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Mathematics Anxiety and Academic Performance among Higher Secondary School Students in Bangladesh

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ABSTRACT

Mathematics anxiety may make it difficult to engage students in the learning process and develop their confidence in doing academic exercises. This paper investigates the relationship between mathematics anxiety and mathematics examination achievement among high secondary school students in Bangladesh with mathematics self-efficacy and learning engagement indicated as a mediator. A cross-sectional analytical sample size (470 students) is analysed with the help of partial least squares structural equation modelling. There are three constructs on which five reflective indicators are used to measure and performance is reflected by the percentage in a test. Measurement evaluation facilitates internal consistency, convergent validity and discriminant validity. Self-efficacy, engagement and performance are negatively related to mathematics anxiety. There is a positive relationship between self-efficacy and engagement and performance, and between engagement and performance. The serial indirect association between self-efficacy and engagement is negative and statistically significant. The model explains 33.2% of the variance in mathematics performance. Repeated prediction on anxiety indicators yields a positive predictive relevance statistic albeit with a small improvement over a linear benchmark. The results show confidence and continued learning involvement as the factors that are applicable in the anxiety performance relationship. The response of education must be comprised of supportive assessment practice and the opportunity of attainable mastery and meaningful mathematical practice. The cross-sectional design does not allow the interpretation of a causal nature and fails to determine an order of time in the relationship of hypothesized mediating variables.

INTRODUCTION

The achievement in mathematics is dependent on what the students learn and the circumstances in which they practice the learning. Students have to find answers to questions, choose appropriate procedures, track calculations, and describe any connection between concepts. Such activities need long-term focus and readiness to persist in case of failure of an early solution. In every activity anxiety may make it harder by focusing on the possibility of failure or negative appraisal (Dr. Tooba Saleem *et al.*, 2023). Connection between anxiety and achievement thus needs to be explored together with confidence of students and their engagement in learning. The secondary school is a significant context where this is examined. Classes XI and XII students are introduced to even more challenging mathematical content as they prepare to take more rigorous assessments that affect future education decisions (M.S.Dawngliani *et al.*, 2021). Effective learning involves taking a step beyond the replication of known processes to the meaning and use of ideas. A learner can grasp a worked example but not know how to pick an appropriate method on his or her own. This ambiguity may become particularly decisive in cases where the involvement in classrooms or performance on exams is measured publicly or in a time-based aspect (Winarso, 2023).

Mathematics anxiety is a state of tension, worry and unease about mathematical activities. It can be preceded by an exam, in-teaching problem solving, or when a student is requested to state a solution. The construct is limited to mathematical instances and is not to be used interchangeably with low achievement. Students who have similar scores in examinations might have varied degrees of anxiety (Milena *et al.*, 2022). Similarly, anxious students can still be active in the process of learning. A framework to analyse this should, however, permit emotional experience, perceived competence, and learning behaviour to be separate.

Mathematics self-efficacy reflects the confidence of the ability to learn mathematical material and perform the corresponding tasks. It revolves around perceived capability as opposed to the overall self-esteem. When students think that they can find a method, describe a solution, and get better with practice, they might be more willing to attempt solving a problem that they do not know (Anjum *et al.*, 2022). Learning engagement relates to attention, practice, accomplishment of a task, and persistence by which this goodwill can be seen into observable participation. The constructs offer probable intermediate associations between anxiety and achievement, but also enables anxiety to maintain a distinct connection with performance.

The learning applicability of these relations can be applied in the design of educational assistance. A strategy that is

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solely based on examination preparation can be blinded by not considering students who do not practice since mathematical activities cause them to feel uncomfortable (Daker *et al.*, 2023). On the other hand, an absence of a chance to develop competence and assurances can make students unsure about their skills in solving the problems. A comparison between confidence and engagement in the same paradigm can shed light over whether they are different correlates of achievement. It is also capable of ascertaining whether an anxiety -performance relationship still holds given the consideration of their statistical contributions.

This study is based on the investigation of the links between these relationships in a Bangladesh context of higher secondary. Academic performance is specific to mathematics achievement but not an average performance in subjects. This difference concurs the result with the subject-specific psychological measures (Latip *et al.*, 2023). The data analyzed consists of 470 observations and the analysis of a model that included mathematics anxiety, mathematics self-efficacy, mathematics learning engagement, and an examination percentage. The hypothesis structure is a form of the six direct relations and one serial indirect relation. Measurement quality, explained variance and predicting beyond the estimation sample are also assessed in the study.

The main aim is to evaluate the relationship between mathematics anxiety and academic performance and explore the effects of self-efficacy and engagement. To be more exact, analysis in question takes into consideration whether anxiety is negatively related to both mediators, whether confidence is positively related to engagement and whether each of the mediators is at least partially related to performance (Malanchini *et al.*, 2020). The serial pathway checks the consistency of the pattern between anxiety, confidence, engagement, and achievement and the conceptual order. These do not assume causal mechanisms are determined by the survey but are objectives about associations.

The research adds a combined description of emotional, motivational, and behavioural aspects of learning mathematics. It disaggregates the results of examinations and perceived competence and evaluates the measurement characteristics of the characterize multi-item measures and then interprets structural associations (Rahman *et al.*, 2022). It also differentiates explanatory performance and a more limiting prediction exercise, which solely employs anxiety indicators. This difference keeps the explanation variance of the model that cannot be extracted to form the same meaning of getting the accuracy of the same model when predicting the score of an individual student based on the information that is only limited.

LITERATURE REVIEW

Hypothesis Development

Mathematics anxiety and perceived capability

It is possible to define mathematics anxiety as a negative emotional reaction to the expected or real mathematical requirements. It depends on the circumstance to express itself. Anxiety about time, accuracy and consequences may be some of the aspects associated with examination anxiety (Nurdaniati *et al.*, 2022). The anxiety problem in classrooms may be manifested in the situations when the student is required to answer without any preparation or explain a process to other people. Fear of unknown issues can indicate the lack of understanding on where to start. A similarity in these experiences is that the available capability is of concern that one might not be able to cope with the task, but is still not a direct measure of actual mathematical knowledge (Istikomah *et al.*, 2022).

A cognitive explanation holds that anxiety may be at odds with the concentration in solving problems. Students can repeatedly assess the probability of failure in the process of trying to memorize of intermediate calculations or contrasting strategy of solving (Ramdani *et al.*, 2022). There is a motivational explanation that unpleasant experiences with tasks can have an impact on future expectations. Confidence may be destroyed when one views difficulty as a sign of personal inefficiency. This argument connects anxiety with self-efficacy without necessarily having the constructions to be equal (Lailiyah *et al.*, 2021). Emotional discomfort pertains to the encountering the task, and self-efficacy pertains to the ability to accomplish it.

Self-efficacy also depends on the perceptions of the students towards success and difficulty. Competence can be demonstrated by an accomplishable endeavor done on one's own. The challenging work with the help of the appropriate comments can prove that a strategy should be changed (Caviola *et al.*, 2022). Nevertheless, having uncertainty time and time again can contribute to undermining the potential of students. In the framework suggested, higher levels of mathematics anxiety will correlate with a reduced confidence in mastering the subject matter, selecting the operations, and describing solutions (Schmitz *et al.*, 2023). The construct level is used to evaluate the relationship and not through individual research answer.

H1 proposes that mathematics anxiety is negatively associated with mathematics self-efficacy among higher secondary school students in Bangladesh.

