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The mediating effects of digital literacy and innovation and creativity to the relationship of social technological variables and school effectiveness

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ABSTRACT

This study examined the mediating effects of digital literacy, innovation, and creativity on the relationship between social-technological variables and school effectiveness in selected public elementary schools in Surigao del Sur, Philippines. Using a descriptive-correlational and predictive research design, data were gathered from 98 elementary school heads and 297 teachers across seven districts under Cluster 2 of the Schools Division. A researcher-made Likert scale questionnaire, patterned after the Key Result Areas (KRAs) of school heads, served as the primary instrument. Statistical analyses included descriptive measures, correlation, mediation analysis, and a Partial Least Squares-based Structural Equation Model (PLS-SEM). Findings revealed that social-technological variables such as teacher quality, student-centered learning, and family and community engagement were manifested to a high extent, while technology integration and social-emotional learning were rated high by school heads but only average by teachers. School effectiveness in terms of teacher effectiveness, academic support, and student engagement was also perceived at a high level, attributed to the joint efforts of teachers, administrators, and DepEd capacity-building initiatives. However, both school heads and teachers rated digital literacy, innovation, and creativity of leaders at only an average level, identifying these areas as key opportunities for improvement. Correlation analysis confirmed significant positive relationships between social-technological variables and school effectiveness, while mediation analysis established that digital literacy, innovation, and creativity significantly strengthened these relationships. The PLS-SEM explained 87.1% of the variance in school effectiveness, demonstrating the robustness of the model. Based on these findings, intervention

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activities were proposed, including training workshops on digital technologies and artificial intelligence integration, semi-annual benchmarking of innovation practices, and the structured implementation of School-Based Learning Action Cells to promote creativity. Supported by DepEd policies and resources, these initiatives are expected to enhance the digital, innovative, and creative capacities of school leaders, ensuring sustained improvements in school effectiveness in alignment with global educational trends.

Keywords: digital literacy, innovation, school effectiveness

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INTRODUCTION

In the rapidly evolving digital landscape, the integration of digital literacy, innovation, and creativity has become a critical component in advancing the effectiveness of educational institutions. As societies grow increasingly dependent on technology, schools must adapt by embedding digital skills into curricula to meet the demands of the 21st century (Thelma et al., 2024; Smith, 2024). The intersection of digital literacy and innovation fosters critical thinking, adaptability, and problem-solving skills, all of which are vital for sustaining institutional success and student achievement (Jones & Patel, 2025). Despite the recognized importance of these elements, the extent to which they mediate the relationship between social-technological factors and school effectiveness remains insufficiently examined.

The global educational community has acknowledged the significance of digital transformation through frameworks such as UNESCO's Education 2030, which promotes the integration of digital competencies to enhance learning outcomes (Li et al., 2025). Across the world, governments have implemented programs aimed at developing digital proficiency among both students and educators (Brown & Carter, 2021). In the Philippines, the Department of Education (DepEd) has launched initiatives to emphasize digital literacy and innovation, seeking to bridge the gap between conventional and modern teaching methods (DepEd, 2023). However, despite these reforms, many Filipino educators continue to face challenges related to limited digital access, inadequate training, and insufficient institutional support, creating barriers to maximizing the potential of digital integration in schools.

Existing research highlights notable contextual differences that complicate the wholesale application of international findings to the Philippine setting. For example, disparities between rural and urban schools in terms of technological infrastructure pose challenges to equitable digital integration (Li, 2024). Teachers, particularly those in resource-limited environments, often report difficulty adapting to new technologies due to insufficient technical support and professional training (Polly et al., 2021). These issues highlight the urgent need to investigate how digital literacy, innovation, and creativity operate as mediating factors in improving school effectiveness within localized contexts (Derder et al., 2024).

The importance of this investigation lies in its potential to advance the understanding of how digital competencies influence broader social-technological variables and their relationship with school outcomes. Without such insights, educational institutions risk falling behind in

delivering quality and relevant learning experiences in an era marked by rapid technological change (Elumalai et al., 2023; Rasdiana et al., 2024). Anchored in legal and policy frameworks such as the Enhanced Basic Education Act of 2013 (Republic Act 10533) and DepEd's Digital Transformation Strategy, the study underscores the alignment of digital competencies with national goals for educational quality and workforce readiness (DepEd, 2023; Mattar et al., 2022). This grounding reinforces the necessity of examining how schools can effectively translate these competencies into practice.

