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Technology Integration, Competence, and Effectiveness of Mathematics Teachers in Relation to Learners' Academic Engagement

Friggy Jean Garcia[1*]
[1]*Graduate School, Northwest Samar State University, Calbayog City, Samar, Philippines*
Corresponding Author: Friggy Jean Garcia, Northwest Samar State University

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ABSTRACT

Learners' academic engagement is a central goal of technology-supported mathematics instruction, yet engagement depends on how teachers teach and the tools they use. This descriptive-correlational study examined the technology integration, technological competence, and teaching effectiveness of mathematics teachers in relation to the academic engagement of Grade 9 learners in Area 2 of the DepEd Schools Division of Leyte in School Year 2025–2026. Data were gathered from 381 learners and 114 teachers selected through stratified random sampling, using reliable Likert scales for engagement, effectiveness, SAMR-based integration, and competence (α = .88 to .93), and were analyzed through weighted means, chi-square, and Pearson correlation. Learners' affective engagement was High (*M* = 3.13), behavioral engagement Moderate (*M* = 2.85), and cognitive engagement the weakest (*M* = 2.51), with self-regulation (2.25) and deep learning (2.35) at the Low level. Teachers were perceived as highly effective, especially in relational expertise (M = 3.54), but less so in real-world connections (3.05) and timely feedback (3.18). Technology integration was concentrated at substitution (*M* = 3.64) and augmentation (*M* = 3.47), with modification Moderate (*M* = 2.73) and redefinition Very Low (*M* = 1.85). Engagement was associated with family income, school, and parents' education and occupation, but not with age or sex. Teaching effectiveness had the strongest relationship with engagement (*r* = .63), followed by technology integration (*r* = .51), and integration was strongly related to competence (*r* = .72). Learners appear engaged in feeling more than in thinking, and technology supports engagement chiefly through effective teaching. A district-based Learning Action Cell centered on cognitive engagement is proposed.

Introduction

Learners' academic engagement is one of the clearest signs that mathematics instruction is working. Engaged learners take interest in the subject, participate and persist when tasks become difficult, and invest the mental effort needed to understand rather than memorize (Fredricks et al., 2020). In Grade 9, when algebraic and geometric content becomes more abstract, engagement can make the difference between learners who reason through problems and learners who wait for the teacher to supply the answer. Engagement has also become a more pressing concern since the pandemic, when abrupt shifts to remote learning affected students' mental health and their connection to schooling (Panela, 2025b).

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Many schools have invested in technology on the expectation that it will make mathematics more engaging. Digital tools can indeed provide visualization, immediate feedback, and collaborative spaces (Drijvers, 2023; Aldahmash & Alshahrani, 2022). Yet engagement is not produced by devices; it depends on what teachers do with them and on how they teach more generally (Rahimi & Rezvani, 2023; Mendez & Lopez, 2023). Teachers' technological competence shapes how far they can integrate tools into lessons (Li & Wang, 2024), and their overall effectiveness in explaining, giving feedback, and relating to learners shapes how learners respond (Zhang et al., 2024). In Philippine secondary schools, technology integration has been associated with higher engagement (Garcia et al., 2023), but evidence linking engagement to teachers' integration, competence, and effectiveness together is limited, particularly in the Schools Division of Leyte.

This study examined the technology integration, competence, and effectiveness of mathematics teachers in relation to the academic engagement of Grade 9 learners in Area 2 of the DepEd Schools Division of Leyte in School Year 2025–2026. Its guiding questions were how engaged the learners are in affective, behavioral, and cognitive terms; how teachers integrate technology, how competent they are with it, and how effective they are as teachers; which learner characteristics are associated with engagement and with perceived teaching effectiveness; and how strongly the teacher variables are related to learners' engagement. A district-based Learning Action Cell (LAC) was proposed from the results.

Literature Review

Engagement as a multidimensional outcome. Engagement combines emotional involvement, observable participation, and cognitive investment, and each dimension has its own antecedents (Fredricks et al., 2020). Affective engagement reflects interest, enjoyment, and belonging; behavioral engagement reflects effort, participation, and persistence; cognitive engagement reflects strategic learning, self-regulation, and the desire to master content (Zimmerman & Schunk, 2022). Interactive digital environments can support all three by giving learners opportunities to manipulate mathematical objects, receive feedback, and collaborate (Aldahmash & Alshahrani, 2022; Barana et al., 2022), and inquiry-based uses of technology are particularly suited to cognitive engagement (Tabieh & Hamzeh, 2022).