Anxiety and mathematics learning engagement

Engagement involves the ways in which the students are involved in learning mathematics. Listening, doing given homework, practicing after leaving school and following a failed attempt all offer chances to cement down knowledge. The cognitive aspect of engagement also exists (Qu *et al.*, 2020). A learner attempting to comprehend the logic behind a solution can build up knowledge that can be more readily applied to tasks previously unknown than knowledge found on memorised procedures (Qu *et al.*, 2020). These related activities are integrated in the study under a reflective engagement construct.

Fears of low involvement can be followed by anxiety as students will not face those situations where they

experience some discomfort. Diversions can be less obvious than skipping school. A student can stay but not ask questions, not progress quickly independently or give up work due to a failure (Saputra *et al.*, 2022). Such behaviours have the potential to minimise the chances of uncovering misunderstandings and getting feedback. Meanwhile, anxiety does not necessarily mean the withdrawal in full. The direction and strength of the association is an empirical question because some students might react to the increase in preparation (Brewster & Miller, 2020).

The model proposed defines negative anxiety-engagement and this relates to self-efficacy. This enables the analysis to identify a relationship relating to confidence and the other relationship between emotional discomfort and participation (Juliyanti & Pujiastuti, 2020). The difference is important since a nervous student can be quite justified in feelings of confidence, but struggle with ability to maintain focus during stress. On the contrary, a lowly confident student can evade tasks without indicating that there is high anxiety (Isnaini & NurDalilah, 2023). Having both predictors in the equation of engagement makes the equation more informative than a mere comparison between anxiety and participation.

H2 proposes that mathematics anxiety is negatively associated with mathematics learning engagement among higher secondary school students in Bangladesh.

Self-efficacy and engagement

The belief in mathematical competence may be used to initiate and persist in a challenging activity. When the students believe that hard work and relevant strategies will help them result in understanding, then they have a motivation to continue even in the absence of immediate success (Islam *et al.*, 2021). The given expectation can promote regular practice and interest in explanations. It can also affect the manner in which students perceive errors. Failure can be transformed into data regarding a practice that has to be changed as opposed to data about the impossibility of success with the assistance of additional effort (Sonia *et al.*, 2020).

There is no equivalent relationship between confidence and engagement in that confidence ensures a preparatory level. Students may overrate their abilities and devote inadequate efforts (Hafeez *et al.*, 2022). Instead, the framework is that stronger task-specific confidence will be associated with more active learning in the observed sample. The self-efficacy items deal with comprehension, method choice, explanation and efficacy by effort. The conceptual relationship of these capabilities to the engagement items with regard to attention, practice, persistence, and reasoning is that these capabilities are distinct enough to be assessed separately (Sim & Maat, 2022).

H3 proposes that mathematics self-efficacy is positively associated with mathematics learning engagement among higher secondary school students in Bangladesh.

Anxiety and examination performance

Examination performance is a summary of the performance in a given assessment arrangement. It serves as a measure of knowledge in math, knowledge of the content being tested, and the skills to communicate the solutions under the given conditions (Liu, 2023). The anxiety can be connected to the performance as follows

- the process that takes place during preparation and
- the process that takes place during the assessment.

Problems with maintaining focused attention may negatively influence preparation, whereas anxiety during an exam may make the process of retrieval and monitoring challenging (Erdem & Arikan, 2023). The proposed direct path is the association that is left when the variables of confidence and engagement are added to the performance equation.

A direct statistical relationship is not to be seen as a description of processes involved. The state of previous success, level of instructions, the level of testing, as well as the learning materials could also be associated with anxiety and performance. Learners who have historically had low performance might then experience increased anxiety (Weissgerber *et al.*, 2022). The current model thus tests the existence of further negative connection that can be observed in the given structure. It does not identify whether anxiety is the cause of poor performance or the relation is reciprocal as time goes by.

H4 proposes that mathematics anxiety is negatively associated with academic performance in mathematics among higher secondary school students in Bangladesh.

Self-efficacy and examination performance

Self-efficacy can also be linked to achievement as students, who think that they can succeed in mathematical tasks, are better equipped to work at solutions and track progress (Moustafa *et al.*, 2021). Confidence can help to apply procedures autonomously and also be open to revisiting an unsuccessful strategy. These exercises are applicable when tests involve students having to relate concepts other than to recreate the same example in a classroom. Still, perceived capability and my exhibited achievement are independent variables (Siaw *et al.*, 2020). Their association should be determined and not be presumed based on the wording of the confidence scale.

The model encompasses a direct self-efficacy-performance path, as well as an indirect path via engagement. The straight line allows confidence to be linked to performance outside of learning activities measured by the engagement scale (Dr. Tooba Saleem *et al.*, 2023). This indirect path appreciates the fact that confidence can be a part and parcel of the long-term involvement, which, by extension, can be associated with achievement. This specification does not force all the relations between confidence and examination performance to proceed in a way where one behavioural construct is measured (M.S.Dawngliani *et al.*, 2021).

H5 proposes that mathematics self-efficacy is positively

associated with academic performance in mathematics among higher secondary school students in Bangladesh.

Engagement and examination performance

The development of mathematical understanding is based on the activities that present students to different problems and make them analyze their thinking. Familiarity with procedures can be enhanced with practice, and access to explanations can be enhanced with attention during lessons (Winarso, 2023). Unsuccessful approaches allow a chance to fix if one perseveres. A pursuit of the rationale of a solution can reinforce conceptual relationship. It is therefore expected that these dimensions of engagement are accompanied by more robust achievement but the quality and difficulty of practice still stand to its value as education (Milena *et al.*, 2022).

The engagement is to be viewed both in terms of opportunities and individual motivation. The student can be unfairly exposed to silent study, teacher comments or proper materials (Latip *et al.*, 2023). All these conditions cannot be divided by a wide engagement score. The hypothesis relationship has to do with the involvement embodied by the measured items following the consideration of anxiety and self-efficacy (Anjum *et al.*, 2022). This does not mean that students are the only people who should struggle to go through structural barriers to learning or that more time studying means corresponding change in examination performance.

H6 proposes that mathematics learning engagement is positively associated with academic performance in mathematics among higher secondary school students in Bangladesh.

Serial mediation and the conceptual model

The serial pathway relates the experience of emotion to the perceived ability, further involvement, and performance of the examination (Daker *et al.*, 2023). Its conceptual chain suggests a higher level of anxiety is accompanied by the lower level of self-efficacy, the lower level of self-efficacy is accompanied by the lower level of engagement, and the lower level of engagement is accompanied by the poorer level of achievement (Malanchini *et al.*, 2020). The three coefficients should come up with a negative product. With this formulation, the direct paths and the shorter indirect routes are included in the model keeping the proposed sequence in a specific statistical representation.

H7 hypothesizes that mathematics anxiety is indirectly negatively related to academic achievement in the form of mathematics self-efficacy and mathematics learning engagements; this will occur sequentially.

The conceptual framework is shown in Figure 1. The exogenous construct is mathematics anxiety. The endogenous mediating constructs are self-efficacy and engagement, and the ultimate outcome is the mathematics performance. The framework enables direct relationships between anxiety and performance, confidence and performance, and engagement and performance to coexist with the pathway of serial relationships (Rahman *et al.*, 2022). Since all measures of the psychology are viewed as having taken place in a cross-sectional design, it is understood that the arrows are theoretical in their expression of the order and not the observed transitions of time. The need to have statistical support of the serial coefficient, rather than demonstrating that it happened as a developmental order, makes it compatible with this ordering (Nurdaniati *et al.*, 2022).

