



Conceptualizing Mathematics-Related Mental Stress Among Secondary School Students: A Theoretical Framework for Scale Construction

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Abstract

Mathematics-related mental stress is a pervasive but conceptually under-differentiated phenomenon in secondary school education, frequently subsumed under the broader and older construct of mathematics anxiety. This paper advances a theoretical framework that distinguishes mathematics-related mental stress (MRMS) as a multidimensional construct comprising cognitive-evaluative, affective-emotional, physiological, and behavioural dimensions, situated within antecedent (cognitive, pedagogical, and socio-familial) and outcome (achievement, avoidance, self-efficacy, and career-choice) variables. Drawing on cognitive appraisal theory, the transactional model of stress and coping, self-efficacy theory, and existing psychometric work on mathematics anxiety and attitudes, the paper argues that available instruments inadequately capture the construct's full breadth, particularly its physiological and behavioural facets, and are rarely normed on Indian secondary-school populations. A conceptual model (the MRMS framework) is proposed together with an operational definition and a staged blueprint for scale construction — domain specification, item generation, content validation, pilot testing, item analysis, and factor-analytic validation. The paper concludes by outlining the theoretical, pedagogical, and policy implications of a validated MRMS-Scale, situating its utility within India's National Education Policy (NEP 2020) emphasis on socio-emotional wellbeing and competency-based mathematics learning.

Keywords: *mathematics-related mental stress, mathematics anxiety, scale construction, secondary school students, theoretical framework, psychometrics*



1. Introduction

Mathematics occupies a distinctive place in the school curriculum: it is simultaneously regarded as a gatekeeper subject for higher education and career mobility, and as one of the subjects most consistently associated with negative affect among learners. A substantial body of research has documented what is popularly termed "mathematics anxiety" — a state of discomfort experienced when manipulating numbers or solving mathematical problems (Ashcraft, 2002; Hembree, 1990). However, the anxiety literature, while foundational, tends to foreground the affective-emotional and evaluative dimensions of learners' distress and gives comparatively little systematic attention to its physiological and behavioural manifestations, or to the way sustained, low-grade stress accumulates across the academic year rather than being confined to discrete testing episodes.

This paper proposes that "mathematics-related mental stress" (MRMS) is a conceptually broader and, for secondary-level learners, a more ecologically appropriate construct than mathematics anxiety alone. Where anxiety is typically framed as an acute, situation-specific emotional response, mental stress is better understood through the transactional lens of stress appraisal (Lazarus & Folkman, 1984), in which a student continuously evaluates mathematics-related demands against perceived coping resources across homework, classroom recitation, periodic testing, and long-term achievement pressure. Framed this way, MRMS is not merely a symptom to be measured at a single time point but a sustained psychological process with cognitive, emotional, physiological, and behavioural components.

The absence of a psychometrically robust, contextually grounded instrument to measure this construct among Indian secondary school students constitutes both a research gap and a practical constraint on teachers, counsellors, and curriculum planners who require diagnostic tools suited to classroom-level decision-making. This paper therefore has two related aims: first, to articulate a theoretical framework that conceptually differentiates and organises the dimensions of mathematics-related mental stress; and second, to translate that framework into a staged blueprint for the construction and future validation of a Mathematics-Related Mental Stress Scale (MRMS-Scale).



1.1 Rationale and Significance

Secondary school — broadly Standards 9 to 12 in the Indian schooling structure — is the stage at which mathematics becomes both more abstract and more consequential, coinciding with board examinations, stream selection, and competitive-examination preparation. Stress experienced during this stage has been linked in related literature to reduced conceptual engagement, surface-level rote strategies, and avoidance of mathematics-intensive streams and careers (Ashcraft & Krause, 2007; Wigfield & Meece, 1988). A theoretically grounded and psychometrically sound instrument would allow researchers to move beyond anecdotal identification of "math-stressed" students toward systematic screening, early intervention, and evaluation of pedagogical or counselling interventions. This is particularly salient in the context of NEP 2020, which explicitly foregrounds student wellbeing, stress-free assessment, and competency-based mathematics pedagogy as policy priorities.