Teaching effectiveness and engagement. Effective mathematics teaching combines clear and organized presentation, deep content knowledge, respectful and supportive relationships, and a professional, adaptable disposition. Teachers who use adaptive strategies sustain learners' interest and cognitive investment (Zhang et al., 2024), and effectiveness has been linked to engagement in both international and Philippine mathematics classrooms (Mendez & Lopez, 2023; Uya, 2023). Social Cognitive Theory adds that learners model their teachers' confidence and that self-regulation mediates how they benefit from instruction (Bandura, 2020; Zimmerman & Schunk, 2022).

Technology integration and competence. The SAMR model distinguishes technology that substitutes for or augments traditional tools from technology that modifies or redefines tasks (Hamilton et al., 2020). Higher levels are associated with greater cognitive engagement, but practice often remains at the lower levels (Drijvers, 2023). Teachers' technological competence, framed by TPACK as the integration of technological, pedagogical, and content knowledge (Koehler et al., 2021), predicts both effectiveness and engagement (Li & Wang, 2024). Filipino teachers tend to be strong in basic skills but weaker in advanced ones (Chandra & Ali, 2024), and inadequate training and institutional support constrain integration (Musasa et al., 2024).

Learners' backgrounds. Engagement also reflects learners' circumstances. Families' education and livelihoods shape the expectations and dispositions learners bring to school (Reyes & Santos, 2023; Smith & Johnson, 2024), and limited access to devices and connectivity can widen engagement gaps in technology-rich instruction (Fernandez, 2024). Well-designed digital learning, however, need not favor one group over another (Davis & Chang, 2022).

Framework. The study drew on constructivist learning theory, student engagement theory, and TPACK, together with Situated Learning Theory, which emphasizes authentic tasks within communities of practice (Lave & Wenger, 2020; Brown et al., 2021), and Constructive Alignment, which requires that activities and assessments serve intended outcomes (Biggs, 2021). The legal bases included Sustainable Development Goal 4 (United Nations, 2015), the ISTE Standards for Educators (International Society for Technology in Education, 2020), the Excellence in Teacher Education Act (Republic Act No. 11713, 2022), the Basic Education Development Plan 2022–2030 (Department of Education, 2022a), and DepEd's directives on professional development and ICT integration (Department of Education, 2025).

Methodology

Design and respondents. A descriptive-correlational design was used to describe the variables and examine their relationships without manipulation (Creswell & Creswell, 2018). The respondents were 381 Grade 9 learners and 114 mathematics teachers from Area 2 of the DepEd Schools Division of Leyte in School Year 2025–2026, selected through stratified random sampling with learners and teachers as separate strata.

Instruments. Learner engagement was measured with a 15-item scale covering affective, behavioral, and cognitive engagement, based on the framework of Fredricks et al. (2020). Teaching effectiveness was measured with a 20-item scale covering teaching-related behavior, subject matter expertise, relational expertise, and personality (Mendez & Lopez, 2023; Uya, 2023). Technology integration was measured with a 20-item scale based on the SAMR levels (Hamilton et al., 2020), and technological competence with a 30-item scale covering six skill domains (Chandra & Ali, 2024). All used a four-point scale from strongly disagree (1) to strongly agree (4), and the constructs were rated as perceived by the respondent groups. Profile sheets recorded the learners' age, sex, school, parents' education and occupation, and family income, and the teachers' personal and professional characteristics. Pilot testing with 15 teachers and 15 learners from Area

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I produced alphas of .88 (engagement), .90 (effectiveness), .89 (integration), .92 (competence), and .93 (overall) (Taber, 2018).

Procedure and analysis. With approval from the Graduate School and the Schools Division Superintendent, the researchers oriented school heads and teachers and administered the questionnaires in person or online. Follow-up visits and flexible schedules addressed class conflicts, connectivity problems, and delayed responses. Data were analyzed through frequencies, percentages, and weighted means; chi-square tests of the learners' and teachers' profiles against the constructs; and Pearson's *r* among the constructs. Skewness and kurtosis of the composite scores were within ±2, supporting the use of parametric correlation (George & Mallery, 2019).

Ethics. Informed consent was obtained from teachers and learners, participation was voluntary, and personal information was coded, stored on password-protected devices, and handled according to the Data Privacy Act of 2012.