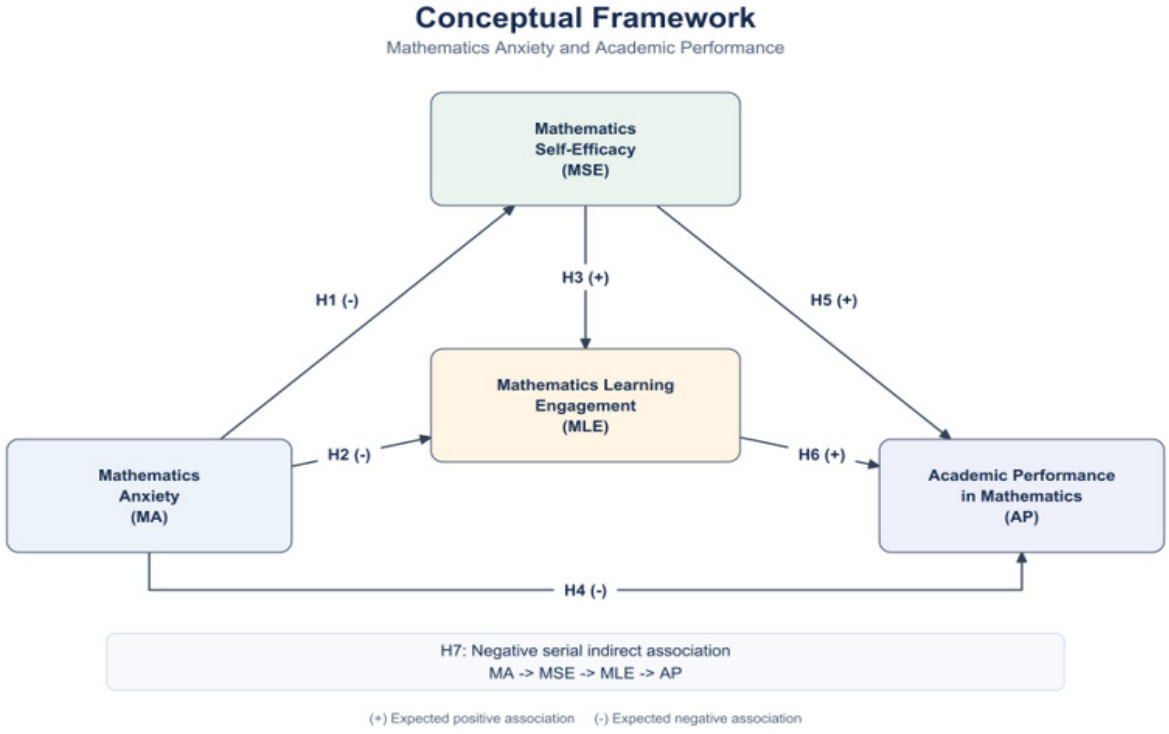


Figure 1: Conceptual framework of the hypothesised relationships

MATERIALS AND METHODOS

Research design and analytical sample

The design used in the study is a quantitative and cross-sectional design to test the relationship between mathematics anxiety, self-efficacy, engagement and mathematics achievement. There are 470 observations in the sample of analysis. The instrument has identified a target population of Class XI and Class XII students of mathematics or higher mathematics in Bangladesh. The questionnaire will contain the eligibility checks related to enrolment, participation in the subject, comprehension of the participant information, and participation willingness (Sahithi, 2021). The student is the unit of analysis and each record provides psychological indicators and a measure of examination-performance.

The sample will include Class XI students (232) and Class XII students (238). Ages reported are 16-19 years old. Background data encompasses gender, academic group, type of institution, location of institution, education board, subject (mathematics), study hours per week, tutoring, parent education, and attendance. Numerals are still present in the analytical summaries as category codes in several variables. Instead of placing substantive labels onto these codes without verifying their validity, they are maintained (Dr. Swarooprani. K, 2022). The existence of several categories of institutional/ board records characterizes the records observed, but does not determine probability sampling or national representativeness.

Instrument and construct measurement

There are five reflective indicators of mathematics anxiety, mathematics self-efficacy, and mathematics learning engagement. The responses are based on a five-point scale of agreement where strongly disagree to strongly agree is used. The increased values are the more anxiety, confidence, and engagement respectively. There are no reverse-coded items. Reflective measurement considers the items as manifestations of the related concept of the constructs. Before the structural relationships could be interpreted, this specification is measured using indicator loadings, internal consistency, convergent and discriminant validity.

The anxiety questions deal with nervousness during the start of a test, tension during classroom problem solving, worry about explaining solutions, anxiety when having to deal with a problem that is unfamiliar, and concern about being assessed. The self-efficacy items are the knowledge of taught content, solving the proper problems, finding the right ways, describing the steps of the solution and mastering the challenging material with effort (Adaikkalam Zabihi *et al.*, 2025). The engagement includes attention, completing tasks, practicing regularly, persisting following unsuccessful attempts, and attempting to make sense of mathematical reasoning. The item content has a general subject of focus and differentiates emotion, perceived capability and learning participation.

A single indicator of academic performance is the examination-percentage indicator. The calculation planned is the mark gained divided by the maximum mark available and times the figure by 100. In a situation where two mathematics papers make up the test, the tool indicates combining the obtained and maximum marks on the same test. Other questions ask examination type, date, subject, source of mark, and allow verification. These are the administrative questions that are not reflective performance questions. Therefore, the internal consistency coefficients and the average variance extracted are not used as the interpretation of academic performance.

Screening and descriptive assessment

The output of the screening is that there are 470 imported observations and 470 complete analysis observations. There are no observations with incomplete model data that are not counted and no similar model-response pattern is found. These checks outline the variables of analysis and cannot say that all backgrounds and administration fields are comprehensive (Mellenbergh *et al.*, 2003). Neither does duplicate-pattern screening independently verify the identity of participants. Descriptive assessment summarises background trends, indicator distributions, unweighted scale means, and test scores. The scale means are convenient summaries which are differentiated with the fitted construct scores employed in the structural model.

The measured variables are described using means, standard deviations, observed ranges, skewness and excess kurtosis. The analysis percentage is left in its original reporting unit to analyze the descriptive analysis and foresee the mistakes in prediction (Andiappan & Wan, 2020). The standardised structural coefficients are used to explain how model constructs relate to each other but this should not be directly interpreted to represent percentage point change in examination marks. The analysis is carried out in this separation of scales. It does not confusion the magnitude of a standardised coefficient and the magnitude of an observed score difference.

Measurement and structural assessment

The estimated relationships between the specified constructs are estimated by means of partial least squares structural equation modelling. The measurement assessment includes indicator loading and bootstrap interval, Cronbach alpha, rho A, composite reliability and average variance extracted. The heterotraitmonotrait ratio and bootstrap interval, FornellLarcker comparison, and indicator cross-loadings are used to test discriminant validity. Academic performance is not incorporated in the multi-item reliability analysis and HTMT measures since the single examination indicator available in academic performance fails to give the item structure to be used in the two measures.

The variance inflation factors between the predictors of each endogenous construct assesses structural collinearity. The 5,000 bootstrap resamples are used to evaluate direct

relationships. Standardised estimates, bootstrap standard errors, absolute test statistics and percentile confidence intervals are reported in the analysis. The probability values in the table are a two-sided normal approximation. Supporting the hypothesis would need the anticipated direction of the coefficient and a bootstrap interval which would not include zero. The values less than 0.001 are not reported as 0.001 but as $p < 0.001$.

