

Student Mathematics Motivation and Engagement among Senior High School Students: Basis for a Proposed Enhancement Framework

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Abstract

This quantitative cross-sectional descriptive-correlational study examined the association between student Mathematics motivation and Mathematics engagement among 300 Grade 11 students from three private Catholic senior high schools in Davao City, Philippines. Within the three participating schools, nine Grade 11 sections were selected through simple random sampling, and eligible students in the selected sections comprised the study sample. Adapted questionnaires measured student Mathematics motivation across intrinsic motivation, extrinsic motivation, and perception of Mathematics, and Mathematics engagement across emotional, social, and cognitive engagement. Data were analyzed using means, standard deviations, Pearson product-moment correlation, and single-predictor linear regression. Results showed high student Mathematics motivation ($M = 3.61$, $SD = 0.55$) and high Mathematics engagement ($M = 3.85$, $SD = 0.79$). Motivation was positively associated with engagement, $r = .628$, $p < .001$, 95% CI [.554, .692]. The regression model was significant, $F(1, 298) = 194.06$, $p < .001$, and higher self-reported Mathematics motivation statistically predicted higher self-reported Mathematics engagement, $B = 0.90$, $SE = 0.06$, 95% CI [0.782, 1.018], $\beta = .628$. The model explained 39.4% of the variance in engagement. Because the study was cross-sectional and based on self-report data, these findings are interpreted as association and statistical prediction rather than causal determination. The results, together with theory and prior literature, informed a proposed enhancement framework whose pathways require further validation.

Keywords: engagement, framework, Mathematics, motivation, secondary education

1. Introduction

Mathematics engagement remains a central concern in secondary education because Mathematics functions as a gateway subject for higher education, technical employment, scientific literacy, civic reasoning, and daily problem solving. Engagement in Mathematics cannot be reduced to class attendance, passive compliance, or the completion of assigned exercises. It reflects the extent to which students invest emotion, social participation, and mental effort in mathematical activity. Fredricks et al. (2004) described engagement as a multidimensional construct that includes behavioral, emotional, and cognitive participation, while Wang et al. (2016) extended this logic to Mathematics and science through subject-specific measures that capture visible, affective, and intellectual participation. For senior high school students, this multidimensional view is important because learners may remain physically present in a Mathematics class yet withdraw from the reasoning, persistence, and peer exchange that meaningful mathematical learning requires.

The contemporary learning context gives urgency to the problem. The 2022 cycle of the Programme for International Student Assessment documented substantial concern in Mathematics performance across many education systems, with the Philippines scoring below the OECD average in Mathematics (OECD, 2023a, 2023b). Although achievement scores are not the same as engagement, they raise a closely related educational question: what helps students remain willing to participate, persist, reason, and maintain interest when Mathematics is perceived as demanding, abstract, or emotionally difficult? A response based only on content remediation may overlook motivational conditions that are associated with students' willingness to exert effort. A stronger response should therefore examine motivational factors associated with students' emotional, social, and cognitive participation in mathematical work.

Mathematics education research has increasingly treated engagement as a subject-specific construct rather than a generic indicator of school participation. Jansen et al. (2023) argued that secondary Mathematics engagement requires careful attention because teachers often observe different forms of participation, including students' visible work, willingness to explain ideas, sustained effort, and sense-making during mathematical tasks. Middleton et al. (2023) showed that students' prior motivation, task-level emotions, and appraisals of value and control have meaningful relationships with Mathematics

engagement during the first year of high school. Ryan et al. (2022) likewise found that student interest, attitudes, emotions, and self-beliefs are central to willingness to engage in Mathematics after transition to secondary education. These findings suggest that engagement in Mathematics is not a single classroom behavior. It is a coordinated pattern of affective response, social interaction, and cognitive effort.

Student Mathematics motivation is a theoretically relevant correlate of Mathematics engagement because it captures students' reasons for engaging with and sustaining effort in mathematical tasks. Self-determination theory explains that motivation varies in quality, ranging from controlled forms that depend mainly on external pressure to autonomous forms grounded in personal value, interest, and internal endorsement (Ryan & Deci, 2020; Vansteenkiste et al., 2020). In educational settings, Howard et al. (2021) showed that different forms of student motivation are associated with distinct academic and well-being outcomes, while Bureau et al. (2022) found that need-supportive conditions, particularly those that support competence and autonomy, strengthen self-determined motivation. These theoretical and empirical patterns matter in Mathematics because the subject often demands delayed success, repeated practice, tolerance for error, and conceptual persistence.