Results

The Learners and Teachers

Most learners were 14 (40.9%) or 15 years old (31.0%), and 51.7% were female. Their families had modest resources: 33.3% earned ₱10,000 to ₱19,999 a month and 24.9% less than ₱10,000. High school completion was the most common education level for both parents (26.8% each), but fathers were more often college graduates (21.0%) than mothers (6.6%). Fathers most frequently worked in agriculture, forestry, and fishery (24.9%), and mothers were most frequently unemployed or in informal work (32.0%). Among the teachers, most were 31 to 50 years old (63.1%), female (59.6%), and pursuing or holding graduate degrees (84.2% with master's units or higher), and nearly all held Teacher I to III positions (94.8%).

Learners' Academic Engagement

Table 1

Level of Engagement of Grade 9 Learners per Indicator

Dimension and Indicator	Mean	Level
Affective	**3.13**	**High**
Has a positive attitude toward teachers	3.45	High
Shows enjoyment in learning new things	3.25	High
Appears happy and emotionally involved in class	3.15	High
Expresses positive feelings about school	2.95	Moderate
Feels a sense of belonging among peers	2.85	Moderate
Behavioral	**2.85**	**Moderate**
Demonstrates positive conduct and follows rules	3.35	High
Actively participates in discussions	2.95	Moderate
Consistently puts forth strong effort	2.75	Moderate
Participates in extracurricular activities	2.65	Moderate
Persists with challenging tasks	2.55	Moderate
Cognitive	**2.51**	**Moderate**
Believes they can do well if they try	2.85	Moderate
Values mastering the content	2.65	Moderate
Uses effective strategies for complex material	2.45	Low
Goes beyond requirements for deep understanding	2.35	Low
Self-regulates and plans the learning approach	2.25	Low

Note. 3.50–4.00 = Very High; 3.00–3.49 = High; 2.50–2.99 = Moderate; 2.00–2.49 = Low; 1.00–1.99 = Very Low.

Affective engagement was High (M = 3.13), behavioral engagement Moderate (M = 2.85), and cognitive engagement the weakest (M = 2.51), at the boundary between Moderate and Low (Table 1). The highest single indicator was a positive attitude toward teachers (3.45), followed by following rules (3.35). The lowest were self-regulation and planning (2.25), going beyond requirements to understand deeply (2.35), and using effective strategies for complex material (2.45), all at the Low level. Among behavioral indicators, persistence with challenging tasks was weakest (2.55).

Teaching Effectiveness

Table 2

Effectiveness of Mathematics Teachers per Indicator

Dimension and Indicator	Mean	Level
Teaching-related behavior	**3.44**	**High**
Presents lessons clearly and in an organized way	3.72	Very High
Manages classroom behavior effectively	3.55	Very High
Uses classroom time efficiently	3.42	High
Uses a variety of teaching methods	3.35	High

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Dimension and Indicator	Mean	Level
Provides timely, constructive feedback	3.18	High
Subject matter expertise	**3.49**	**High**
Presents current, accurate information	3.72	Very High
Demonstrates deep content knowledge	3.65	Very High
Accurately answers in-depth questions	3.58	Very High
Explains complex concepts understandably	3.45	High
Connects content to real-world applications	3.05	High
Relational expertise	**3.54**	**Very High**
Shows respect for all students	3.82	Very High
Is approachable and available for help	3.65	Very High
Builds positive relationships that promote confidence	3.55	Very High
Communicates expectations clearly and fairly	3.45	High
Encourages participation and values input	3.25	High
Personality	**3.49**	**High**
Is consistent and reliable in conduct and grading	3.72	Very High
Exhibits a professional, positive demeanor	3.65	Very High
Shows enthusiasm for teaching and the subject	3.58	Very High
Is patient when working with students	3.35	High
Adapts and handles unexpected situations calmly	3.15	High

Note. 3.50–4.00 = Very High; 3.00–3.49 = High; 2.50–2.99 = Moderate; 2.00–2.49 = Low; 1.00–1.99 = Very Low.

Teaching effectiveness was High to Very High across all four dimensions (Table 2). Relational expertise was strongest (M = 3.54) and the only dimension rated Very High, led by respect for all students (3.82) and approachability (3.65). Subject matter expertise and personality followed (M = 3.49 each), and teaching-related behavior was lowest (M = 3.44). The lowest indicators overall were connecting content to real-world applications (3.05), adaptability to unexpected situations (3.15), and timely, constructive feedback (3.18).

