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Technology-Integrated Applications in Mathematics and Technological Competence in Relation to the Engagement and Achievement of Public Junior High School Learners

Teresa P. Boncales[1*]
[1]*Graduate School, Northwest Samar State University, Calbayog City, Samar, Philippines*
Corresponding Author: Teresa P. Boncales, Northwest Samar State University

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ABSTRACT

Whether technology use in mathematics is related to learners' engagement and achievement in resource-constrained public schools remains an open question. This descriptive-correlational study examined technology-integrated applications in mathematics and teachers' technological competence in relation to the engagement and achievement of public junior high school learners in the Trinidad 1 and Trinidad 2 Districts, DepEd Schools Division of Bohol, in School Year 2025–2026. All 42 mathematics teachers and 323 learners selected through stratified random sampling answered pilot-tested scales (α = .82 to .87), and data were analyzed through weighted means, chi-square, and Pearson correlation. Seventeen of 25 utilization indicators were Less Utilized; only content delivery (M = 3.22) and problem-solving (M = 2.62) reached the Utilized level, while digital assessment was lowest (M = 2.05). Teachers were Competent across six domains, weakest in content development (M = 2.98). Learners were Highly Engaged in motivation (M = 3.34) and participation (M = 3.28) and rated their concept understanding highest (M = 3.28). Internet access, gadgets, family income, parents' education, and school were related to learners' engagement and achievement, and teachers' education, position, experience, and training to all variables. Utilization was positively related to teachers' competence (r = .412), learners' engagement (r = .385), and learners' achievement (r = .362). Although technology use is narrow and mainly presentational, greater use goes with more competent teachers and more engaged, confident learners. A Learning Action Cell that builds interactive content skills and widens access is proposed.

Introduction

Schools and policymakers often assume that more technology in the mathematics classroom will produce more engaged and higher-achieving learners. Evidence offers qualified support. Web-based and technology-supported instruction has positive effects on learning (Akın, 2022; Akçay, 2022), interactive and gamified tools raise interest (Suarez & Dela Cruz, 2025), and interest appears to be a pathway through which technology affects performance (Bright, 2024; Wong & Wong, 2019). The size of these effects varies, however, with how teachers use technology and with the conditions under which learners encounter it (Abildinova et al., 2024; Boadu, 2024).

In Philippine public secondary schools, the relationship between technology use and learner outcomes is complicated by uneven resources. Many learners have no device of their own or no stable connection, and teachers often lack mathematics-specific training (Musasa et al., 2025; Zulu, 2020). Whether technology use is still related to engagement and achievement

under these conditions, and whether teachers' competence is related to how much they use it, are practical questions for school leaders deciding where to invest.

This study examined technology-integrated applications in mathematics and teachers' technological competence in relation to the engagement and achievement of public junior high school learners in the Trinidad 1 and Trinidad 2 Districts, DepEd Schools Division of Bohol, during School Year 2025–2026. It asked how extensively technology-enhanced applications are used; how competent teachers are; how engaged learners are and how they rate their achievement; which characteristics of teachers and learners are related to these variables; and whether utilization is related to teachers' competence and learners' engagement and achievement. The answers informed a district-based Learning Action Cell (LAC) in mathematics.

Literature Review

Technology use and learner outcomes. Technology-enhanced learning environments, including simulations, gamified systems, and interactive platforms, have been associated with improved conceptual understanding, engagement, and problem-solving (Srilatha & Sen, 2024). Graphing software supports understanding of functions (Yang et al., 2021), and digital tools help learners apply mathematics to real situations (Wardana, 2024; Forgasz & Forster, 2021). Learners engage more when technology gives them choice and autonomy (Abildinova et al., 2024) and when it supports collaborative reasoning through shared platforms (Webb et al., 2019). Automated feedback strengthens mastery and metacognitive regulation (Chin & Ming, 2024), while AI-supported tools personalize instruction (Awang et al., 2025). Effects on achievement are generally positive but modest, which indicates that technology works best within sound pedagogy (Akçay, 2022; Bozkus, 2021).

Teachers' competence as a condition. Technology use in classrooms depends on teachers' knowledge, confidence, and beliefs (Gumiero & Pazuch, 2024; Tondeur et al., 2017). TPACK describes the integrated knowledge required (You et al., 2019), and the SAMR model describes how far integration goes beyond substitution (Gillespie, 2022; Blundell, 2022). Teachers who reach modification and redefinition foster more creativity and collaboration (Arslan & Aksu, 2022). Skill gaps and low confidence produce resistance (Bećirović, 2023), and professional development that is ongoing and content-specific is the main remedy (Darling-Hammond, 2020; Hodges & Prater, 2024).