Motivation in Mathematics is not limited to enjoyment. It includes intrinsic motivation, extrinsic motivation, and students' perception of Mathematics as useful, meaningful, difficult, or attainable. Intrinsic motivation refers to engagement in Mathematics because the learner finds satisfaction, curiosity, or personal interest in mathematical ideas. Extrinsic motivation refers to participation shaped by grades, recognition, family expectations, future aspirations, or other external outcomes. Perception about Mathematics concerns how students evaluate the subject's relevance, usefulness, and accessibility. Eccles and Wigfield (2020) argued that students' choices, persistence, and performance are shaped by the value they attach to a task and their beliefs about success. In Mathematics, students who see the subject as valuable and learnable have stronger grounds for sustained effort than those who view it as irrelevant or reserved only for naturally gifted learners.

The coexistence of intrinsic and extrinsic motives is especially relevant in senior high school. Students at this level often connect Mathematics with grades, strand requirements, college admission, board program prerequisites, scholarships, and family expectations. Such external motives are not automatically harmful. Self-determination theory recognizes that extrinsic motives may become more adaptive when students internalize them as personally important rather than experience them as mere pressure (Ryan & Deci, 2020). In this sense, high extrinsic motivation can support engagement when teachers help learners connect Mathematics to meaningful goals and personal futures. At the same time, overdependence on grades or rewards may produce shallow participation if students comply only for external approval. A balanced model must therefore examine motivation not as a single score alone but also through its underlying dimensions.

Recent measurement work also reinforces the need to treat Mathematics motivation as domain-specific and multidimensional. Fiorella et al. (2021) validated a Mathematics motivation questionnaire for secondary students that distinguished intrinsic value, self-regulation, self-efficacy, utility value, and test anxiety, while Zhang et al. (2023) found that intrinsic and extrinsic motivation were related differently to cognitive engagement among Chinese senior secondary students. These studies indicate that motivational components do not operate identically and that their associations with engagement may depend on educational and cultural context.

In the Philippine context, Mathematics motivation has been examined alongside self-efficacy and school type. Cayubit et al. (2020) reported differences in academic motivation between Filipino students from private and public high schools and found that Mathematics self-efficacy predicted intrinsic motivation. In Davao Oriental, Nazareth-Tanaid and Osic (2023) also reported significant associations between self-efficacy and students' Mathematics motivation. However, these studies did not directly examine how an overall multidimensional Mathematics-motivation construct is associated with emotional, social, and cognitive Mathematics engagement among Grade 11 learners in private Catholic senior high schools. The present study therefore addresses a context-specific gap. The private Catholic setting is treated as an institutional context of interest, not as a basis for generalizing to all senior high school students in the Philippines.

The present study focuses on Grade 11 students in three private Catholic senior high schools in Davao City. It examines student Mathematics motivation and Mathematics engagement to determine the strength of their association and the extent to which motivation statistically predicts engagement within this sample. The study does not assume that motivation is the sole cause of engagement or that temporal precedence can be established from cross-sectional data. Rather, the results are used, together with theory and prior literature, to formulate a proposed practice-oriented enhancement framework for further validation.

The study was anchored in the view that motivational factors associated with Mathematics engagement can provide a practical basis for classroom planning. A focused model offers practical value because teachers and school leaders need factors that can be measured, discussed, and addressed within routine instruction. Where student Mathematics motivation is strongly associated with emotional, social, and cognitive engagement, schools may consider classroom strategies that make Mathematics more interesting, valuable, connected to future goals, and accessible to students. This approach frames the proposed enhancement framework as a practice-oriented application of correlational findings rather than evidence of intervention effectiveness.

This study addressed the following research questions:

- What is the level of student Mathematics motivation among senior high school students?
- What is the level of Mathematics engagement among senior high school students?
- Is there a significant relationship between student Mathematics motivation and Mathematics engagement?
- Does student Mathematics motivation significantly predict self-reported Mathematics engagement within the sample?
- What proposed Mathematics engagement enhancement framework can be formulated from the study findings and relevant literature?

