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

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ABSTRACT

Learners' engagement in mathematics reflects both their circumstances outside school and the teaching they receive. This descriptive-correlational study examined the engagement of Grade 9 learners in relation to their family and school backgrounds and to the technology integration, technological competence, and teaching effectiveness of their mathematics teachers in Area 2 of the DepEd Schools Division of Leyte in School Year 2025–2026. Through stratified random sampling, 381 learners and 114 teachers responded to a profile sheet and four reliable Likert scales (α = .88 to .93); data were analyzed using weighted means, chi-square, and Pearson correlation. Most learners came from low-income households (58.2% below ₱20,000 monthly), and mothers had considerably less schooling than fathers. Engagement was High in the affective dimension (M = 3.13), Moderate in the behavioral dimension (M = 2.85), and weakest in the cognitive dimension (M = 2.51), with self-regulation lowest (2.25). Engagement was significantly associated with family income (χ^2 = 31.47), school (χ^2 = 23.94), and both parents' education and occupation, but not with age or sex. Teachers integrated technology mainly at the substitution (M = 3.64) and augmentation (M = 3.47) levels and were perceived as effective, especially in relational expertise (M = 3.54). Engagement was most strongly related to teaching effectiveness (r = .63) and moderately related to technology integration (r = .51). Learners' engagement is shaped by their circumstances, but its strongest teacher-related correlate is effective teaching, which schools can strengthen for all learners. An equity-oriented district-based Learning Action Cell is proposed.

Introduction

Learners do not arrive in mathematics class as blank slates. They come from families with different levels of schooling, different livelihoods, and different means, and from schools with different resources and cultures. These circumstances shape how they feel about learning, how much effort they invest, and how deeply they think (Reyes & Santos, 2023; Smith & Johnson, 2024). When instruction becomes increasingly digital, these differences can widen, because learners who lack devices, connectivity, or support at home may be unable to take full part in technology-based tasks (Fernandez, 2024).

At the same time, teachers can do much to engage learners regardless of background. Technology integrated at the higher levels of the SAMR model can turn learners from recipients into investigators (Hamilton et al., 2020; Drijvers, 2023), teachers' technological competence determines whether such integration is possible (Li & Wang, 2024), and effective

teaching, especially supportive relationships, clear explanation, and meaningful feedback, sustains engagement across groups (Mendez & Lopez, 2023; Uya, 2023). Schools that build such practices can create environments that partly offset disadvantages learners bring from home (Reyes & Santos, 2023).

This study placed learners' engagement at its center. It examined the engagement of Grade 9 learners in Area 2 of the DepEd Schools Division of Leyte during School Year 2025–2026 in relation to their own backgrounds and to the technology integration, technological competence, and effectiveness of their mathematics teachers. It asked: What are the learners' family and school backgrounds? How engaged are they in affective, behavioral, and cognitive terms? Which background characteristics are associated with their engagement and with their perceptions of teaching effectiveness? How do teachers integrate technology and how competent and effective are they? How strongly are the teacher variables related to engagement? The findings informed the design of a district-based Learning Action Cell (LAC) attentive to equity.

Literature Review

The meaning of engagement. Engagement is a multidimensional construct comprising learners' emotional involvement, observable participation, and cognitive investment (Fredricks et al., 2020). It is both an indicator of effective instruction and an outcome of it (Uya, 2023). Cognitive engagement, which includes strategic learning and self-regulation, is the dimension most directly linked to understanding, and it depends on learners' capacity to plan and monitor their own learning (Zimmerman & Schunk, 2022).

Family and school context. Learners' engagement reflects family and school influences. Parents' education and occupation shape academic socialization, expectations, and the forms of support available at home, and classroom interaction can either bridge or widen the resulting gaps (Reyes & Santos, 2023). Learners from educationally disadvantaged homes may bring practical strengths that schools seldom draw upon, and targeted interventions can help bridge home–school gaps (Smith & Johnson, 2024). In Philippine mathematics classrooms, access to technology and its perceived relevance to learners' lives shape whether digital instruction engages or excludes (Fernandez, 2024). Well-designed digital environments, however, show no inherent gender gap in engagement, which places the emphasis on instructional design (Davis & Chang, 2022). Teachers' interaction and feedback patterns can differ by learner sex in ways that affect how learners perceive them (Tan & Chen, 2021).