Addressing digital literacy, innovation, and creativity in schools is not only a matter of policy but also of equity. Studies emphasize that developing these skills can reduce disparities in educational access, providing all students with the opportunity to benefit from modern, technology-driven learning environments (Delos Reyes, 2024; Martinez, 2025). At the same time, strengthening these competencies allows educators to refine strategies for integrating technology into classroom instruction, making teaching and learning processes more adaptive, inclusive, and effective. Moreover, by enhancing the mediating role of digital skills, schools can more effectively respond to the challenges of global competitiveness and local developmental needs.

Ultimately, the study of these mediating factors holds practical implications for educators, policymakers, and researchers alike. Investigating the role of digital literacy, innovation, and creativity contributes to the discourse on school effectiveness by highlighting their potential to transform institutional performance and student outcomes (Williams & Lopez, 2025). The findings are expected to provide empirical evidence that informs future educational policies and classroom practices, offering pathways toward bridging digital divides and ensuring that schools remain effective in a fast-changing, interconnected world.

Statement of the problem

This study aims to contribute to a deeper understanding of how technology-driven education enhances institutional performance and student learning outcomes. Specifically, this seeks to answer the following questions;

1. What is the extent of manifestation of the social and technological variables in terms of technology integration, teacher quality, student-centered learning, family and community engagement, and social-emotional learning?
2. What is the extent by which the variables of teacher effectiveness, academic support, and student engagement measure school effectiveness?
3. What is the extent of manifestation of digital literacy, innovation, and creativity in the respondent elementary schools?
4. Is there a significant relationship between the social-technological variables and school effectiveness?
5. Do digital literacy, innovation, and creativity mediate the relationship between social and technological variables and school effectiveness?
6. What structural equation model may be developed for school effectiveness?
7. Based on the model, what intervention activities can be proposed for continual school effectiveness?

METHODOLOGY

This study employed a quantitative approach, focusing on problem statements that could be addressed through the use of quantitative evidence, particularly Likert scale responses. These scales were designed to measure the levels or extent of manifestations of the variables under investigation, including social-technological factors, digital literacy, innovation, creativity, and school effectiveness. Statistical tools were employed to analyze the data with the intent of identifying correlations, testing mediation effects, and establishing structural relationships among the variables. Specifically, the research utilized a descriptive-predictive design, deemed appropriate to capture both the current state of educational practices and the predictive capacity of interrelated variables. The descriptive element of the study allowed the researchers to document and describe the phenomenon using quantitative measures, while the predictive aspect supported the development of a Structural Equation Model (SEM) aimed at predicting school effectiveness based on the interplay of the identified factors.

The research was conducted in selected educational institutions within the Province of Surigao del Sur, located in the CARAGA Region of the Philippines. It was concentrated within Cluster 2 of the Schools Division of Surigao del Sur, which encompasses seven districts: San Miguel 1, San Miguel 2, Tago, Bayabas, Cagwait, Marihatag, and San Agustin. These districts were deliberately chosen to represent diverse geographic, socio-economic, and educational contexts. San Miguel, the province's largest municipality and classified as first class, is divided into two districts with multiple public and private schools serving both central and marginalized learners, including Indigenous Peoples in geographically isolated areas. The Municipality of Tago, a second-class municipality centrally located in the province, operates numerous schools and prioritizes education in its development agenda. Bayabas, a fifth-class coastal municipality, provides a contrasting perspective with its smaller population and schools facing infrastructure and access challenges. Cagwait, a second-class coastal town known for its beaches, and Marihatag, a third-class municipality with strong Indigenous and ecological advocacies, added further diversity to the study's research locale. Finally, San Agustin, a second-class municipality in the southeast, highlighted initiatives on inclusivity and equity in education. Together, these municipalities and districts provided a varied educational landscape reflecting urban, rural, upland, coastal, and Indigenous contexts, thereby enriching the scope of the study.

The participants consisted of elementary school heads and teachers across the 123 elementary schools within Cluster 2. Stratified random sampling was used to ensure fair representation of respondents across the districts. To qualify, school heads were required to have at least three years of leadership experience, ensuring familiarity with administrative roles and school effectiveness initiatives. Master teachers and selected classroom teachers were also included, offering perspectives from instructional practice and curriculum implementation. A total of 98 school heads and 297 teachers were sampled, providing both leadership and teaching viewpoints that allowed for a balanced assessment of educational dynamics in the study area.