R 2 and adjusted R 2 are used to explain the variance of the data. Local effect sizes are the outcome regressions with and without a predictor and the fitted construct scores are held constant. These f 2 values give contributions in that calculation and cannot be considered to be the results of re-estimating all reduced models of measurement (Mimansha Patel & Nitin Patel, 2019). The specific indirect associations are determined by multiplying the corresponding coefficients in the same bootstrap replicate. The combination of the right paths, which include the serial pathway and the greater mediated association, is done by total indirect and total associations.

Prediction and ethical considerations

Predictive assessment involves ten folds which are repeated five times. The prediction activity is based on the five indicators of anxiety as the input information of academic performance. Estimation and calibration take place in the training folds. The root means squared error, mean absolute error, and Q 2 predict are used to measure performance with respect to training-fold mean predictions. Another benchmark is a linear model with the same predictor information. There are 2,350 pooled repeated predictions, but they are repeated predictions on 470 students and not 2,350 independent participants.

The participant-information protocol defines voluntary participation, confidentiality and no consequences of examinations or access to education (Sahithi, 2021). It adds that there is no need to use names and student identification numbers, and allows them to withdraw prior to submission of questionnaires. In participants less than 18 years, the protocol will mandate the consent of guardians and student assent in accordance with the relevant institutional protocols. Approval to check marks is made independent. These are the specifics of ethical design of the instrument; they are not to be confused with the documentation that illustrates the accomplished institutional review or execution of each consent procedure.

RESULTS AND DISCUSSION

Sample characteristics and screening

Table 1 indicates that 17- and 18-year-old students are the largest age groups with 34.04% and 32.13 % respectively.

Table 1: Background characteristics of the analytical sample

Characteristic	Recorded category	n	%
Age	16	81	17.23
Age	17	160	34.04
Age	18	151	32.13
Age	19	78	16.60
Gender	Male	119	25.32
Gender	Female	121	25.74
Gender	Another identity	129	27.45
Gender	Prefer not to say	101	21.49
Class	Class XI	232	49.36
Class	Class XII	238	50.64
Academic Group	Science	470	100.00
Institution Type	Government	262	55.74
Institution Type	Non-government	208	44.26
Institution Location	Rural	229	48.72
Institution Location	Urban	241	51.28
Education Board	Dhaka	58	12.34
Education Board	Chattogram	47	10.00
Education Board	Rajshahi	52	11.06
Education Board	Cumilla	44	9.36
Education Board	Jashore	51	10.85
Education Board	Barishal	53	11.28
Education Board	Sylhet	63	13.40
Education Board	Dinajpur	59	12.55
Education Board	Mymensingh	43	9.15

Mathematics Subject	Higher Mathematics	470	100.00
Weekly Study Hours	Less than 2 hours	93	19.79
Weekly Study Hours	2–4 hours	102	21.70
Weekly Study Hours	5–7 hours	87	18.51
Weekly Study Hours	8–10 hours	99	21.06
Weekly Study Hours	More than 10 hours	89	18.94
Private Tutoring	Yes	233	49.57
Private Tutoring	No	237	50.43
Parent Education	No formal education	63	13.40
Parent Education	Primary	79	16.81
Parent Education	Secondary	67	14.26
Parent Education	Higher secondary	58	12.34
Parent Education	Bachelor's degree	55	11.70
Parent Education	Postgraduate degree	73	15.53
Parent Education	Do not know	75	15.96
Class Attendance	Occasionally	112	23.83
Class Attendance	About half of the classes	122	25.96
Class Attendance	Most classes	111	23.62
Class Attendance	Almost all classes	125	26.60

Note: N = 470. Numeric category codes are retained as recorded; substantive labels require a verified codebook.

Class XI takes 49.36% and Class XII takes 50.64%. This is a level of near balance that offers a significant level of representation of both of the levels of classes in the sample that is to be observed. Institution-type codes have 262 and 208 observations and institution-location codes have 229 and 241 observations. These distributions explain coverage without determining equivalence of institutional settings as well as supporting conclusion on the difference in anxiety among groups of people.

The numeric background categories are to be interpreted thoroughly. The gender variable has four categories which are recorded and the academic group and mathematics subject have got one observed code. Though the instrument provides response options, the frequency table does not provide an independently validated mapping between the response options and the dataset codes. The analysis therefore does not give these codes demographic identities or labels of academic-stream. Neither does it extrapolate the findings to unobserved groups of subjects or conclude that there was proportional participation based on the national enrolment.

Table 2: Data screening and analysis settings

Screening or analysis setting	**Value**
Imported Observations	470
Complete Analysis Observations	470
Excluded Incomplete Observations	0
Duplicate Model Response Patterns	0
Bootstrap Resamples	5000
Prediction Folds	10
Prediction Repetitions	5

Note: Completeness refers to the model variables. No invitation denominator is available for a response-rate calculation.

Table 2 validates that the entire sample of 470 imports observations is covered in the total analytic sample. Incomplete model observation and duplicating model-response pattern have no exceptions. The inferential process involves the utilization of 5,000 bootstrap resamples and the prediction involves ten folds and five repetitions. These outputs determine the size of computational samples and the assessment settings. They fail to give a response rate since the number of invited students or eligible non-participating students is not reflected in the screening summary.

Descriptive statistics

The results of table 3 show that the means of the anxiety score is 3.041, and the standard deviation of the anxiety score is 0.983. The mean self-efficacy is 2.956 and the mean engagement is 3.003. These meanings are almost near the middle of the five-point scale. They are not to

Table 3: Indicator and scale descriptive statistics

Variable	Mean	SD	Min	Max	Skewness	Kurtosis
MA1	2.943	1.182	1	5	0.018	-0.848
MA2	3.036	1.197	1	5	-0.047	-0.890
MA3	3.009	1.144	1	5	-0.008	-0.783
MA4	3.053	1.164	1	5	-0.014	-0.831
MA5	3.166	1.154	1	5	-0.152	-0.696
MSE1	2.877	1.163	1	5	0.095	-0.767
MSE2	2.883	1.178	1	5	0.133	-0.784
MSE3	2.949	1.178	1	5	0.052	-0.787
MSE4	3.006	1.201	1	5	0.047	-0.855
MSE5	3.066	1.184	1	5	-0.066	-0.823
MLE1	2.900	1.114	1	5	0.068	-0.680
MLE2	2.985	1.163	1	5	0.053	-0.789
MLE3	2.989	1.132	1	5	0.047	-0.827
MLE4	3.045	1.157	1	5	-0.054	-0.821
MLE5	3.098	1.125	1	5	0.023	-0.783
AP	61.785	13.741	11	99	-0.228	0.406
MA	3.041	0.983	1	5	-0.041	-0.769
MSE	2.956	0.977	1	5	0.026	-0.738
MLE	3.003	0.934	1	5	0.095	-0.580

Note: N = 470 for every row. MA, MSE, and MLE are unweighted item averages. AP is an examination percentage. Kurtosis is excess kurtosis.

be considered as clinical classifications or evidence that all students have a moderate level of anxiety. The dispersion observed has significant variation around averages. The mean of academic performance is 61.785 % and standard deviation is 13.741 % points and the score varies between 11 % and 99 %.