Resources as a condition. Barriers such as inadequate infrastructure, limited devices, and unstable internet are common in disadvantaged schools and constrain both teachers and learners (Herro et al., 2021; Zulu, 2020; Bray & Tangney, 2023). Learners without technology at home have fewer chances to practice, which can widen achievement gaps that technology is meant to close (Al-Sharikh, 2024).

Theoretical lenses. Social constructivism explains how interaction mediated by tools supports learning (Vygotsky, 1978), and motivation theory explains how interest and self-efficacy translate into engagement (Schunk et al., 2014; Slavin, 2020). Cognitive Load Theory explains why poorly designed technology can distract rather than help (Asma, 2020), and Realistic

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Mathematics Education and authentic learning explain why real-world tasks matter (Da, 2023; Wijaya, 2023).

Methodology

Design and participants. This descriptive-correlational study (Johnson & Christensen, 2020) involved all 42 mathematics teachers in six public secondary schools of the Trinidad 1 and Trinidad 2 Districts and 323 Grade 7 to 10 learners chosen through stratified random sampling by grade level. Hinlayagan National High School (93 learners) and Tagum Sur National High School (88) contributed the most learners.

Instruments. The questionnaire included profile sheets and four Likert-type scales: utilization of technology-enhanced applications in five dimensions (Haris, 2022), teachers' technological competence in six domains (Gumiero & Pazuch, 2024), learners' engagement in four dimensions (Jacinto, 2023), and learners' self-assessed mathematical achievement in five competencies (Kirabo et al., 2024). Means of 3.26–4.00 indicated a high level, 2.51–3.25 a moderate level, and 1.76–2.50 a low level. Pilot testing in San Miguel District with 15 teachers and 15 learners produced alphas of .82 to .87.

Data collection. The researchers secured approval from the Graduate School, endorsement from the District Supervisors, and permission from school heads. After orienting the teachers, they administered the questionnaires outside regular class time. Scheduling conflicts, teachers' initial hesitation, and intermittent connectivity were resolved through coordination and assurances of confidentiality.

Analysis. Descriptive statistics summarized the data; chi-square tests examined profile relationships; and Pearson's *r* tested the relationships of utilization with competence, engagement, and achievement ($\alpha = .05$).

Ethics. Participation was voluntary, learners took part with parental consent, and data were handled confidentially under the Data Privacy Act of 2012.

Results

Respondents' Characteristics

Of the 42 teachers, 61.90% were female, 64.28% were 31 to 50 years old, and 54.76% held a bachelor's degree as their highest qualification. Teacher I (42.86%) and Teacher III (35.71%) were the most common positions, and 52.38% had taught for 6 to 15 years. Of the 323 learners, 51.08% were male and 63.47% were 13 or 14 years old. Most households earned between ₱5,001 and ₱20,000 a month (65.01%), 58.82% of learners had their own smartphone, 18.58% had a laptop, and 27.25% had no internet access at home.

Extent of Utilization

Table 1

Extent of Utilization of Technology-Enhanced Applications per Indicator

Dimension and Indicator	Mean	Level
Content delivery	**3.22**	**Utilized**
Technology is used to present mathematical concepts clearly	3.50	Highly Utilized
Teachers use interactive software to explain topics	3.30	Highly Utilized
Multimedia tools (videos, animations) enhance lessons	3.20	Utilized
Lessons incorporate real-world problems through technology	3.10	Utilized
Digital platforms support differentiated instruction	3.00	Utilized
Problem-solving	**2.62**	**Utilized**
Technology fosters student collaboration on problem-solving	2.90	Utilized
Digital tools help students explore multiple solution methods	2.70	Utilized
Technology encourages critical thinking during problem-solving	2.60	Utilized
Students use simulations to test problem-solving strategies	2.50	Less Utilized
Online resources provide challenging real-world problems	2.40	Less Utilized
Use of digital tools	**2.20**	**Less Utilized**
Students regularly use calculators and graphing software	2.40	Less Utilized
Teachers integrate apps that enhance math skills	2.30	Less Utilized
Students access online tutorials for math concepts	2.20	Less Utilized
Digital whiteboards or tablets are used during lessons	2.10	Less Utilized
Technology facilitates data collection and analysis tasks	2.00	Less Utilized
Classroom engagement	**2.23**	**Less Utilized**
Real-time feedback from digital tools motivates students	2.40	Less Utilized
Technology encourages active student participation	2.30	Less Utilized
Students interact with peers through digital collaboration tools	2.20	Less Utilized
Class discussions integrate technology-based activities	2.15	Less Utilized
Gamified learning platforms are used to sustain interest	2.10	Less Utilized
Assessment practices	**2.05**	**Less Utilized**
Online quizzes provide immediate feedback to students	2.20	Less Utilized
Technology is used to conduct formative assessments	2.10	Less Utilized
Teachers use digital data to inform instructional decisions	2.05	Less Utilized
Assessment tasks include application of technology skills	2.00	Less Utilized
Digital portfolios track student progress over time	1.90	Less Utilized

Note. 3.26–4.00 = Highly Utilized; 2.51–3.25 = Utilized; 1.76–2.50 = Less Utilized.