The primary instrument used in the study was a researcher-developed survey questionnaire designed to capture information on the study's key variables. The tool was divided into three sections, each utilizing a Likert-scale format for standardized responses. The first section assessed social-technological variables, including technology integration, teacher quality,

student-centered learning, family and community engagement, and social-emotional learning. The second section measured school effectiveness through teacher effectiveness, academic support, and student engagement. The final section focused on digital literacy, innovation, and creativity. To ensure validity and reliability, the questionnaire items were patterned after the Key Result Areas (KRAs) of school heads, aligning closely with their leadership responsibilities. The instrument underwent pilot testing with a small group of respondents to identify ambiguous items, which were revised accordingly. It was also validated by external experts, including the adviser and panel members, who provided recommendations that improved the instrument's clarity and accuracy. Reliability was further supported by high Cronbach alpha values across the different variables, ranging from 0.941 to 0.985, establishing strong internal consistency.

The data gathering procedure began with securing the necessary approvals from the Schools Division Office and district supervisors. Letters of permission outlining the objectives and scope of the study were submitted, ensuring compliance with institutional protocols. Prior to data collection, orientations were conducted to brief participants about the study and their rights as respondents. Informed consent was obtained, confirming voluntary participation. Surveys were administered in person, and collected responses were encoded in Microsoft Excel following formats prescribed by the institutional statistician. This facilitated accurate and organized preparation for statistical analysis.

Ethical considerations were strictly observed throughout the research. Respondents were fully informed about the purpose and scope of the study, and their confidentiality and anonymity were guaranteed. Personal identifiers were not disclosed, and data were used exclusively for academic purposes. Respect for participant autonomy was maintained, ensuring voluntary participation and compliance with standards of research integrity. These safeguards reinforced the credibility and ethical soundness of the study.

The data analysis employed a range of statistical tools appropriate to the study's objectives. Mean and standard deviation were used to describe the extent of manifestation of the study variables, while Pearson correlation analysis was applied to determine the strength and direction of relationships between social-technological factors and school effectiveness. Mediation analysis was carried out to assess whether digital literacy, innovation, and creativity mediated the relationship between social-technological variables and school effectiveness. Furthermore, Structural Equation Modeling (SEM), specifically Partial Least Squares (PLS)-based SEM, was used to develop and validate a causal model that explained direct and indirect relationships among the variables. This methodological approach allowed the study to address its objectives comprehensively, yielding findings that are both descriptive and predictive in nature.

RESULTS AND DISCUSSION

This study involved 395 participants, composed of 98 school heads and 297 teachers across 123 elementary schools under Cluster 2 of the Schools Division of Surigao del Sur. As outlined in the methodology, the participants were chosen through stratified random sampling to ensure fair representation of diverse contexts, including coastal, upland, rural, and urban schools in San Miguel 1 and 2, Tago, Bayabas, Cagwait, Marihatag, and San Agustin Districts. The respondents completed a validated Likert-scale survey questionnaire that measured their

perceptions of social-technological variables—namely technology integration, teacher quality, student-centered learning, family and community engagement, and social-emotional learning—as well as digital literacy, innovation, creativity, and school effectiveness. Statistical analyses included descriptive measures, correlation, mediation, and Structural Equation Modeling (SEM) via Partial Least Squares (PLS).

Findings show that school heads rated the overall extent of technology integration at a high level (mean = 3.59), while teachers rated it at an average level (mean = 3.36). Both groups strongly agreed on the importance of using technology to enhance instruction, with school heads scoring 4.25 (Very High) and teachers 4.21 (Very High). They also rated the provision of professional development on technology integration very highly (school heads = 4.22; teachers = 4.21). However, gaps emerged in areas such as integrating technology across all subject areas (school heads = 3.51, High; teachers = 3.35, Average), using technology for assessment (school heads = 3.48, High; teachers = 3.26, Average), and evaluating students on their use of technology (school heads = 3.39, Average; teachers = 2.58, Low). Teachers' lower ratings highlight challenges related to limited resources, inadequate infrastructure, and lack of clear assessment tools, reflecting broader systemic issues documented in the Philippine Institute for Development Studies (2021) and addressed by DepEd Order No. 016, s. 2023.

In terms of teacher quality, both school heads (mean = 3.73, High) and teachers (mean = 3.62, High) rated the variable highly. School heads placed very high emphasis on responsiveness to students' needs (mean = 4.30) and professional development (mean = 4.27), whereas teachers highlighted their passion for teaching (mean = 4.28) and use of varied strategies (mean = 4.26) as strengths. Constructive feedback (school heads = 3.39, Average; teachers = 3.46, High) and holding high expectations for achievement (school heads = 3.60, High; teachers = 3.38, Average) were rated lower, showing areas where practical classroom realities and workload issues may hinder consistent implementation. These findings echo DepEd Order No. 42, s. 2017, which underscores continuous training and reflective practice, and local studies affirming Filipino teachers' strong dedication despite constraints.