The highest mean among anxiety indicators is the concern of upcoming assessment with the mean of 3.166. The mean of the self- efficacy indicators is highest in confidence in mastering difficult topics after prolonged effort with a mean of 3.066. Attempts to understand the rationale behind solutions have the highest level of engagement with a mean of 3.098. Such differences at the item level are descriptive in nature, unsupported by independent tests of the differences in means. Their primary importance is to demonstrate the content that is represented by each scale instead of providing a final ranking of educational priorities.

The distributional summaries indicate that the skewnesses of psychological indicators are limited. There is a negative skew in the academic performance with skewness of -0.228 and excess kurtosis of 0.406. The means using the unweighted scale have small skewness values. The fact that these summaries are satisfied does not alone confirm that the data is multivariately normal or that it does not contain any influential observations. They give background to the responses that are observed and assist in a clear description of the variables that are being analysed in measurements and structures.

Indicator quality and convergent validity

Table 4 indicates that the loading of all 15 reflective indicators is above 0.788. The anxiety loadings vary between 0.820 and 0.854, self-efficacy loadings are between 0.788 and 0.868, and engagement loadings are between 0.809 and 0.839. The bootstrap intervals are positive and

Table 4: Indicator loadings and bootstrap intervals

Construct	Indicator	Loading	SE	95% CI
MA	MA1	0.854	0.013	0.825 to 0.877
MA	MA2	0.820	0.016	0.786 to 0.849
MA	MA3	0.853	0.013	0.826 to 0.877
MA	MA4	0.825	0.017	0.789 to 0.855
MA	MA5	0.853	0.014	0.824 to 0.877
MSE	MSE1	0.833	0.016	0.799 to 0.861
MSE	MSE2	0.788	0.019	0.749 to 0.822

MSE	MSE3	0.868	0.011	0.843 to 0.889
MSE	MSE4	0.805	0.019	0.764 to 0.837
MSE	MSE5	0.841	0.014	0.811 to 0.866
MLE	MLE1	0.809	0.017	0.772 to 0.840
MLE	MLE2	0.813	0.017	0.777 to 0.844
MLE	MLE3	0.831	0.015	0.800 to 0.858
MLE	MLE4	0.810	0.018	0.773 to 0.842
MLE	MLE5	0.839	0.014	0.809 to 0.865
AP	AP	1.000	—	Not applicable

Note: 5,000 bootstrap resamples. All reflective loadings have $p < 0.001$. The single AP loading is fixed at 1 and is not a reliability test.

uphold the indicators and their relationships with their respective constructs. The loading of the examination indicator is set at unity in its single-indicator form. Such value is model specification, and does not create error-free measurement of examination achievement.

Table 5 substantiates internal consistency of the three multi-item constructs. Cronbach alpha is between 0.879 and 0.897 and composite reliability is between 0.911 and 0.924. Rho A generates a steady evaluation. The anxiety, self-efficacy, and engagement have an average variance

Table 5: Reliability and convergent validity

Construct	Items	Alpha	Rho A	CR	AVE
MA	5	0.897	0.899	0.924	0.708
MSE	5	0.885	0.893	0.915	0.684
MLE	5	0.879	0.880	0.911	0.673
AP	1	—	—	—	—

Note: CR = composite reliability; AVE = average variance extracted. Reliability and AVE are not applicable to AP.

extracted of 0.708, 0.684, and 0.673, respectively. All the constructs thus explain above fifty percent of the average variance in their indicators. These discoveries confirm the application of the outlined measurement blocks into the further analysis but do not prove the validity outside of the current sample or other unexamined groups of students.

Discriminant validity

In Table 6, the values of the HTMT of anxiety and self-efficacy, anxiety and engagement, and self-efficacy and engagement are 0.363, 0.343, and 0.500, respectively. All the three values are less than 0.85. The upper bootstrap confidence limits are 0.429 to 0.579 and they are less than 1. There is the greatest relationship between confidence

Table 6: HTMT assessment of discriminant validity

Construct pair	HTMT	95% CI
MA and MSE	0.363	0.268 to 0.458
MA and MLE	0.343	0.254 to 0.429
MSE and MLE	0.500	0.416 to 0.579

Note: Intervals use 5,000 bootstrap resamples. AP is excluded because it has one indicator.

and engagement, which is anticipated given the relationship between these two concepts. However, the findings suggest that these constructs should be regarded individually as opposed to making a composite measure of positive mathematics learning experience.

Complementary evidence in table 7 shows the Fornell-Larcker comparison. The averages of the square roots of the extracted variance are 0.841, 0.827, and 0.820 corresponding to anxiety, self-efficacy, and engagement respectively. All of them surpass the absolute correlations with the corresponding multi-item construct. The cross-

Table 7: Fornell Larcker assessment and construct correlations

Construct	MA	MSE	MLE	AP
MA	0.841	-0.327	-0.305	-0.378
MSE	-0.327	0.827	0.446	0.453
MLE	-0.305	0.446	0.820	0.471
AP	-0.378	0.453	0.471	—

Note: Diagonal entries for MA, MSE, and MLE are square roots of AVE. Off-diagonal entries are construct-score correlations. AP has no AVE diagonal.

loadings of indicators are also lower in absolute value as compared to the corresponding primary loading. Anxiety has a negative correlation with performance, whereas self-efficacy and engagement have a positive correlation with performance (Daker *et al.*, 2023). The AVE value is not specified on the performance diagonal as the result of one examination would not warrant the same interpretation of convergent-validity.

Collinearity and direct relationships

Table 8 shows that there is low collinearity in the structural equations. Variance inflation factors are given a range of 1.000-1.314. In the case of the performance equation, the coefficients are 1.161, 1.314 and 1.294 respectively towards anxiety, self-efficacy and engagement respectively. Such findings indicate that intense linear overlap of the predictors considered does not prevail in the estimation

Table 8: Structural collinearity assessment

Outcome	Predictor	VIF
MSE	MA	1.000
MLE	MA	1.120
MLE	MSE	1.120
AP	MA	1.161
AP	MSE	1.314
AP	MLE	1.294

Note: VIF is calculated among predictors within each outcome equation.

of the coefficient. They do not, but do not prove the lack of omitted-variable bias or common-method influences. Collinearity test deals with the particular statistical property of predictors that were fitted.

Table 9 helps to support all the six direct hypotheses. Self-efficacy has a negative relationship with anxiety with β = 0.327 as the beta and -0.243 -0.411 as the confidence interval. After considering the factor of self-efficacy, there is a negative relationship between anxiety and engagement with β = 0.179. Engagement is linked to self-efficacy with 8 positive relationships, β = 0.387 and

Table 9: Direct structural relationships

Hypothesis	Path	β	SE	t	95% CI
H1	MA → MSE	-0.327	0.043	7.653	-0.411 to -0.243
H2	MA → MLE	-0.179	0.040	4.495	-0.258 to -0.102
H3	MSE → MLE	0.387	0.039	10.014	0.311 to 0.463
H4	MA → AP	-0.205	0.039	5.202	-0.278 to -0.126
H5	MSE → AP	0.255	0.041	6.266	0.176 to 0.332
H6	MLE → AP	0.295	0.040	7.359	0.214 to 0.372

Note: All six paths have $p < 0.001$ and are supported. Confidence intervals are percentile bootstrap intervals; t = absolute estimate divided by bootstrap SE.

confidence interval is 0.311 to 0.463. This is the largest positive direct relationship in the model and supports the relationship between perceived capability and learning participation proposed.