2. Method

2.1 Design and Setting

The study used a quantitative cross-sectional descriptive-correlational design. This design was appropriate for describing naturally occurring variables and examining statistical relationships without experimental manipulation (Creswell & Creswell, 2023). The descriptive component summarized students' self-reported Mathematics motivation and Mathematics engagement, while the correlational component examined the strength and direction of the association between the two variables. A single-predictor linear regression was used as a statistical prediction model to estimate the proportion of variance in engagement associated with motivation; it was not used to infer causal influence or temporal precedence. After the quantitative analyses, the observed patterns were synthesized with self-determination theory, expectancy-value perspectives, and Mathematics engagement literature to formulate a proposed practice-oriented enhancement framework. The framework was not directly tested or independently validated and is therefore presented as a provisional application of the study findings. The study was conducted in three private Catholic senior high schools in Davao City, Philippines, during School Year 2024–2025, with school identities anonymized.

2.2 Respondents and Sampling

The accessible population comprised 1,200 Grade 11 students enrolled in the three participating private Catholic senior high schools during School Year 2024–2025. These three schools served as the participating study sites. Within the three schools, nine Grade 11 sections were selected through simple random sampling, and all eligible students in the selected sections were invited to participate. Of the 300 students invited, all 300 submitted usable questionnaires, yielding a 100% response rate. The final sample was distributed equally across the three schools: School A, $n = 100$; School B, $n = 100$; and School C, $n = 100$. Because students were nested within sections and schools, observations were not fully independent at the cluster level. The primary analyses did not adjust standard errors for clustering, and this is acknowledged as a limitation because only three school-level sites were represented.

2.3 Measures

Student Mathematics motivation was assessed using an adapted version of the Student Mathematics Motivation Scale developed by Nurkarim et al. (2023). The original scale contains 19 items distributed across intrinsic goals (8 items), extrinsic goals (5 items), and perceptions of Mathematics (6 items), using a five-point response format. Nurkarim et al. developed the scale with junior high school students in Indonesia and reported an overall Cronbach's alpha of .817. In the present study, all 19 items were retained in their original subscales, and the adaptations consisted of minor wording modifications to align with the local senior high school context and phrasing, rather than the original junior high school setting. Negatively worded items were reverse-coded before subscale and overall scores were computed. The final-sample reliability analysis yielded a strong internal consistency, with an overall Cronbach's alpha of .84, and subscale alphas of .82 for intrinsic goals, .78 for extrinsic goals, and .80 for perceptions of Mathematics.

Mathematics engagement was measured using a modified student-report scale based on Wang et al. (2016). The original Math and Science Engagement Scales conceptualize engagement through cognitive, behavioral, emotional, and social dimensions. The present study retained only emotional, social, and cognitive engagement because behavioral engagement overlapped significantly with classroom attendance and assignment completion metrics already tracked by the schools, making self-reporting redundant; behavioral engagement was not measured and is not inferred from the present results. The retained version contained 24 items: emotional engagement (8 items), social engagement (8 items), and cognitive engagement (8 items), using a five-point frequency scale. Adaptations included contextual adjustments to ensure the scenarios described were culturally appropriate and applicable to the specific curriculum of the participating schools. Wang et al. (2016) reported student-report Mathematics reliability coefficients of .93 for overall engagement, .75 for cognitive engagement, .82 for behavioral engagement, .89 for emotional engagement, and .74 for social engagement. In the present study, the final-sample reliability coefficients were .91 for the retained overall engagement scale, .87 for emotional engagement, .76 for social engagement, and .80 for cognitive engagement.

The adapted questionnaire was reviewed by three experts for content relevance, clarity, and alignment with the study objectives using a standardized validation rubric evaluating each item on a 4-point scale for clarity, relevance, and age-appropriateness. The review resulted in minor rephrasing of three complex items to improve readability and the replacement of a few localized terms from the original scale with their Philippine equivalents. A pilot survey involving 35 students was conducted before full data collection to assess item clarity and preliminary reliability. No exploratory or confirmatory factor analysis was conducted in the present study; accordingly, the factor structure of the adapted scales was not independently revalidated, and this is acknowledged as a measurement limitation.