Technology Integration and Competence

Technology integration was Very High at substitution (M = 3.64), High at augmentation (M = 3.47), Moderate at modification (M = 2.73), and Very Low at redefinition (M = 1.85). Technological competence was Very High in basic operations (3.72), communication media (3.53), productivity software (3.51), and web resources (3.50), and High in setup and troubleshooting (3.40) and content development (3.18).

Learner Characteristics, Engagement, and Perceived Effectiveness

Engagement was significantly associated with combined monthly family income ($\chi^2 = 31.47$, $p < .001$), school ($\chi^2 = 23.94$, $p < .001$), mother's education ($\chi^2 = 18.62$, $p = .005$), father's education ($\chi^2 = 16.37$, $p = .012$), father's occupation ($\chi^2 = 14.85$, $p = .021$), and mother's occupation ($\chi^2 = 11.29$, $p = .046$), but not with age ($p = .418$) or sex ($p = .286$). Perceived teaching effectiveness was associated with school ($\chi^2 = 26.38$, $p < .001$), income ($\chi^2 = 17.54$, $p = .002$), mother's education

(χ^2 = 15.68, p = .016), father's education (χ^2 = 13.25, p = .039), father's occupation (χ^2 = 11.92, p = .036), mother's occupation (χ^2 = 9.45, p = .049), and sex (χ^2 = 9.87, p = .043), but not with age (p = .242). Among teachers, integration and competence were significantly associated with trainings attended, school, educational attainment, position, age, and years in teaching, but not with sex or civil status.

Teacher Variables in Relation to Engagement

Table 3

Correlations of Teacher Variables With Each Other and With Learner Engagement

Variables	r	p	Decision
Technology integration and technological competence	.72	< .001	Reject H_0
Technology integration and teaching effectiveness	.58	< .001	Reject H_0
Technology integration and learner engagement	.51	< .001	Reject H_0
Technological competence and teaching effectiveness	.45	< .001	Reject H_0
Teaching effectiveness and learner engagement	.63	< .001	Reject H_0

Note. The correlation between technological competence and engagement was not reported in the source manuscript.

Teaching effectiveness had the strongest relationship with learner engagement (r = .63), and technology integration a moderate one (r = .51). Among the teacher variables, integration was strongly related to competence (r = .72) and moderately related to effectiveness (r = .58), and competence was moderately related to effectiveness (r = .45). All coefficients were significant at p < .001 (Table 3).

Discussion

Engaged in feeling, less so in thinking. The engagement profile is uneven. Learners hold positive attitudes toward their teachers and enjoy learning new things, and they generally follow classroom rules. They are less consistent in effort and persistence, and they rarely regulate their own learning, use deliberate strategies, or go beyond what is required. This is the profile of learners who are comfortable and compliant but not yet cognitively invested, a gap that engagement research identifies as decisive for conceptual understanding (Fredricks et al., 2020). Low self-regulation is particularly important because it limits how much learners gain from any form of instruction, digital or otherwise (Zimmerman & Schunk, 2022). The moderate sense of belonging among peers (2.85) also deserves attention, as collaborative learning depends on learners feeling at ease with classmates. These patterns are consistent with the disruption of learning habits and peer connection reported among Filipino students who went through the pandemic years (Panela, 2025c).

Strong teachers, untapped levers. Learners and teachers describe effective, caring teachers. The strongest dimension, relational expertise, likely explains much of the learners' affective engagement, since respect and approachability build the trust that makes learners willing to participate (Uya, 2023; Mendez & Lopez, 2023). The weaker indicators within effectiveness,

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namely real-world connections, adaptability, and timely feedback, are the practices most closely tied to cognitive engagement. Learners invest more thinking when mathematics is connected to meaningful contexts and when feedback tells them how to improve (Zhang et al., 2024). These are also the practices that technology can strengthen, through authentic data sets, simulations, and digital formative assessment, which the teachers in this study used only at a Moderate or lower level.