The anxiety coefficient has been found to be negative with a value of -0.205 in the performance equation. The positive coefficient of self-efficacy is 0.255 and the positive coefficient of engagement is 0.295. All the related bootstrap intervals are not equal to zero and all probability values are less than 0.001. The highest positive point estimate of the predictors of performance is engagement. Analysis, however, does not involve an explicit test of comparing those coefficients. The number order should not thus be construed as evidence that engagement is statistically more effective than self-efficacy.

Explained variance and local effect sizes

Table 10 indicates that the model has a correlation of 10.7%, 22.7% and 33.2 % with self-efficacy, engagement, and mathematics performance respectively. Adjusted values are 0.105, 0.224, and 0.328, respectively. Adjusted and unadjusted values are not very different. The performance equation thus represents a significant amount of observed variation and an unexplained

Table 10: Explained variance and local effect sizes

Outcome	Predictor	R^2	Adjusted R^2	f^2
MSE	All specified	0.107	0.105	—
MLE	All specified	0.227	0.224	—

AP	All specified	0.332	0.328	—
MSE	MA	—	—	0.120
MLE	MA	—	—	0.037
MLE	MSE	—	—	0.173
AP	MA	—	—	0.054
AP	MSE	—	—	0.074
AP	MLE	—	—	0.101

Note: Effect sizes hold fitted construct scores fixed when removing predictors. Thresholds of 0.02, 0.15, and 0.35 are descriptive conventions.

amount remains around two-thirds. This left difference is also in line with the narrowness of the model which has three psychological and behavioural predictors without prior achievement or institutional learning conditions.

Self-efficacy contributes the most significant local effect, f 2 = 0.173, to the engagement. The rest of the effect sizes lie between 0.037 and 0.120 and are of the small descriptive type employed in the analysis. In the equation of performance, engagement has a contribution of f2 = 0.101, self-efficacy = 0.074, and anxiety 0.054. The coefficients are statistically supported as such, with small contributions made by individuals. The findings support an integrated explanation of the predictors, instead of a reason majority of the performance variance on a single construct.

The estimated structural model is shown in Figure 2. The coefficients and explained-variance values in the table are that of Table 9 and 10. The figure presents the six direct paths in a summary form and the serial indirect coefficient is reported separately. Maintaining this disconnection stops the confusion of the indirect association with another direct arrow between anxiety and performance.

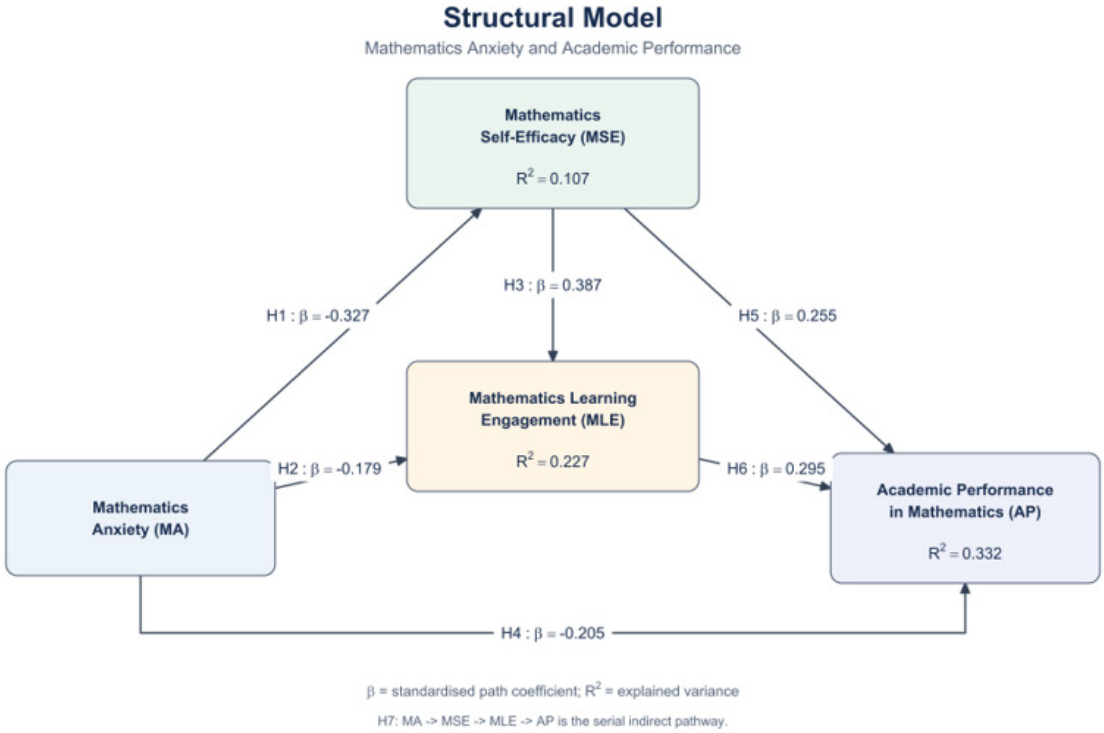


Figure 2: Structural model with standardised coefficients and explained variance

Indirect and total associations

Table 11 justifies the suggested serial indirect correlation. The anxiety to self-efficacy and engagement to performance has a β = - 0.037 with a confidence interval of -0.056 to -0.023. The H7 is thus supported. The finding aligns with an interrelated trend where anxiety is more accompanied by low confidence, less accompanied by less engagement and less in turn accompanied by less performance. The coefficient explains the result of the given associations

Table 11: Indirect and total associations

Path or association	**β**	**SE**	**95% CI**
MA → MSE → MLE	-0.127	0.021	-0.171 to -0.088
MA → MSE → AP	-0.083	0.017	-0.118 to -0.052

MA → MLE → AP	-0.053	0.014	-0.083 to -0.028
MA → MSE → MLE → AP	-0.037	0.008	-0.056 to -0.023
MSE → MLE → AP	0.114	0.020	0.078 to 0.155
MA → AP total indirect	-0.173	0.024	-0.225 to -0.128
MA → AP total association	-0.378	0.039	-0.451 to -0.300

Note: All associations have p < 0.001. H7 is MA → MSE → MLE → AP. Indirect coefficients are products within the same bootstrap replicate.

and does not define the chronological order of these experiences among single students.

The indirect routes that are shorter are also favored. Self-efficacy and engagement are associated with anxiety indirectly with an association of -0.083 and -0.053 respectively with the performance. There is an indirect relationship of 0.114 between self-efficacy and performance via engagement. The overall indirect anxiety performance is -0.173 and the overall association is -0.378. The direct coefficient of -0.205, which is retained, indicates that the measured mediators are not statistically significant in explaining the whole relationship. The sign of direct and indirect associations is the same, and it results in a pattern similar to complementary partial statistical mediation.

Predictive assessment and hypothesis summary

Table 12 shows the recurrence of prediction. The pooled PLS root mean squared error value is 12.775 percentage points which is less than 12.843 of the linear benchmarks and 13.756 of the training-mean benchmarks. The mean absolute error of PLS is 9.901 and that of the linear model is 9.963. Predict value of Q 2 pooled = 0.137. PLS thus is an increment on the mean benchmark and the error is slightly smaller than the linear comparison. The difference in the root means squared error of 0.068 points compared to the linear model is not very large in real-life context.

