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

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ABSTRACT

Learners experience technology in mathematics through their teachers' choices and through the resources available at home. This descriptive-correlational study examined the engagement and achievement of 323 public junior high school learners in the Trinidad 1 and Trinidad 2 Districts, DepEd Schools Division of Bohol, in School Year 2025–2026, in relation to the technology-integrated applications used by their 42 mathematics teachers and the teachers' technological competence. Pilot-tested scales (α = .82 to .87) were analyzed using weighted means, chi-square, and Pearson correlation. Learners were Highly Engaged in motivation (*M* = 3.34) and participation (*M* = 3.28) and engaged in collaboration (M = 3.20) and attention (M = 3.16); technology made mathematics more interesting (3.40) but reduced distractions the least (3.05). They rated themselves Highly Competent in concept understanding (*M* = 3.28) and Competent in procedural fluency, problem-solving, real-world application (*M* = 2.92), and formula memorization (*M* = 2.84). Home resources were limited: 76.77% of families earned ₱20,000 or less monthly and 27.25% had no internet. Engagement and achievement were significantly related to internet access, gadgets, income, parents' education, and school, and to teachers' training, education, experience, and position, but not to age, sex, or parents' occupation. Teachers used technology mainly for presentation, yet utilization correlated positively with engagement (*r* = .385) and achievement (*r* = .362). Learners respond strongly to technology, but their focus, real-world application, and equitable access need deliberate support. A learner-centered Learning Action Cell is proposed.

Introduction

Engagement and achievement are the two outcomes by which mathematics teaching is ultimately judged. Engagement describes how learners take part, how motivated they are, how they work with others, and how well they sustain attention; achievement describes what they understand and can do. The two are linked, since engaged learners practice more and persist longer, and interest in mathematics has been shown to predict achievement among middle school learners (Wong & Wong, 2019; Schunk et al., 2014).

Technology is widely promoted as a way to raise both. Interactive applications, gamified exercises, and simulations make mathematics more interesting and help learners see abstract relationships (Srilatha & Sen, 2024; Suarez & Dela Cruz, 2025), and technology use is associated with better performance, partly through greater interest (Bright, 2024). Yet learners experience technology through two filters: the teachers who decide how it is used, and their

own homes, which determine whether they have devices and connectivity to continue learning outside class (Herro et al., 2021; Zulu, 2020). Many Filipino learners also returned to school after pandemic disruptions that affected their mental health and learning routines (Panela, 2025b).

This study placed learners at its center. It examined 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, in relation to the technology-integrated applications used in their mathematics classes and their teachers' technological competence. It described learners' engagement and self-assessed achievement in detail; described their home and family resources; tested which learner and teacher characteristics are related to engagement and achievement; and tested whether the extent of technology utilization is related to these outcomes. The results informed a district-based Learning Action Cell (LAC).

Literature Review

Learner engagement in technology-rich mathematics. Engagement in mathematics includes participation, motivation, collaboration, and attention. Technology can enhance participation and ownership when it gives learners choice and autonomy (Abildinova et al., 2024), and shared digital platforms support collaborative reasoning and argumentation (Webb et al., 2019). Technology-based clubs and group tasks foster collaboration in problem-solving (Jacinto, 2023). Motivation rises with gamified and interactive activities (Suarez & Dela Cruz, 2025), and social constructivism explains how interaction mediated by tools supports learning (Vygotsky, 1978). Attention is more fragile: Cognitive Load Theory warns that poorly designed digital activities can overload working memory and distract learners (Asma, 2020).

Mathematical achievement with technology. Technology supports conceptual understanding through visualization and manipulation (Yang et al., 2021; Forgasz & Forster, 2021), procedural fluency through practice with feedback (Chin & Ming, 2024), and problem-solving through simulations and real-world tasks (Wardana, 2024; Srilatha & Sen, 2024). Realistic Mathematics Education and authentic learning emphasize applying mathematics to meaningful contexts (Da, 2023; Wijaya, 2023), and technology-supported problem-based learning helps design authentic tasks (Kirabo et al., 2024). Meta-analytic and empirical studies report positive but modest effects on achievement (Akın, 2022; Akçay, 2022), with stronger effects when technology transforms rather than replaces tasks (Bozkus, 2021; Arslan & Aksu, 2022).

The teacher's role. Teachers' knowledge, confidence, and beliefs determine how technology reaches learners (Gumiero & Pazuch, 2024; Tondeur et al., 2017). Integration models such as SAMR and TPACK describe the progression from substitution to transformation and the knowledge it requires (Gillespie, 2022; You et al., 2019). Professional development, mentoring, and support are needed to build these capacities (Darling-Hammond, 2020; Hodges & Prater, 2024).

