

Understanding What Drives Filipino Students to Like Mathematics: Evidences from Large Scale Assessment

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Abstract

This study investigated the psychosocial and instructional factors that influence Filipino students' preference for mathematics, which focused on the roles of teacher support, instructional quality and growth mindset. Despite the foundational role of mathematics in academic and career pathways, many Filipino learners exhibit low interest in the subject. Addressing this challenge, the study draws on Expectancy-Value Theory, Self-Determination Theory and Mindset Theory to examine how perceived teacher support and instructional quality serves as a statistically significant positive predictor of math preference and whether these relationships are moderated by a growth mindset. Secondary data were drawn from the 2022 Programme for International Student Assessment (PISA), involving 6,258 15-year-old students from a nationally representative sample of public and private schools in the Philippines. Instruments for measuring preference for mathematics (ST268), quality of mathematics instruction (ST272), mathematics teacher support (ST270), growth mindset (ST263) were developed and validated by the OECD. Controlling for sex and socioeconomic status, results showed that both perceived teacher support and instructional quality significantly predict students' preference for mathematics. Furthermore, growth mindset significantly moderates these relationships: students with stronger growth mindsets benefit more from high-quality instruction and supportive teacher behaviors. These results emphasize the multifaceted nature of math preference and suggest that a growth-oriented classroom culture is associated with stronger perceptions of instructional and relational supports. Implications for practice include the integration of growth mindset principles in teacher training and curriculum development, as well as prioritizing student-centered, supportive teaching methods.

Keywords: Assessment, Education, Mindset, Preference, Support.

Introduction

In the Philippines, mathematics is especially significant due to its role in national education standards and its impact on future career opportunities. Although many people view mathematical ability as an innate talent, research indicates that students' interest and preference for math arise from a combination of instructional practices, motivational beliefs and social-emotional support (1-3). Although mathematical ability is frequently viewed as an innate talent, extensive research indicates that student interest and preference for math stem from an interplay of instructional practices, motivational beliefs and social-emotional support (1-3). Understanding these contributing factors is particularly relevant in developing nations where schools encounter systemic challenges, such as limited institutional resources and strong sociocultural expectations regarding achievement (4). Despite empirical

evidence that instructional and affective factors shape engagement with mathematics (5, 6), little is known regarding how these dynamics manifest in the Philippines, where educational, cultural and resource conditions differ markedly.

Evidence demonstrates that positive, well-structured classroom environments enhance students' sense of belonging and personal competence, which subsequently increases their motivation to learn mathematics (2). Likewise, effective teaching, characterized by instructional clarity, constructive feedback and active student participation, plays a vital role in sustaining long-term interest (7, 8). However, ongoing challenges in teacher preparation and institutional support frequently hinder high-quality instruction within Philippine schools (9). Teacher support is equally pivotal. When learners perceive educators as approachable, encouraging and genuinely

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invested in their success, they build stronger self-concepts and positive mathematical attitudes (10). Supportive classroom relationships not only improve academic performance but also help students persist during academic difficulties (11). Yet, the extent to which teacher support and instructional quality translate into affective engagement may depend on students' own motivational orientations, particularly their learning mindset. Specifically, students possessing a growth mindset are more likely to interpret academic challenges as meaningful learning opportunities rather than indicators of fixed intellectual ability (12). This belief system can amplify the positive effects of high-quality instruction and teacher support by fostering feedback receptivity, resilience after failure and appreciation for effortful learning (13). Conversely, fixed-mindset students may derive fewer benefits, viewing difficulty as a threat to competence. Thus, growth mindset acts as a moderating factor conditioning these supportive relationships.

Furthermore, demographic characteristics like gender and socioeconomic status shape students' experiences which influencing mindsets and preferences (14, 15). Yet, research investigating the joint effects of instruction, teacher support and growth mindset within a large-scale Philippine context remains scarce. To address these literature gaps, this empirical study utilizes large-scale national assessment data to examine factors driving Filipino students' mathematics preference. Specifically, it aims to: examine whether instructional quality significantly predicts mathematics preference; determine if teacher support predicts such preference; and test if growth mindset moderates these associations. Gender and socioeconomic status are statistically controlled.