1.2 Objectives of the Paper

- To conceptually differentiate mathematics-related mental stress from mathematics anxiety and general academic stress.
- To identify and organise the theoretical dimensions of MRMS through an integrative review of stress, anxiety, and self-efficacy theories.
- To propose a conceptual framework depicting antecedents, dimensions, and outcomes of MRMS among secondary school students.
- To outline a staged methodological blueprint for constructing and validating an MRMS-Scale.

2. Theoretical Foundations

The proposed framework draws on four complementary theoretical strands, each contributing a distinct lens on how mathematics-related distress arises and is sustained.



2.1 Cognitive Appraisal and the Transactional Model of Stress

Lazarus and Folkman's (1984) transactional model conceptualises stress as arising from an individual's appraisal of a situation as taxing or exceeding their coping resources. Applied to mathematics learning, a student's stress response depends less on the objective difficulty of a problem than on their primary appraisal (is this threatening to my competence or self-worth?) and secondary appraisal (do I have the skills, time, or support to cope?). This model supplies the cognitive-evaluative dimension of the proposed framework and explains why the same mathematical task can be stress-inducing for one learner and neutral for another.

2.2 Mathematics Anxiety Theory

Mathematics anxiety research (Ashcraft, 2002; Richardson & Suinn, 1972) establishes that negative affect toward mathematics has measurable cognitive costs, notably reduced working-memory availability during problem-solving. This literature substantiates the affective-emotional dimension of MRMS and provides psychometric precedent — instruments such as the Mathematics Anxiety Rating Scale (MARS) and its abbreviated derivatives — that inform, without fully replicating, the present framework's item domains.

2.3 Self-Efficacy Theory

Bandura's (1997) self-efficacy theory contributes the behavioural and motivational dimension: students with low perceived mathematics self-efficacy are more likely to avoid challenging problems, disengage during instruction, and select non-mathematical academic streams, independent of their actual ability. Perceived self-efficacy thus functions in the present framework both as an antecedent that shapes appraisal and as an outcome that is eroded by sustained stress.

2.4 Psycho-Physiological Stress Response

General stress physiology (Selye, 1956, as extended in subsequent educational stress research) establishes that sustained psychological stress produces measurable somatic correlates — muscular tension, fatigue, sleep disruption, and autonomic arousal. Although rarely



operationalised in subject-specific educational scales, this strand justifies the inclusion of a physiological dimension distinct from self-reported worry or fear, allowing the MRMS-Scale to capture stress that manifests bodily even where a student underreports emotional distress.

3. Review of Existing Instruments and the Conceptual Gap

A range of instruments has historically been used to approximate mathematics-related distress, summarised in Table 1. While each has made a substantial contribution to the field, none was designed to capture the full four-dimensional structure proposed here, and few have been normed on Indian secondary-school populations under the current curricular framework.

Table 1. Representative Existing Instruments and the Conceptual Gap Addressed by the Proposed Mathematics-Related Mental Stress (MRMS) Framework

Instrument	Author(s) / Year	Primary Focus	Limitation Relative to Proposed MRMS-Scale
Mathematics Anxiety Rating Scale (MARS)	Richardson & Suinn (1972)	Physiological/affective anxiety in test settings	Adult-normed; does not capture behavioural or cognitive-evaluative facets
Fennema-Sherman Mathematics Attitude Scales	Fennema & Sherman (1976)	Attitudes toward mathematics as a subject	Attitude-oriented; stress as a distinct construct is not isolated
Abbreviated Math Anxiety Scale (AMAS)	Hopko et al. (2003)	Brief anxiety screening	Narrow item pool; omits somatic and behavioural indicators
Perceived Stress Scale (generic, adapted)	Cohen et al. (1983, adaptations)	Generalised perceived stress, not subject-specific	Not contextualised to mathematics learning environments

This comparative reading suggests a clear conceptual gap: existing instruments are either narrowly affective (MARS, AMAS), attitudinal rather than stress-focused (Fennema-Sherman), or generic and decontextualised from mathematics learning (adapted perceived-stress measures). None simultaneously operationalises cognitive-evaluative appraisal, affective-emotional experience,



physiological symptomatology, and behavioural avoidance within a single, developmentally appropriate instrument for Indian secondary school students. This gap constitutes the empirical warrant for the MRMS framework proposed in the following section.