The home's role. Learners' access to devices and connectivity varies with family income, and gaps in access can limit the benefits of technology-enhanced learning and widen achievement gaps (Zulu, 2020; Al-Sharikh, 2024). Infrastructure and institutional support condition the effects of technology on learning (Boadu, 2024; Musasa et al., 2025).

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Methodology

Design and Respondents

The study used a descriptive-correlational design (Fraenkel et al., 2019). The learner respondents were 323 Grade 7 to 10 students from six public secondary schools in the Trinidad 1 and Trinidad 2 Districts, selected by stratified random sampling according to grade level. All 42 mathematics teachers in these schools were included through complete enumeration.

Instruments

Learners completed a profile sheet (age, sex, school, parents' education and occupation, family income, gadgets at home, and internet access), an engagement scale based on Jacinto (2023) with five items each for participation, motivation, collaboration, and attention and focus, and an achievement scale adapted from Kirabo et al. (2024) with five items each for concept understanding, procedural fluency, problem-solving, application to real-world contexts, and formula memorization. Achievement items asked learners to rate their own competence when learning mathematics with technology. Teachers rated the extent of utilization of technology-enhanced applications (Haris, 2022) and their technological competence (Gumiero & Pazuch, 2024). Means of 3.26–4.00 were interpreted as Highly Engaged or Highly Competent, 2.51–3.25 as Engaged or Competent, and 1.76–2.50 as Less Engaged or Less Competent. Pilot testing in San Miguel District produced alphas of .85 for engagement and .87 for achievement.

Procedure, Analysis, and Ethics

With approval from the Graduate School, the District Supervisors, and school heads, questionnaires were administered outside regular class hours. Scheduling conflicts and connectivity problems were addressed through flexible arrangements. Data were analyzed with frequency, percentage, weighted mean, chi-square, and Pearson's r ($\alpha = .05$). Learners participated with parental consent, and all data were kept confidential under the Data Privacy Act of 2012.

Results and Discussion

Learners' Home and Family Resources

Table 1

Home and Family Resources of the Learners (n = 323)

Resource	Category	f	%
Monthly family income	₱10,001–20,000	120	37.15
	₱5,001–10,000	90	27.86
	₱20,001–40,000	60	18.58
	Below ₱5,000	38	11.76
	Above ₱40,000	15	4.64
Internet access	Mobile data only	140	43.34
	Broadband connection	95	29.41
	No internet access	88	27.25
Gadgets at home*	Parent's smartphone	280	86.70
	Learner's own smartphone	190	58.82
	Shared device	100	30.96
	Laptop	60	18.58
	Tablet	45	13.93
	Desktop computer	25	7.74

Note. *Multiple responses.

Most learners were 13 or 14 years old (63.47%) and the group was nearly balanced by sex (51.08% male). Their home resources were limited (Table 1). Nearly four in five households (76.77%) earned ₱20,000 or less a month, and 39.62% earned ₱10,000 or less. Smartphones were the main device, often belonging to a parent (86.70%), while fewer than one in five learners had a laptop (18.58%). More than a quarter had no internet at home (27.25%), and the largest group depended on mobile data (43.34%), which is costly and unstable for sustained learning. Parents most often had completed high school (fathers 29.41%, mothers 27.86%), and informal work was the most common occupation (fathers 37.15%, mothers 35.60%). For many of these learners, a smartphone shared with a parent and intermittent mobile data are the only means of digital learning at home.

Learners' Engagement

Table 2

Learners' Level of Engagement per Indicator

Dimension and Indicator	Mean	Level
Participation	**3.28**	**Highly Engaged**
Engages in group work using technology	3.35	Highly Engaged
Actively participates in technology-based lessons	3.30	Highly Engaged
Contributes ideas in digital platforms	3.28	Highly Engaged
Collaborates with peers using digital tools	3.25	Engaged
Asks questions during technology-enhanced activities	3.20	Engaged

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Dimension and Indicator	Mean	Level
Motivation	**3.34**	**Highly Engaged**
Technology makes mathematics more interesting	3.40	Highly Engaged
Enjoys interactive digital activities	3.38	Highly Engaged
Feels motivated to learn with digital tools	3.35	Highly Engaged
Technology increases willingness to solve problems	3.30	Highly Engaged
Technology boosts confidence in learning math	3.25	Engaged
Collaboration	**3.20**	**Engaged**
Shares ideas through digital platforms	3.25	Engaged
Learns from peers during tech-based tasks	3.22	Engaged
Works well with peers using technology	3.20	Engaged
Technology fosters teamwork in class	3.18	Engaged
Technology strengthens peer relationships	3.15	Engaged
Attention and focus	**3.16**	**Engaged**
Interactive tools sustain attention	3.22	Engaged
Concentrates better with digital activities	3.20	Engaged
Technology helps in staying focused in class	3.18	Engaged
Remains attentive during tech-based lessons	3.15	Engaged
Technology reduces distractions in learning	3.05	Engaged

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

Learners were Highly Engaged in motivation (M = 3.34) and participation (M = 3.28), and Engaged in collaboration (M = 3.20) and attention and focus (M = 3.16) (Table 2). Seven of 20 indicators reached the Highly Engaged level; the highest were finding mathematics more interesting with technology (3.40), enjoying interactive digital activities (3.38), and engaging in group work using technology (3.35). The lowest were technology reducing distractions (3.05), technology strengthening peer relationships (3.15), and remaining attentive during technology-based lessons (3.15).