Theoretical Framework

We adapted an integrated framework combining Expectancy-Value Theory (16), Self-Determination Theory (17) and Mindset Theory (18) to account for Filipino students' mathematics preferences. Instead of relying on a singular factor, this model posits that engagement emerges from the dynamic interplay of contextual influences (instructional quality), interpersonal dynamics (teacher support) and intrapersonal orientations (growth mindset). From the perspective of

Expectancy-Value Theory, students engage in mathematics based on their beliefs about their likelihood of success and the value they attach to the subject. High-quality instruction, delivered through clear explanations, scaffolded tasks and formative feedback, reinforces success expectancies (19-21). Furthermore, when teachers display supportive behaviors such as empathy and constructive encouragement, subjective task value increases, directly influencing task choices and future STEM trajectories (22, 23).

Self-Determination Theory advances this perspective by emphasizing the fulfillment of three fundamental psychological needs, i.e., autonomy, competence and relatedness. Autonomy-supportive feedback and classroom environments that cultivate belonging satisfy these needs, which then drives intrinsic motivation (24, 25). In this setting, teacher support acts as both a catalyst for engagement and a mechanism for internalizing mathematics as an enjoyable, worthwhile pursuit. Complementing these frameworks, Mindset Theory adds an intrapersonal lens for understanding responses to academic challenges. Learners with a growth mindset view setbacks as 'opportunities' to learn rather than reflections of 'fixed' ability (26). Consequently, growth-minded students persist through difficulty and fully benefit from quality instruction and supportive teaching; this reinforces positive expectancies, intrinsic motivation and mathematical resilience (27). These integrated theories explain how contextual, relational and psychological factors converge to shape engagement (28-30). These three theories work together to explain why students like math. A supportive teacher first meets a student's basic emotional needs, which builds their confidence to succeed and helps them see math as valuable. A growth mindset then acts as a lens, allowing students to process tough math challenges and teacher feedback as opportunities to learn rather than reasons to give up. However, research examining how these variables jointly operate within the Philippine context remains scarce. To address this empirical gap in Figure 1, this study tests four primary hypotheses:

H1: Perceived mathematics teacher support predicts students' preference for mathematics, controlling for sex and SES.

H2: Growth mindset moderates the relationship between perceived mathematics teacher support

and mathematics preference, strengthening the positive association for students with higher growth mindsets.

H3: Perceived quality of mathematics instruction predicts students' preference for mathematics, controlling for sex and SES.

H4: Growth mindset moderates the relationship between perceived quality of instruction and mathematics preference, strengthening the positive association for students with higher growth mindsets.

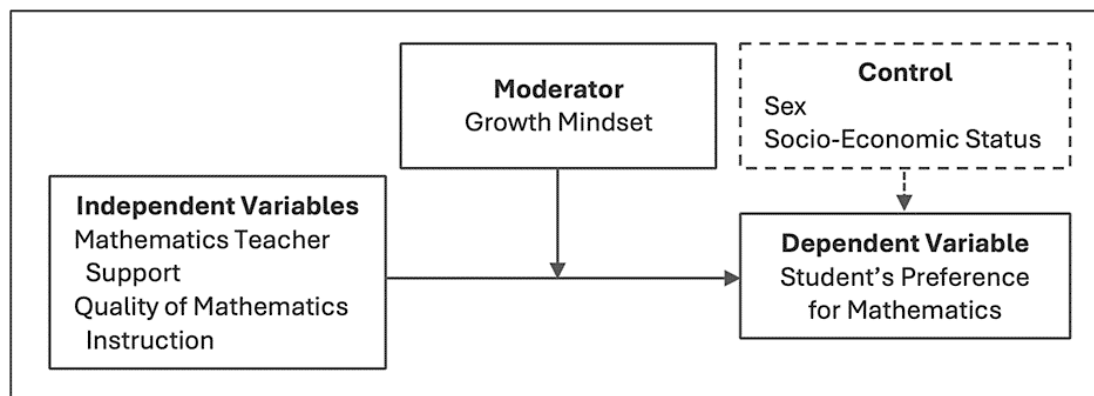


Figure 1: Conceptual Framework of the Study

Methodology

This study employed a quantitative, correlational research design, specifically a moderation analysis using hierarchical regression, to examine how students' preference for mathematics is influenced by their perceived quality of mathematics instruction and mathematics teacher support and whether these relationships are moderated by their growth mindset. The study draws on secondary data from the Programme for International Student Assessment (PISA) 2022, a large-scale international assessment conducted by the Organisation for Economic Co-operation and Development (OECD). The Philippines participated in this administration, collecting a nationally representative sample of 15-year-old students from various public and private schools across the country.