Teachers' technology integration, competence, and effectiveness. Technology in mathematics supports visualization, interactivity, and inquiry (Barana et al., 2022; Tabieh & Hamzeh, 2022), and higher SAMR levels are associated with deeper cognitive engagement (Hamilton et al., 2020; Li & Wang, 2024). Philippine studies associate integration with greater engagement and performance (Garcia et al., 2023). Teachers' competence, which TPACK frames as the integration of technological, pedagogical, and content knowledge, enables meaningful integration (Koehler et al., 2021), though Filipino teachers' advanced competencies lag behind their basic ones (Chandra & Ali, 2024). Effectiveness is linked to engagement through adaptive teaching (Zhang et al., 2024), and engagement rises when teachers mediate technology

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skillfully (Rahimi & Rezvani, 2023). Inadequate training and support constrain all of this (Musasa et al., 2024).

Framework and policy. The study drew on student engagement theory, constructivism, and TPACK, together with Situated Learning Theory, which emphasizes authentic tasks (Lave & Wenger, 2020), and Connectivism, which highlights learning through digital networks (Siemens, 2020). Equity is central to Sustainable Development Goal 4, which calls for inclusive and equitable quality education (United Nations, 2015), and to the Information Technology Education Act, which aims to ensure equitable access to ICT in basic education (Republic Act No. 10929, 2016). The Basic Education Development Plan likewise identifies technology and innovation as means to improve access and engagement (Department of Education, 2022a).

Methodology

Design, Participants, and Sampling

A descriptive-correlational design was employed (Creswell & Creswell, 2018). The participants were 381 Grade 9 learners and 114 mathematics teachers from Area 2 of the DepEd Schools Division of Leyte in School Year 2025–2026, drawn by stratified random sampling from nine named national high schools and other selected schools in the area.

Measures

The learner profile sheet recorded age, sex, school, each parent's highest educational attainment and occupation, and combined monthly family income. Learner engagement was measured with a 15-item, three-dimension scale based on Fredricks et al. (2020). Teachers' technology integration (20 items, SAMR-based; Hamilton et al., 2020), technological competence (30 items, six domains; Chandra & Ali, 2024), and teaching effectiveness (20 items, four dimensions; Mendez & Lopez, 2023) were measured as perceived by the respondent groups. All scales used four response options from strongly disagree to strongly agree. In a pilot with 15 teachers and 15 learners from Area I, Cronbach's alpha was .88 for engagement and .89 to .92 for the other scales (.93 overall), indicating good to excellent reliability (Taber, 2018).

Procedure and Analysis

The study proceeded after approval from the Graduate School and the Schools Division Superintendent. School heads helped schedule orientation and administration, which took place in person or online depending on each school's connectivity. Learner responses that were delayed by other school activities were collected through follow-up visits. Data were summarized with frequencies, percentages, and weighted means. Chi-square tests examined associations of profile variables with the constructs, and Pearson's *r* examined associations among the constructs. Skewness and kurtosis of all composite scores were within ±2 (George & Mallery, 2019).

Ethical Safeguards

Informed consent was secured, participation was voluntary, and responses were coded and stored securely in compliance with the Data Privacy Act of 2012. Learners who could not participate in person could respond online so that no learner was excluded for reasons of access.

Results and Discussion

Learners' Family and School Backgrounds

Table 1

Family Background of the Grade 9 Learners (n = 381)

Characteristic	Category	f	%
Father's education	High school graduate	102	26.8
	College graduate	80	21.0
	High school level	67	17.6
	Elementary level or graduate	66	17.3
Mother's education	High school graduate	102	26.8
	High school level	78	20.5
	Elementary level or graduate	112	29.4
	College graduate	25	6.6
Father's occupation	Agriculture, forestry, and fishery	95	24.9
	Unemployed or informal work	72	18.9
	Service and sales	67	17.6
Mother's occupation	Unemployed or informal work	122	32.0
	Service and sales	92	24.1
	Clerical and administrative	45	11.8
Monthly family income	Below ₱10,000	95	24.9
	₱10,000–19,999	127	33.3
	₱20,000–29,999	86	22.6
	₱30,000 and above	73	19.2

Note. Only the most frequent categories are shown for education and occupation.

The learners were mostly 14 (40.9%) and 15 years old (31.0%), and 51.7% were female. Most came from households of limited means (Table 1). More than half of the families (58.2%) earned less than ₱20,000 a month, and only 7.3% earned ₱40,000 or more. Fathers had more schooling than mothers: 21.0% of fathers but only 6.6% of mothers had finished college, while 29.4% of mothers had at most an elementary education and 5.8% had no formal schooling. The most common livelihoods were agriculture, forestry, and fishery for fathers (24.9%) and unemployment or informal work for mothers (32.0%). Learners came from nine named national high schools and a larger group of other selected schools.

This background matters for technology-based instruction. Households with low and irregular incomes are less likely to own devices or sustain connectivity, which limits learners' ability to continue digital tasks at home (Fernandez, 2024). Mothers' more limited schooling may also constrain the academic support available in households where mothers often take the main role

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in monitoring schoolwork (Reyes & Santos, 2023). Learners from farming and informal-work families also bring practical knowledge of measurement, quantity, and trade that mathematics instruction can build upon (Smith & Johnson, 2024).

