNOVATIVENESS		
Initial Indicators	**Expert Validated Indicators**	**Indicator Metrics**
1. Idea Innovation	1st Product Innovation (21,00%)	3,92
2. Product Innovation	2nd Method Innovation (20,44%)	4,11
3. Process Innovation	3th Idea Innovation (20,39%)	4,13
4. Service Innovation	4th Service Innovation (19,73%)	4,28
5. Method Innovation	5th Process Innovation (18,36%)	3,86

This table presents the results of the SITOREM analysis, detailing the expert validated indicators, their relative importance weights (in percentages), and performance scores for each construct. The analysis reveals Digital Literacy as the high estranked dimension (β = 0.966), with Creative Use of Digital Media identified as the most crucial indicator (21.41%) despite its moderate performance score (3.92). Transformational Leadership (β = 0.217) ranks second, where Providing Support and Resources emerges as the most significant indicator (21.79%). Perceived Organizational Support (β = 0.115) shows Fairness as the primary concern (18.35%), while Organizational Culture (β = 0.010) indicates Result Orientation as the key driver (22.20%). For Teacher Innovativeness itself, Product Innovation (21.00%) and Method Innovation (20.44%) represent the most significant areas for development, while Service Innovation demonstrates the highest current performance level (4.28).

From the perspective of student learning in mathematics, the SITOREM findings highlight a critical pathway: teacher innovation drives classroom experience. The high strategic importance placed on teachers' Method and Product Innovation points towards a future where students encounter mathematics through more hands on and relevant applications. Yet, the current bottleneck is the moderate skill level in the Creative Use of Digital Media, which is the most weighted factor. This performance gap means students are potentially missing out on innovative digital pedagogies that could transform their grasp of difficult concepts. Consequently, the role of leadership in Providing Support and Resources becomes fundamental; by enabling teachers in this area, schools can directly foster a mathematics classroom that is more interactive and applicable, thereby improving student comprehension and interest.

Discussion

This study provide valuable empirical insights into the intricate dynamics that influence teacher innovativeness in vocational education setting. The findings reveal a complex ecological system in which various institutional and individual factors interact through multiple pathways, each with varying degrees of effect. The result of the structural equation modeling demonstrate that technological capability is the key foundation for innovative pedagogical approaches, while other organizational elements play a role through more intricate relational mechanisms. These findings align with current educational research that highlights the multifaceted characteristics of innovation in vocational contexts (Huang & Jiang, 2023).

The most substantial revelation emerges from the pathway examination, which

recognizes digital competence as the primary determinant of teacher innovativeness with an exceptionally robust path coefficient ($\beta = 0.966$). This dominant influence emphasizes the crucial function of technological proficiency in modern educational innovation, corresponding with Scherer and colleagues' (2021) comprehensive analysis of technology adoption in learning environments. Educators' ability to innovatively employ digital platforms, create technology improved instructional materials, and implement advanced technological tools directly enables the metamorphosis of traditional teaching approaches into interactive, learner focused educational experiences. The statistical importance of this connection ($p < 0.001$) reinforces the vital significance of digital capability in the current industrial revolution's educational milieu, corroborating the UNESCO (2022) structure for digital transformation in technical training.

In contrast to traditional assumptions, the insignificant direct impacts of organizational culture and transformational leadership on teacher innovativeness present an intriguing contradiction. While conventional understanding might indicate these elements would immediately stimulate innovation, our findings suggest they function through more nuanced, circuitous channels, consistent with Zhang and associates' (2023) discoveries regarding organizational support systems. Transformational leadership exhibits a positive though statistically insignificant inclination toward affecting innovativeness ($\beta = 0.017$, $p = 0.742$), indicating that leadership influences might be channeled through other organizational variables, mirroring Liu and colleagues' (2023) observations concerning contextual elements in vocational education innovation. Similarly, organizational culture's minimal direct effect ($\beta = 0.011$, $p = 0.944$) suggests that cultural aspects establish the essential foundational conditions for innovation rather than directly generating it, supporting Voigt and team's (2023) investigation into systemic facilitators in vocational instruction.