PISA employed a two-stage stratified sampling design to establish a nationally representative sample of 15-year-old students enrolled in Grade 7 or higher across public and private schools nationwide. In the first stage, schools were sampled using systematic Probability Proportional to Size (PPS) selection based on explicit geographic and institutional strata; in the second stage, a target cluster of approximately 42 eligible students was randomly selected within each participating school. Data collection was conducted through a proctored Computer-Based Assessment (CBA) consisting of a two-hour cognitive test evaluating reading, mathematics and science literacy,

alongside a contextual Student Questionnaire measuring individual socioeconomic status, home background and learning environment (31).

The development and validation of the PISA 2022 questionnaire were carried out using a comprehensive, multi-faceted approach to determine both validity and reliability across diverse international students. According to the PISA 2022 Technical Report (32), the OECD employed rigorous expert reviews, systematic pilot testing and standardized translation procedures to improve content validity and cross-cultural relevance. Furthermore, advanced psychometric techniques, such as item response theory and latent regression models, were implemented to address issues of construct validity and to refine item scaling methodologies, as detailed in the theoretical considerations on scaling methodology (33). Moreover, researchers have examined the measurement invariance of the questionnaire using multiple-group confirmatory factor analysis (MGCFA) and later confirmed the consistent performance of the instrument across different countries (34).

To ensure data integrity, list-wise deletion has been applied to address missing values. From an initial sample of 7,193 Filipino students, a total of 6,258 complete responses remained and were included in the final analysis. The number of female students is 3210 (51%) and number of male students in this sample is 3048 (49%); which

indicates that both sexes are well represented. The variables utilized for this study include: sex (ST004), socio-economic status (ST259Q01JA), perceived quality of mathematics instruction (ST272, e.g., “how would you rate the quality of your mathematics instruction this school year”), mathematics teacher support (ST270), growth mindset (ST263, e.g., “Some people are just not good at mathematics, no matter how hard they study”) and preference for mathematics over other core subjects (ST268, e.g., “I want to do well in my mathematics class”). In this study, “math preference” simply means how much a student likes math compared to other school subjects. It focuses strictly on their feelings about math, rather than how confident they feel in their abilities or how well they score on tests. Researchers chose to focus on preference because, around age 15, a student's attitude toward a subject heavily influences whether they choose high school tracks like STEM and stick with them. The specific data set used in this paper can be accessed through Figshare repository.

While the scale items utilized in this study were validated internationally by the OECD using Item Response Theory (IRT) and Multiple-Group Confirmatory Factor Analysis (MGCFA) across participating countries, we relied on these global technical reports rather than conducting a distinct, country-specific measurement invariance test solely for the Philippine subgroup. As a result, while the questions are reliable on a global level, it is still possible that local cultural differences affected how Filipino students interpreted and answered them.

Moreover, although using the national PISA 2022 dataset provides a helpful big-picture look at 15-year-old Filipino students, relying on pre-made data comes with limitations. Because the international test could not be customized, it could not account for local Philippine dialects, teaching styles, or unique school conditions. Crucial factors like class size, teacher workload, school facilities, type of school and the language used in class were

also left unmeasured. To get a more complete view, future studies should collect fresh data directly from local classrooms using interviews and direct observations.