2.4 Variable Specification

The independent variable was student Mathematics motivation, operationalized through three indicators: intrinsic motivation, extrinsic motivation, and perception about Mathematics. Intrinsic motivation referred to students' personal interest, satisfaction, and willingness to learn Mathematics for its own intellectual value. Extrinsic motivation referred to reasons for studying Mathematics connected with grades, recognition, expectations, and future benefits. Perception about Mathematics referred to students' beliefs about the usefulness, relevance, difficulty, and attainability of the subject. The dependent variable was Mathematics engagement, operationalized through emotional, social, and cognitive engagement. Emotional engagement referred to students' interest, enjoyment, and positive affect toward Mathematics learning. Social engagement referred to peer interaction, idea sharing, and help-seeking or help-giving during Mathematics activities. Cognitive engagement referred to effort, persistence, deep thought, and desire to understand mathematical concepts.

2.5 Data collection and Ethics

The data collection process followed a structured protocol. Permission to conduct the study was obtained from the appropriate institutional and school authorities before the survey was administered. Ethical approval was obtained from the University of the Immaculate Conception Ethics Review Committee. For participants below 18 years old, written parent or guardian consent and student assent were obtained before participation. Students were informed that participation or refusal would not affect their grades, school standing, or relationship with teachers, and that they could decline or withdraw without penalty. To ensure confidentiality and prevent undue peer or teacher pressure during data collection, all survey materials were distributed in identical opaque envelopes. Students who chose not to participate or who lacked parental consent were instructed to simply remain in their seats and return the blank questionnaire sealed in the envelope, ensuring their non-participation was not visible to their teachers or classmates. The respondents completed the questionnaire in a classroom or school facility under the supervision of the researcher. Survey completion required approximately 30 to 45 minutes. Participation was voluntary, and respondents were informed that they could skip any item or withdraw without penalty. No personally identifiable information was included in the data set used for analysis. The collected data were stored securely in a password-protected digital file, and access was restricted to research purposes. These safeguards were applied to protect privacy, autonomy, and participant welfare.

2.6 Data Analysis

The data were analyzed in four stages. First, means and standard deviations were computed to determine the level of student Mathematics motivation and the level of Mathematics engagement by indicator and overall mean. The interpretation followed the five-point scale ranges: 4.20 to 5.00 as very high, 3.40 to 4.19 as high, 2.60 to 3.39 as moderate, 1.80 to 2.59 as low, and 1.00 to 1.79 as very low. Second, Pearson product-moment correlation was used to test the relationship between student Mathematics motivation and Mathematics engagement. Third, single-predictor linear regression was used to determine whether student Mathematics motivation significantly predicted Mathematics engagement. Fourth, the framework was developed by aligning the strongest empirical patterns with motivational theory and Mathematics engagement literature. The framework was organized to show how motivational targets can be translated into classroom actions that support emotional, social, and cognitive engagement.

Before analysis, the dataset was screened for completeness and data-entry errors. No missing values were present in the analytic dataset, and no imputation was required. For Pearson correlation and simple linear regression, assumptions were evaluated using scatterplots to verify linearity, Q-Q plots and histograms to assess the normal distribution of residuals, residual-versus-fitted plots to confirm homoscedasticity, and Cook's distance to check for influential outliers. Because the regression model contained only one predictor, multicollinearity was not applicable. Two-sided 95% confidence intervals were reported for the principal correlation and regression coefficient. The analysis did not adjust for clustering by school or section.

3. Results

Table 1 presents the descriptive statistics for student Mathematics motivation. The overall mean was 3.61 with a standard deviation of 0.55, described as high. Among the indicators, extrinsic motivation obtained the highest mean ($M = 3.77$, $SD = 0.56$), followed by perception about Mathematics ($M = 3.66$, $SD = 0.59$) and intrinsic motivation ($M = 3.40$, $SD = 0.50$).

Table 1. Descriptive Statistics for Student Mathematics Motivation

Indicator	M	SD	Description
Intrinsic motivation	3.40	0.50	High
Extrinsic motivation	3.77	0.56	High
Perception about Mathematics	3.66	0.59	High
Overall	3.61	0.55	High

Note. N = 300. Scale interpretation: 3.40 to 4.19 = high.

Table 2 presents the descriptive statistics for Mathematics engagement. The overall mean was 3.85 with a standard deviation of 0.79, described as high. Among the indicators, cognitive engagement obtained the highest mean ($M = 4.19$, $SD = 0.69$), followed by emotional engagement ($M = 3.73$, $SD = 0.79$) and social engagement ($M = 3.63$, $SD = 0.88$).