Content delivery (M = 3.22) and problem-solving (M = 2.62) were Utilized, while use of digital tools (M = 2.20), classroom engagement (M = 2.23), and assessment practices (M = 2.05) were Less Utilized (Table 1). The only Highly Utilized indicators were presenting concepts clearly (3.50) and using interactive software to explain topics (3.30). Seventeen of the 25 indicators were Less Utilized, and the lowest was the use of digital portfolios to track progress (1.90).

Teachers' Competence, Learners' Engagement, and Achievement

Teachers were Competent in every domain, from content development and management (M = 2.98) to word processing, spreadsheets, and presentation (M = 3.25). Learners were Highly Engaged in motivation (M = 3.34) and participation (M = 3.28) and Engaged in collaboration

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(*M* = 3.20) and attention and focus (*M* = 3.16). They rated their achievement Highly Competent in concept understanding (*M* = 3.28) and Competent in procedural fluency (3.18), problem-solving (3.04), real-world application (2.92), and formula memorization (2.84).

Learners' Characteristics in Relation to Engagement and Achievement

Table 2

Chi-Square Tests Between Learners' Profile and Their Engagement and Achievement

Learner Profile Variable	Engagement χ^2 (p)	Achievement χ^2 (p)
Age	4.18 (.124)	4.12 (.129)
Sex	2.42 (.193)	2.36 (.198)
School	8.76 (.033)*	8.94 (.031)*
Father's educational attainment	9.92 (.019)*	9.85 (.020)*
Mother's educational attainment	10.58 (.014)*	10.42 (.017)*
Father's occupation	3.84 (.152)	3.72 (.156)
Mother's occupation	4.11 (.139)	4.08 (.141)
Combined monthly family income	12.68 (.008)*	12.56 (.009)*
Gadgets available at home	13.95 (.006)*	13.74 (.007)*
Internet access at home	15.36 (.004)*	14.88 (.005)*

Note. *p < .05.

Six learner characteristics were significantly related to both engagement and achievement: internet access (χ^2 = 15.36 and 14.88), gadgets at home (χ^2 = 13.95 and 13.74), family income (χ^2 = 12.68 and 12.56), mother's education (χ^2 = 10.58 and 10.42), father's education (χ^2 = 9.92 and 9.85), and school (χ^2 = 8.76 and 8.94) (Table 2). Age, sex, and both parents' occupations were not. The same variables were related to learners' perceptions of utilization. Among teachers, educational attainment, position, years in teaching, and trainings were related to utilization, competence, engagement, and achievement, while age, sex, civil status, and school were not; trainings had the largest values in each test (χ^2 = 12.36 to 13.57).

Relationship of Utilization to Competence, Engagement, and Achievement

Table 3

Pearson Correlations of Utilization With Teachers' Competence and Learners' Outcomes

Variables	r	r^2	p	Decision
Utilization and teachers' technological competence	.412	.170	.001	Reject H_0
Utilization and learners' engagement	.385	.148	.003	Reject H_0
Utilization and learners' mathematics achievement	.362	.131	.005	Reject H_0

Utilization was positively and significantly related to teachers' competence (*r* = .412, *p* = .001), learners' engagement (*r* = .385, *p* = .003), and learners' achievement (*r* = .362, *p* = .005), with shared variance of 13.1% to 17.0% (Table 3).

Discussion

Technology use is narrow. The utilization profile shows that technology in these classrooms is mostly a presentation tool. Teachers use it to display and explain, but learners seldom use

calculators and graphing software, collaborate through digital tools, play gamified platforms, or have their learning assessed digitally. Seventeen of 25 practices were Less Utilized. In SAMR terms, integration remains at substitution and augmentation (Gillespie, 2022; Blundell, 2022). Several explanations converge: teachers' weakest competencies are in creating interactive modules (2.90) and adapting digital content (2.95), which are the skills learner-centered use requires (Gumiero & Pazuch, 2024), and learners' limited home technology makes teachers cautious about tasks that depend on devices or connectivity (Zulu, 2020; Herro et al., 2021).