To test the proposed hypotheses, a series of three-step hierarchical multiple regression analyses were conducted. Although PISA data stem from a complex two-stage cluster sampling design, single-level unweighted regression was selected as the primary analytical approach. Unweighted OLS estimates are methodologically preferred when testing theoretical relationships and interaction effects, as controlling for key stratification variables (Sex and Socioeconomic Status) within the model yields unbiased and more statistically efficient parameter estimates than weighted models (35). Mean-centering was also performed to reduce multicollinearity. In each model, the first step included the control variables, namely sex and socioeconomic status. The second step added the independent variable (either perceived instructional quality or teacher support) and the moderator (growth mindset). Finally, the third step included the interaction term between the independent variable and the moderator to test for moderation effects.

Normality, multicollinearity, heteroskedasticity and autocorrelation of the data sets were tested prior to hypothesis testing. According to literature (36), data can be regarded as normally distributed when its skewness and kurtosis score falls within the range of -2 to +2. Moreover, numerous studies suggest that a Variance Inflation Factor (VIF) value below 10 and a Tolerance value above 0.1 are indicative of acceptable collinearity levels in a regression model (37, 38). Table 1 presented the skewness and kurtosis of the interval variables; and also, the VIF and tolerance values of the predictors and control variables, all of which are within the favorable values. Thus, multicollinearity and normality assumption on the distribution of the variables were met. Assumption checks for heteroskedasticity and autocorrelation for each model will be discussed in the results section.

Table 1: Skewness, Kurtosis, VIF and Tolerance of the Variables

	Normality		Multicollinearity	
	Skewness	Kurtosis	VIF	Tolerance
Math Preference*	-0.08	0.26	-	-
Math Teacher Support	-0.88	-0.04	1.05	0.95
Quality of Math Instruction	-0.18	-0.79	1.09	0.92
Growth Mindset	0.44	0.72	1.01	0.99
Socio-Economic Status	-0.22	-0.78	1.06	0.94

Sex - - 1.02 0.98

Note: Favourable value intervals are $-2 \leq \text{Skewness} \leq 2$, $-2 \leq \text{Kurtosis} \leq 2$, $\text{VIF} < 10$ and $\text{Tolerance} \geq 0.1$ *Dependent Variable.

Results

Descriptive

The results show that Filipino students have slightly above average perception regarding mathematics preference, math teacher support and quality of math instruction; except for growth mindset which fell below its midpoint of 2.5 as shown in Table 2. Meaningful relationships were found among students' preference for mathematics, perceptions of instructional quality, teacher support and their growth mindset. Unexpectedly, growth mindset showed a weak but statistically significant negative correlation with math preference. However, this result does not contradict the conceptualization of growth mindset as a moderating variable, since

moderation does not require significant zero-order correlations between the moderator and dependent variable (39, 40). Moreover, growth mindset was not significantly related to the independent variables, which is an ideal setting for regression analysis and helps mitigate multicollinearity issues. Additionally, socioeconomic status and sex demonstrate links with several academic variables, which suggests that background influences both perception and preference. These initial patterns justify further analysis through hierarchical regression to test the moderation hypotheses while controlling for the extraneous effects of socio-economic status and sex.

Table 2: Descriptive and Zero-order Correlations Among All Variables

Variable	Scale Limit	M (SD)	Pearson Correlation Matrix					
			MP	MTS	QMI	GM	SES	Sex
MP	1 – 4	2.57 (0.58)	1					
MTS	1 – 4	3.33 (0.73)	0.12***	1				
QMI	1 – 10	6.17 (2.52)	0.29***	0.19***	1			
GM	1 – 4	2.36 (0.57)	-0.06***	-0.01	0.00	1		
SES	1 – 10	6.13 (2.63)	0.08***	0.08***	0.24***	-0.03***	1	
Sex	-	-	-0.04***	-0.12***	-0.05***	0.07***	-0.01	1

Note: MP = Math Preference, MTS = Math Teacher Support, QMI = Quality of Math Instruction, GM = Growth Mindset, SES = Socio-Economic Status, SD = Standard Deviation, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Hypothesis Testing for H1 and H2