The structural performance equation is less restrictive than the prediction exercise as the equation relies on

Table 12: Repeated prediction of mathematics examination performance

Assessment	PLS RMSE	PLS MAE	LM RMSE	Mean RMSE	Q^2 predict
Repetition 1	12.752	9.888	12.827	13.743	0.139
Repetition 2	12.767	9.902	12.792	13.768	0.140
Repetition 3	12.767	9.900	12.848	13.749	0.138
Repetition 4	12.765	9.888	12.861	13.753	0.138
Repetition 5	12.825	9.930	12.886	13.767	0.132
Pooled	12.775	9.901	12.843	13.756	0.137

Note: Predictors are MA1–MA5 only. Each repetition produces 470 predictions; pooling gives 2,350 dependent repeated predictions. LM = linear model. Errors are in percentage points.

the indicators of the anxiety alone. It is the positive Q 2 prediction of the positive value that should be viewed in that context of information. It does not show that the entire model is also as predictive in terms of performance when it is implemented in new institutions or in different examination systems. The repeated predictions, too, fail to further expand the independent sample size to more than 470. The other error is large enough that the process cannot be applied to provide specific individual grades or make consequential student level decisions.

Table 13 summarizes the seven decisions of the hypothesis. A negative direct negative association is supported by H1, H2 and H4 in regards to anxiety. H3, H5 and H6 are supported with positive relationships with self-efficacy and engagement. The negative serial indirect pathway is supported in H7. Compliance with the signs of the coefficients with the specified directions reinforces internal consistency of the model. However, the fitment

Table 13: Summary of hypothesis testing

Hypothesis	Relationship	β	95% CI	Decision
H1	MA → MSE	-0.327	-0.411 to -0.243	Supported
H2	MA → MLE	-0.179	-0.258 to -0.102	Supported
H3	MSE → MLE	0.387	0.311 to 0.463	Supported
H4	MA → AP	-0.205	-0.278 to -0.126	Supported
H5	MSE → AP	0.255	0.176 to 0.332	Supported
H6	MLE → AP	0.295	0.214 to 0.372	Supported
H7	MA → MSE → MLE → AP	-0.037	-0.056 to -0.023	Supported

Note: All p < 0.001. Support requires the expected sign and a 95% bootstrap interval excluding zero. H7 is a serial indirect association.

in all the hypotheses does not imply that the alternative theoretical framework would have a lower fit or that the association does not depend on the unmeasured factors (Rahman *et al.*, 2022).

Discussion

Anxiety within the broader learning process

The findings place mathematics anxiety in a larger trend in confidence, participation, and achievement. It still has a negative association with performance, even with the addition of the two mediators. In parallel, anxiety is negatively correlated with confidence and engagement (Lailiyah *et al.*, 2021). This conglomeration indicates that the anxiety-achievement correlation cannot be well explained as being fear at test time only. The same trend is seen in the ability ratings students give to themselves, and to the stability of their involvedness in mathematical learning practices.

The correlation with self-efficacy is more absolute point-estimate related than occurrence of engagement. One of the interpretations is that anxiety is strongly related to the judgements of the students regarding their abilities to cope with mathematical requirements. Difficulty is also a factor that can make students have low expectations of success. Confidence can also be a measure of past performance and anxiety can be preceded by prior academic struggle. These possibilities are accommodated by the cross-sectional findings (Caviola *et al.*, 2022). They advocate focus on the connection of emotional experience with perceived competence without considering one direction of development.

The retained anxiety - performance coefficient is educationally significant since the correlates of achievement are not all used up by confidence and engagement. The remaining association may be caused by situation anxiety, prior knowledge, the state of examination, and the unmeasured learning experience. Their distinct roles are not defined in the model. The effect of a direct coefficient must thus be interpreted as a conditional relationship within the given equation and not as an independent or unconditional psychological effect. This meaning leaves the difference between the statistical decomposition and a mechanism that has been demonstrated by experiment.

Confidence and sustained participation

There are positive direct correlations between self-efficacy and engagement and performance. The model demonstrates the highest local effect size of confidence-engagement relationship, indicating that perceived capability is especially applicable to learning activities measured (Schmitz *et al.*, 2023). This finding provides the practical significance of confidence in terms of task-specific resource. Those students who think that they can grasp content and find ways to do so also report on more attention, routinely practicing and perseverance. Relationship is capability belief about mathematics as opposed to undifferentiated encouragement and overall optimism.

The positive indirect self-efficacy-performance correlation via engagement suggests that confidence and participation are to be viewed as a complex. Confidence can be pedagogically helpful in combination with tasks that allow practicing and providing feedback. Similarly, successful participation can help to build the confidence in the long run. An instructional methodology informed by this association would provide chances to students to feel controllable difficulty and see enhancement. This would be a suggestion based on the associative trend. The present study lacks estimations of the impact of a classroom-based intervention that will boost confidence (Qu *et al.*, 2020).

Engagement is positively related to achieving even after anxiety and self-efficacy have been taken into account. This upholds the importance of observing the actions of students in learning as well as the way they feel and the way they think they should be able. The engagement scale comprises of completion and understanding (Saputra *et al.*, 2022). Its correlation to performance should not then be narrowed down to the amount of homework or time spent on studying. Intentional consideration, perseverance, and thought might not be a repetitive endeavor with minimal or no reinforcement and conceptual stimulation.

Meaning of the serial pathway

The serial pathway provides a logical statistical explanation as to how the constructs can be interrelated. Its negative mark occurs in the order of apprehension, lack of confidence, lesser participation and less performance as suggested. The interval that does not contain the zero shows that this composite association is non-equal to zero in the described bootstrap procedure. Its magnitude is smaller than either shorter anxiety–performance indirect pathway (Brewster & Miller, 2020). Serial route is consequently, a supportive element of the model in place of the overall explanation of the overall anxiety-performance association.

Educational interpretation is affected by the presence of a number of indirect paths that go through each other. Students might lose confidence without a similar decrease in all measured engagement activities. Others might be confident yet have anxiety that interferes with attention or training (Juliyanti & Pujiastuti, 2020). Any one uniform explanation would miss these other possibilities. The model allows confidence and engagement to be associated with performance in a separate manner as well as adjusting them in a sequence. This framework promotes a more differentiated view of the needs of students, even though no single profile can be formed based on a collection of path coefficients (Isnaini & NurDalilah, 2023).

It should not be assumed that some percentage of students advance in the specified order using the indirect association. It is a sample-level coefficient decomposition. Neither does it indicate that a transformation in the first mediator will be sure to transform the second (Islam *et*

al., 2021). These propositions would need longitudinal measurement and interventions designs to investigate them. It adds value to the existing body of literature to determine that the observed correlations are consistent with a sequence proposed and that the serial correlation is supported in a model with other possible shorter paths.

Explanatory and predictive value

The 0.332 value of R 2 means that the constructs included can explain the variation in mathematics scores together with about a third of the total variation observed. This gives explanatory details, but does not suggest extensive coverage of accomplishment (Sonia *et al.*, 2020). The unknown part can be made up of prior achievement, curriculum exposure, difficulty of the assessment, teaching practices and measurement error. These components, which are not studied, are not quantified. The small value of explained variance of self-efficacy further suggests that anxiety as a factor is inadequate to explain the confidence of students in mathematics.