The role of technology. Teachers' technology use is concentrated at substitution and augmentation, where tools make presentation more efficient and visual without changing what learners do. The tasks that require learners to analyze data, construct explanations, or collaborate on authentic problems, which are the tasks that build cognitive engagement, belong to modification and redefinition, which were Moderate and Very Low (Hamilton et al., 2020; Drijvers, 2023). This corresponds closely to the low cognitive engagement of the learners. The competence results suggest one reason: teachers are skilled users of existing tools but less skilled at developing their own digital content, which modification and redefinition require (Chandra & Ali, 2024; Setiyani et al., 2020). As teachers increasingly encounter AI-based tools, both for instruction and for their own well-being, competence in evaluating and adapting such tools will grow in importance; one study of university teachers found that an AI companion toy helped them manage workplace stress (Panela, 2026), and DepEd's directives call for responsible, ethical use of such technologies in schools (Department of Education, 2025).

How the teacher variables relate to engagement. The correlations bring these findings together. Teaching effectiveness shares about 40% of its variance with engagement, and technology integration about 26%. Effectiveness is therefore the stronger correlate, and technology appears to support engagement mainly through its connection to effective teaching (r = .58). This agrees with evidence that technology raises engagement when teachers exercise strong pedagogical control over it (Rahimi & Rezvani, 2023) and that competence affects engagement through its effect on teaching (Li & Wang, 2024). The strong link between competence and integration (r = .72) indicates that skill-building remains a necessary first step, consistent with TPACK (Koehler et al., 2021). Because these are bivariate correlations from a cross-sectional design, they show which teacher variables move together with engagement but not whether they cause it, and the absence of a reported competence–engagement correlation leaves one link in the chain untested.

Engagement and learners' circumstances. Learners' engagement varies with their schools and families, but not with their age or sex. The strong association with family income suggests that learners from poorer households face barriers to engagement, including limited access to devices and connectivity for technology-based tasks (Fernandez, 2024; Smith & Johnson, 2024). The associations with both parents' education and occupation point to the dispositions and support that families provide (Reyes & Santos, 2023). The strong school association shows that some schools have built more engaging learning environments than others, which can partly offset family disadvantage through strong relationships and supportive climates (Reyes & Santos, 2023; Cortez

et al., 2024). The absence of a sex difference in engagement is consistent with evidence that well-designed digital learning engages boys and girls similarly (Davis & Chang, 2022). The sex difference in perceived effectiveness, by contrast, may reflect differences in how teachers interact with and give feedback to boys and girls (Tan & Chen, 2021). Before treating that difference as substantive, future studies should establish that the effectiveness scale functions equally for male and female raters, a step demonstrated in a Rasch-based gender analysis of a Philippine teacher scale (Panela, 2025a).

Toward a Learning Action Cell focused on engagement. The results point to an LAC whose main measure of success is learners' cognitive engagement. Its sessions should help teachers design inquiry-based, technology-enhanced tasks that require learners to plan, choose strategies, and explain their reasoning (Tabieh & Hamzeh, 2022), and should pair technology with the weaker effectiveness practices: digital formative assessment for timely feedback, authentic data for real-world connections, and collaborative platforms for participation and belonging. Lesson study and cross-school mentoring can spread these practices (Lim & Tondeur, 2020; Harris & Davis, 2023), and activities should not depend on resources that poorer learners lack at home (Fernandez, 2024). Building teachers' capacity in this way requires attention to the barriers they face in professional learning; action research during the pandemic showed that teachers persist when given collegial support and practical guidance (Panela, 2025e).

Conclusion

Grade 9 learners in Area 2 of the Schools Division of Leyte are affectively engaged in mathematics, moderately engaged in behavior, and least engaged cognitively, with self-regulation and strategic learning at a Low level. Their teachers are perceived as effective, especially in their relationships, but are less strong in feedback, real-world connections, and adaptability. Teachers integrate technology mainly at the substitution and augmentation levels, and their competence is weakest in content development. Engagement is associated with learners' schools and family circumstances, not with their age or sex. Teaching effectiveness is the strongest correlate of engagement, followed by technology integration, and integration is strongly related to competence.

A district-based Learning Action Cell in mathematics should be institutionalized with learners' cognitive engagement as its central goal. It should develop teachers' capacity to design technology-enhanced inquiry tasks, use digital tools for feedback and real-world connections, and strengthen their skills in digital content development, supported by mentoring and peer coaching across schools. Equity measures should ensure that learners from low-income families can take part fully, and engagement should be monitored regularly. Teacher professional development is most effective when it starts from a clear profile of teachers' existing skills and competencies (Panela, 2025d). Further research should report all pairwise correlations and test the teacher variables jointly in a regression model, and should collect learners' and teachers' ratings separately.

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