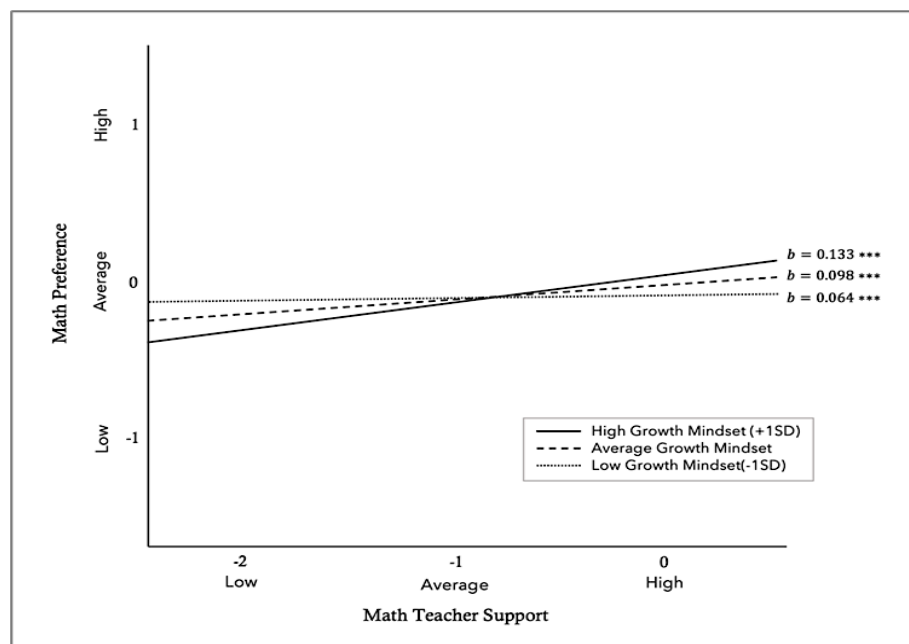
Prior to the analysis, heteroskedasticity and autocorrelation were tested. Harrison-McCabe test indicated that the variance of the residuals is approximately the same for regression model 1 ($p = 0.161$), model 2 ($p = 0.111$) and model 3 ($p = 0.127$) as shown in Table 3. Moreover, Durbin-Watson test for autocorrelation indicated that the residuals are independent for all models ($p > 0.05$). Hence, these gives us confidence to perform regression analysis. Results of the hierarchical regression models, testing the predictive value of math teacher support on students' math preference, as well as the moderating role of growth mindset. As shown in Model 2, math teacher support significantly predicts students' preference for mathematics, which confirms Hypothesis 1. In Model 3, the interaction term between teacher support and growth mindset is also significant, which indicates that there is a moderating effect; this finding supports

Hypothesis 2 as shown in Figure 2. The obtained R^2 value of 0.03 indicates that the model explains 3% of the variance in math preference. While this proportion is small, the model remains statistically significant as indicated by the ANOVA F-test. According to the literature, such results are not unusual in social science research, particularly when the objective is to test theoretical relationships rather than to maximize predictive precision (41). In explanatory modeling, the primary focus is on evaluating the statistical significance, direction and validity of theoretically derived constructs, meaning a model can provide substantial theoretical value even if its overall predictive power is modest. Furthermore, a low coefficient of determination merely reflects that the dependent variable is 'multi-determined', influenced by a host of other factors outside the scope of the current analysis, which does not invalidate the significant effect identified by the model.

Table 3: Main Effects and Moderation of Growth Mindset in the Link Between Math Teacher Support and Math Preference

	Model 1		Model 2		Model 3	
	Standardized Estimate	Standardized Error	Standardized Estimate	Standardized Error	Standardized Estimate	Standardized Error
SES	0.08***	0.00	0.07***	0.00	0.07***	0.00
Sex	-0.07***	0.01	-0.04***	0.01	-0.04***	0.01
Growth Mindset			-0.06***	0.01	-0.07***	0.01
Teacher Support			0.11***	0.01	0.12***	0.01
Interaction					0.04***	0.02
R ²		0.01		0.02		0.03
ANOVA F		25.10***		37.79***		33.26***
Harrison-McCabe		0.49		0.49		0.51
Durbin-Watson		1.96		1.97		2.01

Note: *p<0.05, **p<0.01, ***p<0.001, SES (Socio-Economic Status).