Table 2. Descriptive Statistics for Mathematics Engagement

Indicator	M	SD	Description
Emotional engagement	3.73	0.79	High
Social engagement	3.63	0.88	High
Cognitive engagement	4.19	0.69	High
Overall	3.85	0.79	High

Note. N = 300. Scale interpretation: 3.40 to 4.19 = high.

Table 3 presents the correlation between student Mathematics motivation and Mathematics engagement. The analysis showed a positive and significant relationship between student Mathematics motivation and Mathematics engagement, $r = .628$, 95% CI [.554, .692], $p < .001$.

Table 3. Correlation Between Student Mathematics Motivation and Mathematics Engagement

Variables	r	95% CI	p	Decision
Student Mathematics motivation and Mathematics engagement	.628	[.554, .692]	< .001	Significant

Note. N = 300. Two-tailed test.

Table 4 presents the regression of Mathematics engagement on student Mathematics motivation. The regression model was significant, $F(1, 298) = 194.06$, $p < .001$. Student Mathematics motivation was a significant statistical predictor of Mathematics engagement, $B = 0.90$, $SE = 0.06$, 95% CI [0.782, 1.018], $\beta = .628$, $t = 13.93$, $p < .001$. The model accounted for 39.4% of the observed variance in engagement, $R^2 = .394$, adjusted $R^2 = .392$.

Table 4. Regression of Mathematics Engagement on Student Mathematics Motivation

Predictor	B	SE	95% CI	β	t	p
Student Mathematics motivation	0.90	0.06	[0.782, 1.018]	.628	13.93	< .001

Note. N = 300. Model summary: $R = .628$, $R^2 = .394$, adjusted $R^2 = .392$, $F(1, 298) = 194.06$, $p < .001$.

4. Discussion

The findings show that senior high school students reported a high level of Mathematics motivation. This result is important because motivation provides the psychological basis for effort, persistence, and participation in a subject that many students regard as difficult. Ryan and Deci (2020) explain that motivation differs in quality, and that student behavior can be shaped by intrinsic interest, identified value, external expectations, or pressure. The present pattern suggests that students did not approach Mathematics with indifference. Their responses show that Mathematics had enough personal, academic, and future-oriented value to support participation in the subject.

Extrinsic motivation obtained the highest mean among the motivation indicators, but this finding requires a more cautious interpretation. The present data do not establish whether students' external reasons were autonomously internalized as personally meaningful goals or reflected controlled pressures such as grades, compliance, family expectations, or school demands. Self-determination theory distinguishes these forms of extrinsic motivation because they can have different implications for persistence and well-being (Ryan & Deci, 2020). Accordingly, the result is interpreted as evidence that external or future-oriented reasons were salient to respondents, not as evidence that extrinsic motivation was uniformly adaptive.

At the same time, the lower mean for intrinsic motivation deserves careful pedagogical attention. Intrinsic motivation remained high, but it was the lowest among the three motivation indicators. Ryan and Deci (2020) stress that intrinsic motivation is sustained when students experience interest, autonomy, and satisfaction in the activity itself. Reeve and Cheon (2021) also argue that autonomy-supportive teaching can be developed by teachers and can improve educational practice

when students are invited to make choices, explain their thinking, and experience a sense of ownership. For Mathematics instruction, this implies that grades and future benefits should not be the only reasons students study the subject. Teachers may therefore consider designing tasks that encourage curiosity, appropriate challenge, productive struggle, and discovery.

Students' perception about Mathematics was also high. This result is theoretically meaningful because perception about Mathematics closely resembles the value and expectancy components that Eccles and Wigfield (2020) identified as central to motivation. When students perceive Mathematics as useful, relevant, and intellectually worthwhile, they have stronger reasons to persist even when tasks are difficult. Schunk and DiBenedetto (2020) likewise emphasize that students' beliefs about competence and agency shape motivation and academic action. A positive perception of Mathematics can therefore convert difficulty into challenge rather than threat, especially when teachers provide clear explanations, scaffolds, feedback, and visible links between concepts and real-life applications.

Students reported a high level of Mathematics engagement across the emotional, social, and cognitive dimensions measured in this study. Engagement was strongest in the cognitive dimension, suggesting relatively stronger reported effort, thought, and desire to understand Mathematics among the three measured dimensions. Fredricks et al. (2004) framed cognitive engagement as investment in learning and willingness to exert the mental effort needed to comprehend complex ideas. Wang et al. (2016) extended this multidimensional view to Mathematics and science and showed that engagement must be examined through subject-specific indicators. In this study, the high cognitive mean is notable because Mathematics learning depends heavily on sustained reasoning, representation, procedural fluency, and conceptual sense-making.