Engagement is high despite narrow use. Learners were highly motivated and active even with this limited use, agreeing most that technology makes mathematics more interesting (3.40) and that they enjoy interactive activities (3.38). This strong motivational response is consistent with research identifying interest as a key benefit of technology in mathematics (Bright, 2024; Suarez & Dela Cruz, 2025) and with motivation theory, which links interest to sustained effort (Schunk et al., 2014). Their lower ratings for reduced distraction (3.05) and stronger peer relationships (3.15) suggest that technology captures attention without always directing it productively. Cognitive Load Theory explains this risk: unless activities are structured, digital tools can add extraneous load (Asma, 2020). Many of these learners also spent part of their schooling under pandemic conditions that affected their well-being and learning habits, as documented among Filipino students (Panela, 2025c), and their engagement may be shaped by those experiences.

How utilization relates to the other variables. The three correlations are moderate and positive. The strongest, with teachers' competence, indicates that teachers who are more skilled with technology use it more, which is consistent with TPACK and research on teacher knowledge and beliefs (You et al., 2019; Tondeur et al., 2017). The relationship with engagement agrees with evidence that technology increases participation and motivation when used interactively (Srilatha & Sen, 2024; Webb et al., 2019), and the relationship with achievement agrees with meta-analytic findings of modest positive effects (Akın, 2022; Akçay, 2022). The coefficients each explain less than a fifth of the variance, so utilization is one of several influences on engagement and achievement. The study did not report the correlations between competence and learner outcomes or between engagement and achievement, so the full pattern of relationships remains unknown. The achievement measure was learners' self-assessment, which may overlap with engagement, and the coefficients should therefore be interpreted as relationships with learners' perceived competence.

Resources shape the relationships. The learner characteristics related to engagement and achievement, namely internet access, gadgets, income, parental education, and school, are mostly indicators of resources. Learners with connectivity and devices at home can continue technology-based learning outside school, and those with more educated parents receive more academic guidance (Al-Sharikh, 2024; Bray & Tangney, 2023). Age, sex, and parents' occupation were not significant. The same is true on the teacher side, where education, position, experience, and training, rather than personal characteristics, were significant. Any claim that boys and girls, or male and female teachers, experience technology similarly would be

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strengthened by evidence that the scales function equivalently across sexes, as demonstrated in a Rasch-based gender analysis of a teacher empowerment scale (Panela, 2025a). Some chi-square tests linked one group's profile to the other group's outcome, for example teachers' characteristics to learners' achievement, without describing how teachers and learners were matched, which calls for caution.

Implications. If utilization is related to engagement and achievement, and competence is related to utilization, then building teachers' competence is a reasonable lever. The proposed LAC allocates ₱150,000 to competence-building workshops on tools such as GeoGebra and Desmos and ₱200,000 to improving access to tools, within a ₱500,000, ten-month program that also covers mentoring, curriculum alignment with MATATAG, and monitoring. Training should focus on the weakest areas, namely interactive content creation and digital assessment, and should be grounded in an assessment of teachers' current skills, as done for basic education teachers on Samar Island (Panela, 2025d). Mentoring and collegial support will help teachers sustain new practices, as teachers on Samar found when undertaking action research during the pandemic (Panela, 2025e). The added demands on teachers also warrant attention to their well-being; one study found that university teachers drew comfort from an AI companion device in managing work stress (Panela, 2026). For learners, the results support providing school-based device and internet access so that technology narrows rather than widens gaps (Zulu, 2020). The pandemic years left many Filipino students with difficulties that schools should continue to monitor (Panela, 2025b).

Conclusion

Technology-enhanced applications are used in mathematics classes in the Trinidad Districts mainly for content delivery, with limited use of digital tools, technology-based engagement, and digital assessment. Teachers are competent with technology but less so in creating interactive mathematics content. Learners are highly motivated and participative and rate their mathematical competence positively, especially in concept understanding. Professional characteristics of teachers and resource-related characteristics of learners, rather than demographics, are related to utilization, competence, engagement, and achievement. Utilization is moderately and positively related to teachers' competence, learners' engagement, and learners' achievement.

The division should implement the proposed LAC with emphasis on mathematics-specific digital content development, digital assessment, and structured interactive activities that manage distraction and build collaboration. Schools should expand access to devices and connectivity, especially for learners without them at home, and engage parents in supporting learning. Future studies should report the relationships among all four variables, use tested achievement, and describe how teacher and learner data are linked.

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