**Figure 2:** Simple Slopes of Hypothesis 2

Hypothesis Testing 3 and 4

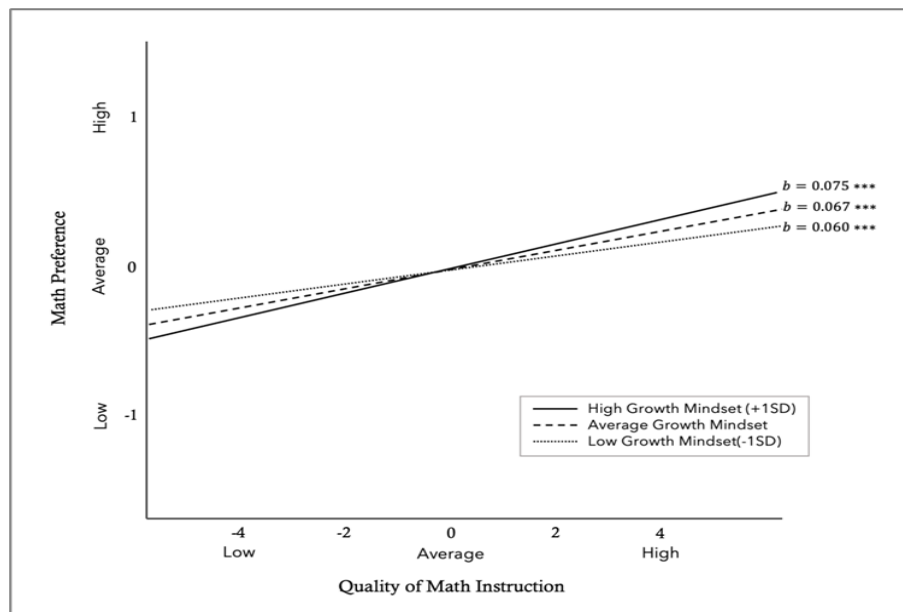
For assumptions check, heteroskedasticity testing indicated that the variance of the residuals is consistent across observations and the estimates are reliable for regression model 1 ($p=0.696$), model 2 ($p=0.786$) and model 3 ($p=0.777$) as shown in Table 4. Moreover, the autocorrelation test indicated that the residuals are independent for all models ($p>0.05$); thus, assumption requirements for performing regression analysis to test the hypothesis 3 and 4 were satisfied.

As shown in Model 2, instructional quality significantly predicts students' math preference, supporting Hypothesis 3. Moreover, as indicated in Model 3, the interaction term is significant, which implies that growth mindset moderates the relationship between the quality of math instruction and math preference, as shown in Figure 3. Thus, this supports the Hypothesis 4. The computed $R^2 = 0.09$, indicated that 9% of the variance in math preference is explained by the model.

Table 4: Main Effects and Moderation of Growth Mindset in the Link Between Quality of Math Instruction and Math Preference

	Model 1		Model 2		Model 3	
	Standardized Estimate	Standardized Error	Standardized Estimate	Standardized Error	Standardized Estimate	Standardized Error
SES	0.08***	0.00	0.01***	0.00	0.01***	0.00
Sex	-0.07***	0.01	-0.04***	0.01	-0.04***	0.01
Growth Mindset			-0.06***	0.01	-0.07***	0.03
Quality of Instruction			0.29***	0.00	0.29***	0.01
Interaction					0.03***	0.00
R ²		0.01		0.09		0.09
ANOVA F		25.10***		155.68***		126.23***
Harrison-McCabe		0.49		0.49		0.49
Durbin-Watson		1.96		1.96		1.96

Note: *p<0.05, **p<0.01, ***p<0.001, SES (Socio Economic Status).

**Figure 3:** Simple Slopes of Hypothesis 4

Discussion

The present study investigated the influence of teacher support and instructional quality on students' math preferences as well as the moderating role of a growth mindset while controlling for the effects of sex and socio-economic status. The four primary findings indicate that

- math teachers' support significantly predicts students' math preference,
- a growth mindset significantly moderates the relation between teacher support and math preference,
- quality math instruction significantly predicts math preference and
- growth mindset also moderate this latter relationship.