Learners' Engagement

Table 2

Engagement of Grade 9 Learners: Dimension Means and Extreme Indicators

Dimension	Mean	Level	Highest Indicator	Lowest Indicator
Affective	3.13	High	Has a positive attitude toward teachers (3.45)	Feels a sense of belonging among peers (2.85)
Behavioral	2.85	Moderate	Demonstrates positive conduct and follows rules (3.35)	Persists with challenging tasks (2.55)
Cognitive	2.51	Moderate	Believes they can do well if they try (2.85)	Self-regulates and plans the learning approach (2.25)

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.

Engagement declined from the affective to the cognitive dimension (Table 2). Affective engagement was High (M = 3.13), with learners holding positive attitudes toward their teachers (3.45) and enjoying new learning (3.25), but their sense of belonging among peers (2.85) and positive feelings about school (2.95) were only Moderate. Behavioral engagement was Moderate (M = 2.85); learners followed rules (3.35) but persisted less with challenging tasks (2.55). Cognitive engagement was weakest (M = 2.51), as learners rarely self-regulated (2.25), sought deep understanding (2.35), or applied effective strategies (2.45).

The learners' positive feelings are directed more toward their teachers than toward school or peers, which suggests that the teacher relationship is carrying much of their engagement. Their behavior is compliant but not persistent, and their thinking is not yet self-directed. In engagement theory, this combination indicates surface rather than deep involvement (Fredricks et al., 2020). Learners who do not plan their own learning or choose strategies depend heavily on structure provided by the teacher (Zimmerman & Schunk, 2022), which may disadvantage learners who lack such structure at home. The moderate sense of belonging and low persistence may also reflect the lasting effects of the pandemic years on Filipino students' well-being and connection to schooling (Panela, 2025b).

Backgrounds Associated With Engagement and Perceived Effectiveness

Table 3

Chi-Square Tests of Learners' Profile Against Engagement and Perceived Teaching Effectiveness

Learner Profile Variable	Engagement χ^2 (p)	Decision	Effectiveness χ^2 (p)	Decision
Age	6.05 (.418)	Accept H_0	7.95 (.242)	Accept H_0
Sex	3.78 (.286)	Accept H_0	9.87 (.043)*	Reject H_0
School	23.94 (< .001)*	Reject H_0	26.38 (< .001)*	Reject H_0
Father's educational attainment	16.37 (.012)*	Reject H_0	13.25 (.039)*	Reject H_0
Mother's educational attainment	18.62 (.005)*	Reject H_0	15.68 (.016)*	Reject H_0
Father's occupation	14.85 (.021)*	Reject H_0	11.92 (.036)*	Reject H_0
Mother's occupation	11.29 (.046)*	Reject H_0	9.45 (.049)*	Reject H_0
Combined monthly family income	31.47 (< .001)*	Reject H_0	17.54 (.002)*	Reject H_0

Note. *Significant at $\alpha = .05$.

Engagement was significantly associated with six of the eight learner characteristics (Table 3). Family income had the strongest association ($\chi^2 = 31.47$, $p < .001$), followed by 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 ($\chi^2 = 11.29$, $p = .046$). Learners' age and sex were not significant. Perceived teaching effectiveness showed a similar pattern, with school ($\chi^2 = 26.38$) and income ($\chi^2 = 17.54$) strongest, and was also associated with learner sex ($\chi^2 = 9.87$, $p = .043$).

Engagement in these classrooms therefore varies with learners' circumstances, not with their personal attributes. Income may matter most because it determines access to devices, connectivity, study space, and enrichment, all of which support engagement in technology-rich instruction (Fernandez, 2024). Both parents' education and occupation also matter, consistent with research showing that each parent contributes to academic socialization in different ways and that classroom interaction can bridge or widen the resulting gaps (Reyes & Santos, 2023). The strong school association shows that schools differ in how engaging they are, and it indicates that schools can compensate for family disadvantage through relationships, relevant content, and supportive climates (Reyes & Santos, 2023; Cortez et al., 2024). The absence of age and sex differences agrees with evidence that engagement depends more on instructional design than on learner demographics (Davis & Chang, 2022).

That learners of different backgrounds perceive teaching effectiveness differently suggests that the same teaching may meet some learners' expectations better than others. The sex association may reflect differences in the feedback and interaction boys and girls receive in mathematics classrooms (Tan & Chen, 2021). Before interpreting it further, researchers should confirm that the effectiveness scale functions equivalently for girls and boys, using the kind of gender-based Rasch analysis recently applied to a teacher scale in the Philippines (Panela, 2025a).