Student-centered learning was perceived at a high level overall (school heads = 3.67; teachers = 3.57). Both groups gave very high ratings to involving students in the learning process (school heads = 4.22; teachers = 4.21). Teachers rated encouragement of critical thinking very highly (mean = 4.25), while school heads gave it a lower high rating (mean = 3.60). Conversely, school heads rated encouragement of student opinions very highly (mean = 4.21), while teachers rated it only high (mean = 3.46). Both groups rated empowerment of students to take ownership of learning only average (school heads = 3.18; teachers = 3.15). These results suggest that while classrooms are shifting toward more participatory practices aligned with DepEd Order No. 21, s. 2019, full empowerment and autonomy remain limited.

Family and community engagement was rated high by both groups, though more strongly by school heads (mean = 3.85) than teachers (mean = 3.41). School heads rated several items very high, including involving parents in activities (mean = 4.35), seeking feedback (mean = 4.37), collaborating with community organizations (mean = 4.39), and respecting cultural diversity (mean = 4.37). Teachers gave very high ratings to parental involvement (mean = 4.28) and communication (mean = 4.25), but rated opportunities for family learning (mean = 2.58, Low) and celebrating contributions (mean = 2.58, Low) much lower. This indicates that while parental engagement is emphasized, deeper family inclusion remains underdeveloped. These

results are consistent with DepEd Order No. 007, s. 2024, which calls for stronger family-school partnerships, and with local studies identifying cultural and resource barriers to engagement.

Social-emotional learning (SEL) showed the greatest divergence in perception, with school heads rating it high (mean = 3.80) and teachers rating it only average (mean = 3.23). School heads rated very highly the teaching of healthy relationships (mean = 4.41), responsible decision-making (mean = 4.46), and conflict resolution (mean = 4.46). Teachers, however, rated these only between average and high (3.37 to 3.41). Teachers rated celebrating students' social growth (mean = 2.59, Low) and training in SEL strategies (mean = 2.58, Low) particularly poorly, compared with school heads who gave borderline average scores. This suggests limited teacher preparation for SEL implementation, despite DepEd Order No. 71, s. 2009 embedding SEL into the curriculum. The overall ratings reveal a strong leadership emphasis but weaker classroom practice, often due to lack of resources and competing academic priorities.

With respect to school effectiveness, both school heads and teachers rated teacher effectiveness, academic support, and student engagement at high levels. School heads rated teacher effectiveness at 3.71 (High) and teachers at 3.60 (High). Teachers rated reflection on teaching practices very highly (mean = 4.35), while school heads rated it only average (mean = 3.20), showing teachers' stronger emphasis on reflective practice. Academic support was rated 3.79 (High) by school heads and 3.56 (High) by teachers. School heads highlighted resources (mean = 4.35), conducive learning environments (mean = 4.45), and data use for tracking progress (mean = 4.42) as very high, while teachers rated these only average to high, reflecting real-world limitations in access. Teachers gave very high ratings to enrichment opportunities (mean = 4.25) and parent involvement (mean = 4.22), highlighting their recognition of holistic support. Student engagement was rated 3.71 (High) by school heads and 3.57 (High) by teachers. Both groups rated participation in discussions and motivation very highly (means = 4.38–4.31), while assignment completion, extracurricular involvement, and collaboration were rated lower, suggesting that while schools succeed in motivating students, sustained engagement remains a challenge.

Correlation analysis confirmed strong, significant relationships between socio-technological variables and school effectiveness (all $p < .001$). Technology integration correlated moderately with teacher effectiveness ($r = 0.573$), academic support ($r = 0.67$), and student engagement ($r = 0.631$). Teacher quality showed stronger correlations ($r = 0.763, 0.746, 0.778$), while student-centered learning yielded the highest correlations ($r = 0.763, 0.795, 0.829$), underscoring its central role. Family engagement ($r = 0.651–0.765$), community engagement ($r = 0.622–0.786$), and SEL ($r = 0.732–0.771$) also had strong, positive correlations, emphasizing their importance in school effectiveness.

Mediation analysis revealed that digital literacy significantly mediated the relationships between teacher quality (10.8%), student-centered learning (8.6%), family engagement (11.7%), community engagement (10.9%), and SEL (9.13%) with school effectiveness, but not technology integration (8.35%, $p = 0.183$). Innovation mediated between 33.5% and 65.8% of effects, with the strongest mediation between technology integration and school effectiveness. Creativity mediated 41.9% to 69.4% of effects, with the highest influence on technology integration. These results confirm the critical roles of digital literacy, innovation, and creativity in enhancing the impact of socio-technological variables.