The first finding, that teacher support predicts math preference, reinforces previous research that supportive teacher behaviors improve academic performance and enhance students' attitudes toward mathematics. Some research reported that teacher support is a significant predictor of mathematical achievement even after controlling for various socioeconomic factors (42). Moreover, studies have shown that positive teacher-student interactions boost self-efficacy and engagement in math, which suggests that supportive practices can nurture a favorable disposition toward the subject (43). In light of the challenges noted in the Philippines (44), these results show the critical role that teacher support plays in shaping student preferences in mathematics.

The second finding suggests that the effect of relational support is amplified for students who believe that their abilities can improve. This interaction is consistent with theoretical models where personal beliefs about the malleability of intelligence interact with environmental factors; students with a growth mindset tend to respond more positively to supportive behaviors (45). Although few studies have examined this moderation directly, the findings indicate that personal psychological factors can interact with educational outcomes.

The third finding indicates that perceived quality of mathematics instruction also serves as a robust predictor of students' preference for mathematics, as clear, coherent and engaging instructional methods directly impact student attitudes (46, 47). High-quality instruction involves not only the accurate delivery of mathematical concepts but also the integration of innovative pedagogical techniques that make learning more interactive and relevant (48). When teachers employ creative instructional strategies that cater to diverse learning styles, students are more likely to find personal relevance in mathematical content, which then increases their overall interest in the subject (49). Furthermore, empirical evidence suggests that the perception of effective instructional design can mitigate common negative attitudes toward mathematics by transforming the classroom into an environment of exploration and discovery. Thus, the quality of instruction stands as a critical factor in shaping students' positive disposition toward mathematics, complementing the effect of teacher support.

The fourth finding suggests that growth mindset also plays a significant role in moderating the relationship between the quality of mathematics instruction and students' preference for mathematics. When instruction is perceived as high quality, students with a higher growth mindset are more likely to internalize and respond positively to the instructional practices, resulting in an increased inclination toward the subject. High-quality instruction comprises not only clarity and rigor in presentation but also incorporates elements of active learning that encourage deeper cognitive engagement. Growth mindset facilitates a more enthusiastic and exploratory approach to learning, where students see challenging instructional content as an opportunity for

personal development rather than as a threat (50). Consequently, students' beliefs regarding their capacity for growth effectively enhance the positive impact of superior instructional quality on their overall preference for mathematics (51).

These statistical relationships become easier to understand when we consider the social and educational realities in the Philippines. In classrooms where teachers are often seen as authority figures, supportive and approachable teachers can help reduce this barrier and create a safe environment where students feel comfortable asking questions and making mistakes without fear of being judged (52). A growth mindset is also important in the Philippines, where family expectations can influence students' attitudes toward achievement (53). When students view failure as part of the learning process rather than as a personal or family failure, they may feel less pressure and anxiety, especially in settings with demanding exams and heavy workloads. Thus, supportive teachers and effective instruction can help students manage these academic pressures and maintain a more positive attitude toward mathematics, even when learning resources are limited.

Implications in Education

The findings carry significant implications for educational practice and teacher professional development. First, the finding that perceived mathematics teacher support significantly predicts students' preference for mathematics stresses the importance of cultivating supportive classroom environments. Such support not only enhances student self-efficacy and motivational beliefs but also contributes directly to students' willingness to engage with challenging material. Educators are encouraged to participate in professional development (PD) programs focused on interpersonal skills and relational teaching techniques so that they can create classrooms characterized by warmth, respect and encouragement (54, 55). In addition, the predictive role of the perceived quality of mathematics instruction suggests that the methods and strategies employed by teachers play a crucial role in shaping students' attitudes toward the subject. Quality instructional practices such as clear explanations, active learning and the integration of real-world contexts are essential for making abstract mathematical concepts accessible and engaging. This supports the call for curriculum

reform and teacher PD initiatives to embed innovative and high-impact teaching strategies in everyday instruction (56, 57).