4. Proposed Conceptual Framework

Integrating the theoretical strands above, mathematics-related mental stress is defined, for the purposes of this framework, as a sustained psychological state arising from a secondary school student's appraisal of mathematics-related academic demands as exceeding their perceived coping resources, manifested through interrelated cognitive-evaluative, affective-emotional, physiological, and behavioural responses. Figure 1 depicts the resulting model.

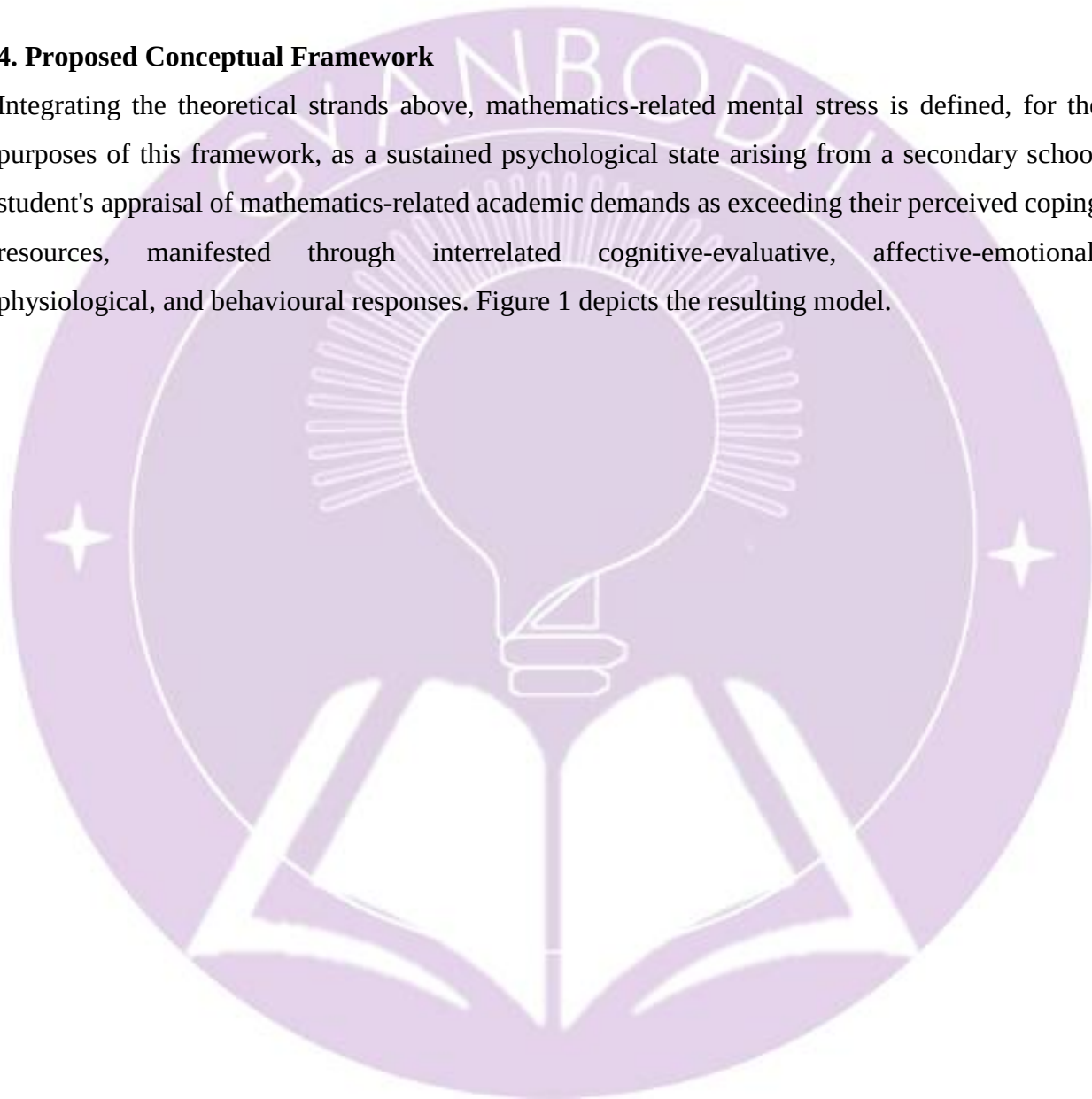
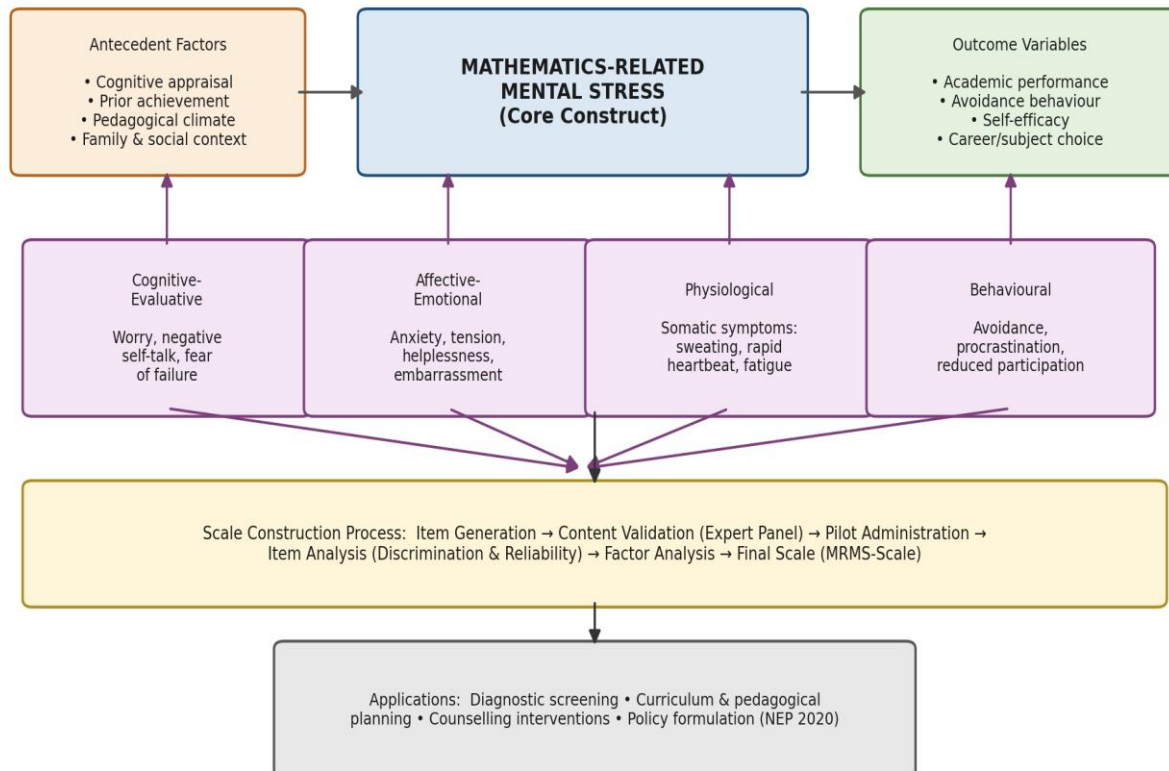