The high self-reported levels should also be interpreted cautiously because motivation and engagement were measured through the same survey context within three private Catholic schools. The descriptive scores may partly reflect social-desirability tendencies, school norms, selection effects, or shared-method variance. The reported levels therefore characterize the participating sample and should not be generalized automatically to students in other school types or regions.

Social engagement obtained the lowest mean among the engagement indicators, although it remained high. This pattern suggests that students may invest personal effort in Mathematics but participate less strongly through peer explanation, mutual help, and collaborative reasoning. Jansen et al. (2023) observed that secondary Mathematics teachers describe engagement not only through individual work but also through student talk, explanation, and participation in shared mathematical activity. Li and Xue (2023) also found that student engagement is shaped by both internal and external conditions, including learning behavior and the learning environment. The comparatively lower social engagement mean identifies a potential area for classroom attention, including structured peer discourse, group problem solving, and reciprocal explanation.

The positive correlation between student Mathematics motivation and Mathematics engagement was strong. With $r = .628$, students with higher motivation also tended to report higher engagement. This result aligns with self-determination theory because motivation supplies the energy and direction for academic action (Ryan & Deci, 2020; Vansteenkiste et al., 2020). It also aligns with Mathematics engagement research showing that interest, value, emotion, and perceived control are closely connected with task participation (Middleton et al., 2023; Ryan et al., 2022). These findings indicate that Mathematics engagement in this sample was associated with students' reported motivational orientation. They do not establish that motivation determines engagement or exclude the contribution of classroom, teacher, peer, or other factors.

The regression model was consistent with the correlational finding: higher self-reported Mathematics motivation was associated with higher self-reported Mathematics engagement. The model accounted for 39.4% of the observed variance in engagement, but this proportion should not be interpreted as causal variance explained because both variables were measured at the same time using self-report instruments. The remaining variance also indicates that engagement is associated with other student, classroom, family, and school factors not examined in this study. The single-predictor model addresses the study's overall-motivation research question but does not identify which motivation dimension contributes most strongly after the other dimensions are considered.

The findings can inform, but do not validate, a proposed Mathematics engagement enhancement framework. The four pathways were formulated by aligning the descriptive patterns and the overall motivation–engagement association with self-determination theory, expectancy-value perspectives, and prior Mathematics engagement literature. Because the individual pathways and intended outcomes were not directly tested, the framework should be treated as a provisional practice model for future validation rather than an empirically established intervention model.

The first pathway is intrinsic interest and autonomy. Intrinsic motivation had the lowest mean among the three motivation dimensions, although it remained within the high range. Consistent with self-determination theory and autonomy-supportive teaching, the framework therefore proposes classroom experiences that may encourage interest, choice, curiosity, and meaningful participation, such as real-life problems, inquiry prompts, limited task choice, student-generated examples, and short challenge tasks (Ryan & Deci, 2020; Reeve & Cheon, 2021). These strategies are presented as provisional classroom directions rather than validated interventions and require future evaluation.

The second pathway is external academic value and internalization. Because extrinsic motivation obtained the highest mean, the framework does not propose removing external goals from Mathematics learning. Rather, teachers may consider helping students connect such goals with personally meaningful reasons for learning. Ryan and Deci (2020) explain that extrinsic motivation becomes more adaptive when students recognize the personal importance of the behavior. Eccles and Wigfield (2020) similarly emphasize utility value, attainment value, and identity relevance. In practice, Mathematics teachers can connect lessons with college programs, health sciences, business decisions, technology, engineering, household finance, and community problem solving. Such connections help students see Mathematics as a meaningful pathway rather than a requirement imposed only for grades.

The third pathway is positive mathematical perception and competence. The results show that students generally perceived Mathematics positively, and this perception may be supported through classroom experiences that make progress and success visible and attainable. Vansteenkiste et al. (2020) explain that competence is a basic psychological need that supports motivation and well-being. Bureau et al. (2022) also found competence to be a particularly strong predictor of self-determined motivation. For Mathematics, teachers may consider using scaffolded tasks, worked examples, formative checks, feedback focused on strategy, and error analysis that treats mistakes as information for learning. Such practices can protect students from the belief that Mathematics ability is fixed.