A notable contribution of the study is demonstrating that growth mindset moderates the relationship between teacher support, instructional quality and students' mathematics preference. This moderating effect implies that students who believe in their capacity to improve are more likely to benefit from supportive and high-quality instructional environments. Consequently, the integration of growth mindset interventions into teacher PD programs and classroom curricula is imperative. Such efforts may include explicit training on how to develop a growth-oriented classroom culture, the incorporation of reflective practices and the use of feedback loops that reinforce the malleability of intelligence. For the Philippines, these findings carry additional significance. Studies on the multifaceted structures of mathematics education in the Philippines indicate that issues such as resource constraints, curricular challenges and limited support networks are recurrent problems (58, 59). Addressing these issues effectively requires concerted efforts to empower teachers through continuous PD, collaborative mentoring systems and incentives aimed at promoting innovative teaching practices. The development of a blended teaching approach that integrates traditional face-to-face methods with technology-mediated instruction may further enhance the capacity of teachers to provide quality support and sustain student engagement despite systemic challenges. At the school and policy levels, administrators and curriculum designers should consider systemic reforms that emphasize both relational and instructional dimensions of teaching. Educational policies that incentivize teacher collaboration, continuous professional growth and the incorporation of growth mindset frameworks can create the conditions necessary for sustained improvements in mathematics education. It is suggested to adopt holistic approach that integrates teacher support, exemplary instructional practices and psychological interventions such as growth mindset training, by this, educational systems can not only improve academic performance but also nurture a genuine interest in mathematics among students (60). Such reforms are critical for transforming educational

outcomes and preparing students for future academic and professional challenges, at least in the Philippines.

Conclusion

This study contributes to the growing body of literature emphasizing the psychosocial and instructional factors that influence students' preferences toward mathematics. The findings affirm that both teacher support and instructional quality are significant predictors of math preference among Filipino students, while growth mindset serves as a key moderator in these relationships. Hence, this study ascertained that when math teachers offer genuine support through encouragement, guidance and understanding, students tend to feel more positive about the subject and are willing to tackle difficult problems. Likewise, clear and engaging teaching methods help students make sense of abstract ideas and stay interested in learning. These results emphasize that effective teaching is not just about covering the syllabus; it also depends on how teachers connect with students and present material in an understandable way. The idea of a growth mindset adds another layer; the students who believe they can improve benefit even more from supportive teachers and high-quality instruction. When students see challenges as chances to learn rather than obstacles, they respond better to both encouragement and clear lessons. By cultivating a classroom culture where effort and improvement are valued, educators can boost not only students' grades but also their genuine interest in mathematics over the long term.

To strengthen mathematics education in the Philippines, schools and policymakers should prioritize ongoing support for teachers. This includes providing regular workshops on classroom engagement strategies and creating mentorship programs where experienced educators share best practices in both instructional design and student encouragement. Additionally, investing in resources such as digital tools and supplementary materials can help teachers deliver clearer, more interactive lessons even in under-resourced schools. Finally, integrating growth mindset principles into the national curriculum and teacher training will give students the confidence to persist through

challenges. By combining these efforts, focused teacher development, improved learning materials and a culture that values effort, the Philippine mathematics education can be strengthened and students can develop more positive attitudes toward mathematics across diverse communities.

Abbreviations

MGCFA: Multiple-Group Confirmatory Factor Analysis, OECD: Organization for Economic Co-operation and Development, PISA: Programme for International Student Assessment, SES: Socio-Economic Status, STEM: Science, Technology, Engineering and Mathematics.

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Author Contributions

Mark Donnel D Viernes: Conceptualization, Methodology, Data Analysis, Writing - Original Draft, Ana Marie P Timan: Data Cleaning, Data Analysis, Writing - Review and Editing. All authors contributed to the interpretation of results and approved the final manuscript.

Conflict of Interest

The authors declare that there are no conflicts of interest related to this work.

Data Availability

The data that support the findings of this study are publicly available through OECD website <https://www.oecd.org/en/data/datasets/pisa-2022-database.html#data>

Declaration of Artificial Intelligence (AI) Assistance

During the preparation of this manuscript, the authors used R Discovery, Grammarly and Google Gemini to support language editing, improve clarity of expression, assist in literature searches and facilitate reference list formatting and manuscript organization. All AI-assisted outputs were carefully reviewed, verified and revised by the authors as necessary. The authors assume full responsibility for the accuracy, integrity and final content of the published manuscript.

Ethics approval

No ethical clearance is needed since the dataset is publicly available through OECD database for PISA.

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