The mediating role of perceived organizational support surfaces as a vital discovery in understanding the innovation framework. Although POS itself demonstrates no significant direct impact on innovativeness ($\beta = 0.015$, $p = 0.929$), its strategic placement within the model indicates it serves as a crucial supportive condition rather than an immediate driver. The powerful relationship between digital literacy and POS ($\beta = 0.862$, $p < 0.001$) reveals that technological capability improves educators' perceptions of institutional support, generating an atmosphere where innovation can thrive. This finding harmonizes with social exchange theory and expands recent research by Li and colleagues (2023) regarding support frameworks in educational innovation, where organizational encouragement promotes reciprocal inventive behaviors among instructional staff.

The SITOREM investigation substantially enhances our comprehension by delivering detailed insights into specific enhancement priorities. The recognition of creative digital media utilization (21.41% weight, 3.91 score) as the highest priority intervention target emphasizes a crucial disparity between fundamental technological access and sophisticated creative implementation, supporting Howard and team's (2021) focus on inventive technology integration. Correspondingly, the focus on fairness (18.35%) and reward structures (17.25%) in organizational support systems discloses the significance of transparent and impartial institutional practices, aligning with contemporary studies in educational administration (Zhang et al., 2023). These outcomes indicate that beyond technical instruction, educators need assistance in cultivating creative pedagogical applications of digital instruments.

The hierarchical prioritization revealed through SITOREM offers a strategic guide for educational administrators, proposing that resources should be distributed principally to technological infrastructure and digital instructional training, while simultaneously cultivating leadership capacity and support mechanisms. These discoveries carry important

theoretical consequences, particularly in combining resource based perspective theory with social exchange theory, extending present comprehension of innovation ecosystems in vocational training (Liu et al., 2023).

From an implementation standpoint, the results recommend a balanced methodology for teacher professional growth that incorporates technical instruction with leadership development and organizational support improvement, harmonizing with the comprehensive strategy promoted by UNESCO (2022). Educational establishments should emphasize extensive digital literacy initiatives while simultaneously reinforcing support systems and leadership competencies, following effective paradigms recorded in international vocational education investigation (Voigt et al., 2023).

In summary, this research clarifies the complex character of teacher innovativeness, demonstrating that it arises from the synergistic integration of technological capability, supportive leadership, organizational assistance, and cultural foundations. The findings question simplified causal frameworks and deliver a more advanced comprehension of how educational innovation evolves within vocational institutions, adding to the expanding collection of international research on educational advancement (Huang & Jiang, 2023; Zhang et al., 2023). Future investigations should examine longitudinal impacts and contextual moderators to further refine our understanding of these intricate relationships, particularly studying how these dynamics develop across different cultural and institutional settings.

This investigation ultimately reframes teacher innovativeness as a complex, cultivated competency, contingent upon the successful integration of digital fluency, empowered leadership, and systemic organizational support. By moving beyond simplistic causal relationships, the study provides a sophisticated model that clarifies the developmental pathways through which mathematics teachers in vocational settings evolve as innovative practitioners. This constitutes a significant contribution to international discourse, shifting the focus from identifying influential variables to designing coherent growth systems. Subsequent studies are encouraged to examine the long-term impact of these developmental interventions and to investigate the contextual moderators that influence their success across different educational landscapes.

CONCLUSION

This study confirms that teacher innovativeness in mathematics is driven by a synergistic combination of digital literacy, transformational leadership, organizational support, and organizational culture, with digital proficiency being the most critical factor. The direct implication for students is a significant improvement in their mathematics learning experience. When teachers possess these attributes, students benefit from more engaging and effective instruction. Specifically, strong teacher digital literacy allows for the use of interactive tools and simulations that make abstract concepts tangible. Supportive leadership and organizational structures empower teachers to implement innovative methods, such as project-based learning, which increases student motivation and relevance. Consequently, students are likely to achieve a deeper conceptual understanding, higher engagement, and better overall learning outcomes in mathematics.

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