Technology appears to engage learners most through interest and enjoyment and least through sustained focus and relationships. This is consistent with evidence that digital tools raise interest in mathematics (Bright, 2024; Suarez & Dela Cruz, 2025) and with motivation theory, which links interest to effort (Schunk et al., 2014). Participation is also strong, particularly in group work, which agrees with research on collaboration supported by digital tools (Webb et al., 2019; Jacinto, 2023). The weaker ratings for focus and peer relationships suggest that technology's novelty does not automatically produce concentration or social connection. Cognitive Load Theory explains the focus result, since unstructured digital activity can distract (Asma, 2020), and social constructivism explains the peer result, since collaboration must be deliberately designed rather than assumed (Vygotsky, 1978). The pandemic years, when many learners studied alone, may also have weakened peer relationships and attention habits, as research on Filipino students' well-being during that period suggests (Panela, 2025c).

Learners' Self-Assessed Achievement

Table 3

Learners' Self-Assessed Mathematical Achievement per Indicator

Competency and Indicator	Mean	Level
Concept understanding	**3.28**	**Highly Competent**
Technology improves comprehension of lessons	3.35	Highly Competent
Understands concepts better with technology	3.30	Highly Competent
Grasps new concepts faster with digital support	3.28	Highly Competent
Digital tools clarify abstract ideas	3.25	Competent
Can explain concepts using technology	3.20	Competent
Procedural fluency	**3.18**	**Competent**
Technology helps in practicing procedures	3.25	Competent
Applies procedures accurately using digital tools	3.20	Competent
Gains fluency through digital practice	3.18	Competent
Solves problems more efficiently with technology	3.15	Competent
Improves speed in solving problems with technology	3.10	Competent
Problem-solving skills	**3.04**	**Competent**
Applies strategies effectively with technology	3.10	Competent
Technology supports critical thinking in problem solving	3.08	Competent
Technology enhances problem-solving ability	3.05	Competent
Explores multiple solutions using digital tools	3.00	Competent
Solves real-world problems better with technology	2.95	Competent
Application to real-world contexts	**2.92**	**Competent**
Applies math concepts to real-world problems using technology	3.00	Competent
Technology connects lessons to everyday life	2.95	Competent
Transfers math learning to practical situations	2.92	Competent
Uses digital tools to simulate real-world applications	2.90	Competent
Technology supports authentic problem contexts	2.85	Competent
Formula memorization	**2.84**	**Competent**
Practices formula application through technology	2.90	Competent
Uses technology to test formula recall	2.88	Competent
Memorizes formulas better with technology	2.85	Competent
Digital tools help recall formulas faster	2.80	Competent
Technology supports retention of formulas	2.75	Competent

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

Learners rated themselves Highly Competent in concept understanding (M = 3.28) and Competent in procedural fluency (M = 3.18), problem-solving (M = 3.04), application to real-world contexts (M = 2.92), and formula memorization (M = 2.84) (Table 3). They agreed most that technology improves their comprehension (3.35) and that they understand concepts better with technology (3.30), and least that technology supports retention of formulas (2.75) and authentic problem contexts (2.85).

A clear gradient appears: learners feel technology helps them understand, somewhat less that it helps them carry out procedures and solve problems, and least that it helps them apply mathematics to real situations or remember formulas. Visual and interactive tools are well

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suited to conceptual understanding (Yang et al., 2021; Srilatha & Sen, 2024), whereas application to real contexts depends on authentic tasks that teachers seldom provide with technology (Da, 2023; Wijaya, 2023; Kirabo et al., 2024). The low ratings for formula retention suggest that technology is not being used for systematic practice and feedback, which automated tools can provide (Chin & Ming, 2024). These are self-assessments of competence rather than test results, and they likely reflect learners' confidence as well as their skill.

Characteristics Related to Engagement and Achievement

Table 4

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

Teacher Profile Variable	Engagement χ^2 (p)	Achievement χ^2 (p)
Age	3.56 (.172)	3.42 (.184)
Sex	2.08 (.214)	2.05 (.219)
Civil status	2.94 (.232)	2.88 (.241)
Highest educational attainment	11.62 (.009)*	10.76 (.015)*
Position	9.24 (.026)*	9.34 (.021)*
Years in teaching	10.88 (.013)*	11.28 (.012)*
School	6.74 (.081)	6.92 (.067)
Relevant trainings and seminars	13.42 (.005)*	12.84 (.008)*

Note. *p < .05. The source does not describe how teacher profiles were matched to learner outcomes.