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Teachers' Integration, Competence, and Effectiveness

Teachers' technology integration was Very High at substitution (*M* = 3.64) and High at augmentation (*M* = 3.47) but only Moderate at modification (*M* = 2.73) and Very Low at redefinition (*M* = 1.85). Competence was Very High in basic operations, communication media, productivity software, and web resources (3.50 to 3.72) but lower in setup and troubleshooting (3.40) and content development (3.18). Effectiveness was strongest in relational expertise (3.54) and lowest in teaching-related behavior (3.44), with real-world connections (3.05) and feedback (3.18) the weakest indicators. Integration and competence were associated with trainings, school, educational attainment, position, age, and years in teaching. In equity terms, these results mean that the tasks most likely to engage learners cognitively are the ones least used, and that their use depends on the training and school support teachers receive (Cortez et al., 2024; Musasa et al., 2024).

Teacher Variables in Relation to Learners' Engagement

Table 4

Correlations Involving Learner Engagement and the Teacher Variables

Variables	r	p	Shared Variance
Teaching effectiveness and learner engagement	.63	< .001	39.7%
Technology integration and learner engagement	.51	< .001	26.0%
Technology integration and teaching effectiveness	.58	< .001	33.6%
Technology integration and technological competence	.72	< .001	51.8%
Technological competence and teaching effectiveness	.45	< .001	20.3%

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

Learners' engagement was most strongly related to teaching effectiveness (*r* = .63) and moderately related to technology integration (*r* = .51) (Table 4). Integration in turn was strongly related to teachers' competence (*r* = .72) and moderately related to effectiveness (*r* = .58). All relationships were significant at $p < .001$.

These relationships show that what teachers do is closely tied to how engaged learners are, even though engagement also varies with learners' backgrounds. Effectiveness is the strongest correlate, which is consistent with the finding that learners' positive feelings center on their teachers and with research identifying the quality of instructional interaction as the main source of engagement (Zhang et al., 2024; Mendez & Lopez, 2023; Uya, 2023). Technology integration is associated with engagement as well, but less strongly, and it is itself linked to effectiveness, which suggests that technology contributes to engagement mostly through good teaching (Rahimi & Rezvani, 2023; Li & Wang, 2024). For equity, this is encouraging: effective teaching is something schools can strengthen for all learners, whatever their families' circumstances. Because the analysis is correlational and the background variables were not controlled in the correlations, the findings do not show how much teaching effectiveness can offset family disadvantage; that question requires a multivariate or multilevel analysis.

An Equity-Oriented Learning Action Cell

The results suggest that the district-based LAC should give explicit attention to equity. Technology-enhanced tasks should be designed to be completed in school, using shared devices and offline-capable tools, so that learners without home connectivity are not left behind (Fernandez, 2024). Lessons should draw on learners' everyday contexts, including farming, fishing, small trade, and household budgeting, to make mathematics relevant and to build on the strengths learners bring from home (Smith & Johnson, 2024; Lave & Wenger, 2020). Teachers should learn to scaffold self-regulation and strategy use explicitly, since many learners cannot obtain this support at home (Zimmerman & Schunk, 2022). Because school context matters, the LAC should operate across schools, with resource-sharing hubs and mobile ICT support for less-resourced schools, as provided in the manuscript's program framework. The LAC's effectiveness will also depend on whether teachers have the time and support to take on these practices; teachers' experiences with action research during the pandemic show that capacity building succeeds when barriers such as workload and limited guidance are addressed directly (Panela, 2025e).

Conclusion

Grade 9 learners in Area 2 of the Schools Division of Leyte come mostly from low-income households with modest parental education, and their engagement in mathematics is strongest in feeling, moderate in behavior, and weakest in thought. Engagement varies significantly with family income, school, and both parents' education and occupation, but not with age or sex, and perceptions of teaching effectiveness vary with the same factors and with sex. Teachers integrate technology mainly at the substitution and augmentation levels, are competent with routine tools but less so with content development, and are perceived as effective, especially in their relationships. Learners' engagement is most strongly associated with teaching effectiveness and moderately associated with technology integration.

Schools and the division should strengthen engagement for all learners through a district-based LAC that develops teachers' capacity for transformative, in-school technology tasks, contextualized lessons, and explicit teaching of self-regulation and learning strategies. Resources should be shared across schools to reduce disparities, and learners from low-income families should have guaranteed access to devices and connectivity during school hours. Teachers' professional development should begin from an assessment of their existing competencies (Panela, 2025d), and teachers' own well-being should be protected as demands grow; research on digital tools that help teachers manage workplace stress offers one direction (Panela, 2026). The longer-term effects of the pandemic on learners' engagement warrant continued study (Panela, 2025c). Future research should examine the relationships through multilevel models that separate school, family, and teacher influences.

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