Prediction outcomes legitimize the practical interpretation of the structural findings. The indicators of anxiety are better-predicting compared to a mean-only baseline, but do not offer a significant improvement over a linear model. Structural paths statistically significant at a level do not imply prediction enhancement at a level. The prediction exercise poses a separate question of the explanatory analysis of the model and requires less information (Hafeez *et al.*, 2022). The fact that it made such a mistake shows the constraints of anxiety responses to predict examination performance. Support of students should then be based on a wider evaluation of the student requirements as opposed to using the predicted scores as conclusive measurements.

Confidence on the coherence of the reported analysis is enhanced by the agreement of reliable measurement, supported structural paths and positive predictive relevance. These kinds of evidence however answer diverse questions. Reliability involves consistency of a measurement block. Structural inference deals with conditional relations. Prediction takes into account a metric of errors on the held-out observations in a specified process. None substitutes for representativeness, causal identification, or external validation (Sim & Maat, 2022). By upholding these differences, the findings can be used to inform the discussion in education without extrapolating them beyond the evidence at hand.

Educational Implications

The results are in favor of the comprehensive method of mathematics support where emotional experience is taken into account in addition to the instructional progress. Educators have the opportunity to notice the symptoms of avoidance, hesitation to describe solutions, and constant worrying about assessment. These observations ought to prompt a supportive discussion and not a predetermined designation of competence (Liu, 2023). Classroom reactions can involve more explicit task requirements, a chance to even privately attempt problems and feedback on particular steps in solutions. The practices are suggested as feasible applications of these observed relationships but not as interventions and analysed by this study.

It is especially so in self-efficacy that opportunities of attainable mastery are available. Activities may develop through guided samples to partial supported issues and finally to unassisted use. The feedback can help to distinguish between reasoning that is right and the way of doing something that needs to be improved (Weissgerber *et al.*, 2022). This provides students with tangible capability and improvement. Simple reassurance is not a sufficient method of instruction when the pupil is not aware of the way to go. An emphasis on visible improvement can bridge confidence and mathematical competence without overturning proper expectations of effort and accuracy.

The quality of participation should be tackled through engagement support. Problems can be presented in practice schedules, where they are explained and methods are compared and errors reflected upon. It is possible to encourage students to note the reasons why the first attempt was unsuccessful and what makes the second change (Erdem & Arikan, 2023). Short checks allow teachers to spot the misconceptions before they build up on a number of issues. These actions bind these non-finitely on purpose. The experiment fails to establish the best dose of practice and the results may not be regarded as a reason to increase workload without considering its educational merit.

Support arrangements at the institutional level can entail a combination of subject teaching and will offer access to relevant student guidance. Distress mathematics-related distress in students must be approached with sensitivity, particularly, when the students are afraid that by seeking help, they are declaring their inability (Moustafa *et al.*, 2021). The communication of assessment can be used to specify expectations and the presence of feedback. Repeated measures of anxiety, confidence, engagement and similar achievement should be used to assess any programme brought in on the foundation of these findings. It should be evaluated whether students with various initial needs are accessing their support equally and whether their benefits are maintained.

The relations also pose a question of the evaluation of support. This rise in confidence that was not accompanied by an equivalent gain in mathematical knowledge might have been of limited educational use. Equally, reduced anxiety and decreased engagement in challenging activities would not necessarily indicate effective learning facilitation. Assessment must, thus, take a number of outcomes into account. Complementary information can be given by examination achievement, desire to attempt problems with which they are not familiar, and explanation of reasoning (Siaw *et al.*, 2020). These indicators should be used to interpret those changes in questionnaire scores and not as the only evidence of progress.

Another difference is related to group averages and

personal experiences. Mean anxiety near the middle of the scale may mask students with high or low scores. The structural coefficients generalise the relationship between the relationships in the sample and fail to highlight which students need this kind of help. Information concerning the circumstances that put the student in a problematic situation, the subject matter, and the methods which have already been tried could be of help in supporting the student. This contextual information can be used to differentiate difficulty posed by a new concept, and difficulty posed by the presence of an audience or examination stress.

The future intervention studies may contrast instructional support and instructional support with structured opportunities to address mathematical concerns (Milena *et al.*, 2022). Measuring the outcomes before and after the implementation should be done using similar measurements. The participation and the consistency of implementation also need to be captured in the evaluation, as a poorly-structured delivery process might hide the worth of a properly-structured one. Where possible, assignment processes need to minimize the systematic disparities among comparison groups. This would be research that would go beyond the current associative evidence and determine whether confidence and engagement improvements are correlated with anxiety and achievement.

The practical use of the existing model is thus the ability to structure definite questions regarding learning. It recognizes the dimensions of confidence and engagement that can be measured and analyzed with anxiety, not based on the scores of the examination (Malanchini *et al.*, 2020). This may enhance the accuracy of further learning enquiry. It lacks a diagnostic category, an individual treatment guideline and an empirically tested threshold of intervention. Support decisions must be sensitive to the academic situation of the student, and must be reviewed by a well-documented body of evidence observed in the process of implementation.

Limitations and Future Research

The primary limitation to interpreting the proposed mediation structure is the cross-sectional design used. Anxiety, confidence and engagement are analysed without repeat observations to determine the order of them over time. All the three psychological constructs can be affected by prior achievement and mutualistic relations are probable. Future studies need to evaluate the constructs on a number of occasions over the span of an academic term and a baseline measure of achievement (Rahman *et al.*, 2022). This design would enable a more informative determination of the causal relationship between changes in confidence and engagement and performance.

It also uses psychological indicators which are self-reported. There might be some shared response tendencies that could make them related. The findings of discrimination-validity confirm the separation of the constructs, but not the separation of the common-method. Examination percentages give a different form of outcomes but reported marks can still have recall or transcription error. Future research must differentiate between internalised scores and recorded scores and compare with authorised ratings. Engagement measures could be used in an observational or teacher-reported format to complement the student questionnaire without the presupposition of measuring the same point of view. Comparison between assessments needs more consideration. Transformation of examination marks into percentages does not eliminate variations in content coverage, difficulty, marking standards, and time of the assessment. The students can be given the same percentage in varying circumstances (Ramdani *et al.*, 2022). A standardized evaluation or a laid down process of consideration of examination variations would bolster comparisons. Clustering should also be considered in future analyses where groups of students are clustered in institutions. Teaching practices and assessment arrangements at the institution level can affect a number of students at once, so assumptions of independence are an empirical problem, not a property of the number of records.

The only limitation of generalisation is the description of recruitment available and the coded background categories. The analysis fails to give a probability sample, a response rate and measurement equivalency across demography and institutional groups. Future studies ought to record the recruitment processes, confirm category mapping, and see whether the measurement construct works in the same way in the appropriate groups. Replication should also do the testing of the alternative model orderings and the testing of prediction with distinctly collected samples. Such measures would help understand what results are consistent outside the current analytical context.

CONCLUSION

The confidence, engagement, and mathematics examination performance in analytical sample of 470 higher secondary students show negative relationship with mathematics anxiety. There are positive correlations between self-efficacy and engagement and performance, and the serial indirect correlation of both constructs is confirmed. The model accounts 33.2% of the performance variance and the prediction based on anxiety offers a slight addition to the specified benchmarks. These findings reinforce an educational meaning that encompasses emotional discomfort as well as perception of capability and learning participation. Practices of supportive assessment, opportunities of realistic mastery, intentional engagement bring in topical guidance towards educational growth. They cannot be effective without direct evaluation. The results develop a consistent pattern of cross-sectional relationships and form a basis to conduct longitudinal studies based on the proven and similar measures of achievement and well-documented recruitment processes.

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