Among learner characteristics, engagement and achievement were significantly related to internet access (χ^2 = 15.36 and 14.88), gadgets at home (13.95 and 13.74), family income (12.68 and 12.56), mother's education (10.58 and 10.42), father's education (9.92 and 9.85), and school (8.76 and 8.94), all at $p < .05$, but not to age, sex, or parents' occupation. Among teacher characteristics, learners' engagement and achievement were related to teachers' trainings (χ^2 = 13.42 and 12.84), educational attainment (11.62 and 10.76), years in teaching (10.88 and 11.28), and position (9.24 and 9.34), but not to teachers' age, sex, civil status, or school (Table 4).

Learners' outcomes thus follow two kinds of resources: material resources at home and professional resources in their teachers. At home, connectivity and devices allow learners to practice and explore beyond the lesson, and parents' education shapes the support they receive (Zulu, 2020; Al-Sharikh, 2024). That internet access showed the strongest association is notable in a population where many learners rely on mobile data or have no connection. In school, teachers' training and qualifications, rather than their personal characteristics, are linked to learners' outcomes, which supports investment in professional development (Darling-Hammond, 2020; Hodges & Prater, 2024). The absence of sex differences among learners suggests that boys and girls respond similarly to technology-based mathematics; establishing that the engagement and achievement items function equivalently for both groups, as done in a Rasch-based gender analysis of a Philippine teacher scale (Panela, 2025a), would confirm this.

Relationship of Technology Utilization With Engagement and Achievement

Teachers' utilization of technology-enhanced applications was low to moderate: content delivery (M = 3.22) and problem-solving (M = 2.62) were Utilized, while digital tools (M = 2.20), classroom engagement (M = 2.23), and assessment (M = 2.05) were Less Utilized. Teachers were Competent in all six technology domains (M = 2.98 to 3.25). Despite this limited use, utilization was significantly related to learners' engagement (r = .385, p = .003) and achievement (r = .362, p = .005), as well as to teachers' competence (r = .412, p = .001).

Learners in classrooms with more technology use tended to be more engaged and to rate their mathematics competence higher. The size of the relationships, explaining 13% to 15% of the variance in learner outcomes, indicates that technology use matters but is one influence among several, including the home resources identified above (Boadu, 2024; Bright, 2024). That learners are highly motivated even though classroom engagement practices and gamified tools are Less Utilized (2.23 and 2.10) suggests considerable untapped potential: if technology were used more for learner activity rather than teacher presentation, engagement and achievement might rise further (Abildinova et al., 2024; Arslan & Aksu, 2022). The study did not report the correlation between engagement and achievement themselves, which would clarify whether engagement carries technology's effect on achievement.

Implications for Learners and the Learning Action Cell

The learner-centered findings suggest three priorities for the proposed district-based LAC, which spans ten months with a budget of ₱500,000 across competence, access, mentoring, curriculum alignment, and monitoring. First, teachers should design technology activities that convert learners' interest into sustained focus and meaningful collaboration, with clear roles, time limits, and tasks that require shared reasoning (Asma, 2020; Webb et al., 2019). Second, technology should be used to connect mathematics to real contexts and to provide practice with feedback for procedures and formulas (Wijaya, 2023; Chin & Ming, 2024). Third, activities should be designed for smartphones and offline use, and schools should provide shared devices and connectivity, so that learners without home internet are not left behind (Zulu, 2020). Teacher preparation for these tasks should start from a careful assessment of current skills, as in the skills mapping of basic education teachers on Samar Island (Panela, 2025d), and should include mentoring that helps teachers overcome barriers to new practice (Panela, 2025e). As demands on teachers grow, their well-being also deserves attention; university teachers have reported using an AI companion tool to manage workplace stress (Panela, 2026).

Conclusion

Junior high school learners in the Trinidad Districts are highly motivated and actively participate in technology-supported mathematics, but their focus and peer relationships are less strongly supported. They feel most competent in understanding concepts and least in applying mathematics to real situations and remembering formulas. Their engagement and achievement are related to home resources, especially internet access, gadgets, income, and parents' education, and to their teachers' training, education, experience, and position, but not to age, sex, or parents' occupation. Although teachers use technology mainly for presentation, greater utilization is associated with higher engagement and achievement.

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Schools should design technology activities that build focus, collaboration, real-world application, and practice, not only interest. They should ensure equitable access through shared devices, school-based connectivity, and smartphone-friendly materials, and engage parents in supporting learning at home. The proposed LAC should equip teachers for these practices. Future studies should use tests or grades to measure achievement and examine the relationship between engagement and achievement directly.

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