The PLS-SEM model captured 87.1% of the variability in school effectiveness, demonstrating robustness. Cronbach's alpha values for all constructs ranged from 0.941 to 0.985, indicating high reliability. Average variance extracted (AVE) values exceeded 0.50 for all variables, demonstrating strong convergent validity, while HTMT values were below 0.85, confirming discriminant validity. The model affirmed that digital literacy and creativity have significant direct effects on school effectiveness, while innovation amplifies the influence of socio-technological variables.

In light of these findings, intervention activities were proposed to sustain and strengthen school effectiveness. These include conducting training workshops on digital technology and AI integration during mid-year breaks, providing benchmarking opportunities semi-annually for school heads to adopt innovative practices, and strictly implementing quarterly School-Based Learning Action Cells (LACs) with logistical and budgetary support to foster creativity. These interventions, supported by division memos and guided by education supervisors, are expected to enhance school leaders' digital literacy, innovativeness, and creativity, thereby ensuring that school effectiveness is continually promoted in line with global educational trends.

CONCLUSION

The present study examined the mediating effects of digital literacy, innovation, and creativity on the relationship between social-technological variables and school effectiveness. Employing a descriptive-correlational and predictive research design, the study surveyed 98 elementary school heads and 297 teachers from seven district schools within Cluster 2 of the Schools Division of Surigao del Sur. Using a five-point Likert scale questionnaire, the research gathered quantitative evidence that was analyzed through descriptive statistics, correlation, mediation analysis, and a PLS-based Structural Equation Model (SEM). The methodology provided a comprehensive foundation for exploring how social-technological factors and leadership competencies shape school effectiveness within varied educational contexts.

Findings revealed that social-technological variables were manifested to a high extent, particularly in terms of teacher quality, student-centered learning, and family and community engagement, while technology integration and social-emotional learning were rated high by school heads but only average by teachers. These differences reflect the varying experiences of leaders and teachers in classroom implementation. School effectiveness, measured through teacher effectiveness, academic support, and student engagement, was also rated at a high level, which may be attributed to the combined efforts of teachers, administrators, and the capacity-building support of the Department of Education (DepEd). However, the results also pointed to areas in need of improvement, especially in teachers' assessments of technology use and student empowerment, as well as in the limited opportunities for family learning and teacher preparation for social-emotional learning.

The study further revealed that the digital literacy, innovation, and creativity of school heads were perceived only at an average level by both teachers and school leaders themselves. These competencies, though essential in leadership amid global educational shifts, represent opportunities for further development. Correlation analysis established significant positive relationships between the social-technological variables and school effectiveness, demonstrating that improvements in technology integration, teacher quality, student-centered learning, family

and community engagement, and social-emotional learning directly contribute to stronger school outcomes. Mediation analysis reinforced this conclusion, showing that digital literacy, innovation, and creativity significantly mediate the influence of social-technological variables on school effectiveness. These mediators amplified the effects of the independent variables, highlighting their importance as drivers of educational improvement.

The SEM results offered a robust model, explaining 87.1% of the variance in school effectiveness. This level of explanatory power underscores the strength of the relationships among the variables and supports the conclusion that the integration of digital literacy, innovation, and creativity within leadership is indispensable in achieving higher levels of school effectiveness. The findings provide strong quantitative evidence in support of existing theories regarding the role of social-technological factors in educational outcomes, while also expanding understanding of the mediating functions of digital competencies and creativity in leadership.

In light of these results, several intervention activities were proposed to strengthen the identified areas for improvement. These include training workshops on digital technologies and artificial intelligence integration in school management, semi-annual benchmarking opportunities for school heads to learn from innovative institutions, and quarterly School-Based Learning Action Cells (LACs) to promote creativity and reflective practice. Supported by DepEd through formal division memoranda and logistical provisions, these interventions are designed to cultivate a culture of digital literacy, innovation, and creativity among school leaders, ultimately advancing school effectiveness in alignment with global educational trends.

Based on the findings and conclusions, it is recommended that DepEd management utilize the results of this study in planning and program development aimed at sustaining and enhancing school effectiveness. Retooling programs for school heads should be prioritized, focusing on strengthening their digital, innovative, and creative capacities. School leaders themselves may directly apply the findings in their school improvement planning, addressing areas of weakness identified in this research. Teachers may also integrate the implications of the study into the School-Based Learning Action Cell (SLAC), ensuring that strategies for classroom implementation reflect the mediation effects established in the model. Finally, future researchers are encouraged to use the SEM results as a baseline for further studies on school effectiveness, possibly incorporating additional variables to broaden the explanatory capacity of the model without sacrificing interpretability. Such efforts will continue to expand understanding of how school leaders can be empowered to achieve the highest possible standards of effectiveness in an era of rapid educational change.

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