Figure 1. Theoretical Framework for Mathematics-Related Mental Stress Scale Construction (MRMS-Scale)



4.1 Antecedent Factors

Antecedents shape the appraisal process that gives rise to MRMS. These include the student's cognitive appraisal style and prior mathematics achievement, the pedagogical climate created by teaching methods and evaluation practices, and the socio-familial context, including parental expectations and peer comparison. These factors are theorised to moderate, rather than directly determine, the intensity of the stress response.

4.2 The Four Dimensions of MRMS



The core construct is organised into four interrelated but empirically separable dimensions, each of which is intended to correspond to a distinct subscale of the proposed MRMS-Scale:

Cognitive-evaluative dimension: worry about performance, negative self-referential thoughts, and anticipatory fear of failure during mathematics-related tasks.

Affective-emotional dimension: felt anxiety, tension, helplessness, and embarrassment associated with mathematics classes, homework, or examinations.

Physiological dimension: somatic correlates of stress such as increased heart rate, sweating, headaches, and fatigue experienced in mathematics-related situations.

Behavioural dimension: avoidance and procrastination of mathematics work, reduced classroom participation, and over-reliance on rote memorisation as a coping strategy.

4.3 Outcome Variables

The framework theorises that sustained MRMS influences academic performance, reinforces avoidance behaviour, erodes mathematics self-efficacy, and shapes subsequent subject and career choices — outcomes that, in turn, may feed back into the antecedent conditions of subsequent appraisal, consistent with the cyclical nature of the transactional stress model.

5. Methodological Blueprint for Scale Construction

Translating the conceptual framework into a validated instrument requires a staged psychometric process, summarised below and depicted in the lower band of Figure 1.

5.1 Domain Specification and Item Generation

Each of the four theoretical dimensions is first operationalised into an item pool through a review of existing anxiety and stress literature, informal interviews with secondary school mathematics teachers and counsellors, and open-ended elicitation from students. An initial pool of approximately 60–80 items, distributed across the four dimensions, is recommended to allow for attrition during subsequent stages.



5.2 Content Validation

The item pool is reviewed by a panel of subject-matter experts — mathematics educators, educational psychologists, and school counsellors — who rate each item for relevance, clarity, and dimensional fit, typically using a content validity ratio (Lawshe, 1975) or content validity index. Items falling below an accepted threshold are revised or discarded, and language is simplified for readability at the secondary-school reading level, with parallel Gujarati and English versions prepared where the instrument is intended for regional deployment.

5.3 Pilot Administration

The refined item pool is administered to a pilot sample of secondary school students (recommended minimum of 150–200 respondents, stratified by grade, gender, and school type) using a five-point Likert response format ranging from "Never" to "Always."

5.4 Item Analysis and Reliability

Item-total correlations and discrimination indices are computed to identify and remove weak or redundant items. Internal consistency is estimated using Cronbach's alpha for the overall scale and for each proposed subscale, with a minimum acceptable threshold of .70 typically applied in educational psychometrics.

5.5 Factor-Analytic Validation

Exploratory factor analysis on the pilot data is used to examine whether the empirical item structure supports the theorised four-dimensional model, followed, in a subsequent independent sample, by confirmatory factor analysis to formally test model fit. Convergent and discriminant validity may be further examined by correlating the MRMS-Scale with established measures of mathematics anxiety and general academic stress.

5.6 Norm Development



Once validated, the scale is administered to a larger, representative sample to generate grade- and gender-differentiated norms, enabling classification of students into low, moderate, and high MRMS categories for diagnostic and counselling use.

6. Implications

6.1 Theoretical Implications

The framework contributes to the educational psychology literature by explicitly distinguishing mathematics-related mental stress from the narrower construct of mathematics anxiety, and by integrating stress-appraisal, anxiety, self-efficacy, and psycho-physiological perspectives within a single testable model.

6.2 Pedagogical and Counselling Implications

A validated MRMS-Scale would allow classroom teachers to identify students experiencing elevated stress before it manifests as avoidance or achievement decline, and would give school counsellors a diagnostic basis for targeted interventions such as relaxation training, cognitive restructuring, or graduated exposure to mathematics tasks.

6.3 Policy Implications

The framework directly supports NEP 2020's emphasis on stress-free, competency-based assessment and student wellbeing by providing a mechanism through which schools and boards can monitor mathematics-related stress at scale, informing curricular pacing, assessment design, and teacher training priorities.

7. Limitations and Future Directions

As a theoretical paper, this framework has not yet been empirically tested; its four-dimensional structure and the proposed antecedent-outcome relationships require confirmation through the staged validation process outlined in Section 5. Future research should also examine measurement invariance across gender, grade level, and school type (government, grant-in-aid, and private), and



should explore longitudinal designs capable of testing the feedback loop between MRMS and subsequent achievement and career choice.

8. Conclusion

This paper has argued that mathematics-related mental stress among secondary school students is a distinct, multidimensional construct warranting a dedicated theoretical framework and a purpose-built psychometric instrument. By integrating cognitive appraisal, mathematics anxiety, self-efficacy, and stress-physiology perspectives, the proposed MRMS framework offers a conceptually coherent foundation for the construction of an MRMS-Scale capable of informing pedagogy, counselling practice, and policy in a manner consistent with the wellbeing priorities articulated in NEP 2020.

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