The fourth pathway is the social-cognitive engagement cycle. Cognitive engagement was the strongest engagement dimension, while social engagement was comparatively weaker. The framework therefore proposes using students' existing cognitive effort as a basis for peer interaction. Middleton et al. (2023) demonstrated the relevance of value, control, teacher support, and peer support in Mathematics engagement, while Jansen et al. (2023) showed that engagement in secondary Mathematics is visible in the ways students explain, ask, collaborate, and make sense of ideas. Teachers may consider using think-pair-share, peer tutoring, small-group proof discussion, solution comparison, and structured mathematical talk to connect individual effort with social reasoning. This approach is proposed as a way to support social engagement while maintaining cognitive demand, subject to future evaluation.

Taken together, the findings provide a rationale for a provisional framework that aligns motivation-related classroom strategies with emotional, social, and cognitive engagement. The framework does not establish the effectiveness of these strategies. Rather, it proposes that intrinsic interest, external value, positive perception, and social-cognitive participation can be considered together in future classroom applications and validation studies. The effects of these proposed strategies on engagement should be evaluated empirically.

Table 5. Proposed Mathematics Engagement Enhancement Framework

Framework pathway	Motivational target	Classroom direction	Intended engagement focus
Intrinsic interest and autonomy	Intrinsic motivation	Use real-life problems, inquiry prompts, limited task choice, student-generated examples, and short challenge tasks.	Greater emotional interest and voluntary participation in Mathematics tasks.
External academic value and internalization	Extrinsic motivation	Connect Mathematics to academic progression, careers, family aspirations, college pathways, and community problem solving.	Stronger persistence and clearer personal reasons for sustained effort.
Positive mathematical perception and competence	Perception about Mathematics	Use scaffolding, mastery feedback, error analysis, worked examples, and visible progress tracking.	Higher confidence, stronger task persistence, and reduced avoidance of difficult concepts.
Social-cognitive engagement cycle	Motivated participation	Use peer explanation, solution comparison, cooperative problem solving, and structured mathematical talk.	Stronger social engagement while maintaining cognitive effort and reasoning.

Note. The framework is a provisional, literature-informed practice model based on the study's descriptive and associational results. The four pathways and intended engagement focuses were not directly tested and require independent validation before claims of effectiveness can be made.

4.1 Limitations

This study has several limitations. First, its cross-sectional correlational design does not establish temporal precedence or causality between Mathematics motivation and engagement. Second, motivation and engagement were measured through self-report at the same time, creating possible common-method and social-desirability bias. Third, participants were drawn from only three private Catholic senior high schools in Davao City, which limits generalizability to public schools, other regions, and different institutional contexts. Fourth, students were nested within sections and schools, but the analysis did not adjust standard errors for clustering. Fifth, the questionnaires were adapted for the present context, and no factor-analytic revalidation of the adapted structure was conducted; therefore, measurement equivalence with the original instruments cannot be assumed. Finally, the proposed enhancement framework was derived from overall descriptive and associational findings combined with theory and literature; its specific pathways and practical effectiveness were not directly tested. Future studies should use longitudinal or experimental designs, broader and more diverse samples, cluster-aware analyses, and independent validation of the adapted measures and proposed framework.

5. Conclusion

The study found high self-reported Mathematics motivation and high self-reported Mathematics engagement among the participating Grade 11 students. Extrinsic motivation had the highest descriptive mean among the motivation dimensions, while cognitive engagement had the highest mean among the engagement dimensions. Mathematics motivation was positively associated with engagement, $r = .628$, $p < .001$, and the single-predictor regression model accounted for 39.4% of the observed variance in engagement. These results indicate a meaningful statistical relationship within the participating sample but do not establish that motivation causes engagement. The findings, interpreted alongside relevant theory and literature, informed a proposed Mathematics engagement enhancement framework centered on intrinsic interest and autonomy, external academic value and internalization, positive mathematical perception and competence, and social-cognitive participation. Because the framework pathways were not directly tested, the framework should be treated as a provisional practice model that requires further validation before claims of effectiveness or broader applicability are made.

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Author contributions

Claribel O. Fernandez was responsible for the conceptualization and design of the study, data collection, data analysis and interpretation, and preparation of the manuscript. The author also reviewed and revised the manuscript and approved the final version for publication.

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Data sharing statement

No additional data are available.

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