



Measuring Mathematics-Related Mental Stress: Construction, Tryout, and Psychometric Validation of a Scale for Secondary School Students in Gandhinagar District

Anjana N. Patel

Research Scholar

Faculty of Education

Swaminarayan University, Kalol

Guide-Dr. (Prof.) Nitin Raval

Faculty of Education

Swaminarayan University, Kalol

Abstract

Mathematics is consistently reported as one of the most stress-inducing subjects at the secondary school stage, with cognitive, emotional, physiological, and behavioural consequences that can depress achievement and discourage subject choice at higher levels. The present study reports the construction, tryout, and psychometric validation of a Mathematics Subject Related Mental Stress Scale (MSRMSS) for secondary school students of Gandhinagar district, Gujarat. An initial pool of 60 Likert-type items was generated across five conceptual components — Cognitive Stress, Emotional Stress, Physiological Stress, Behavioural Stress, and Performance-Evaluation Stress — refined through expert opinion and content validity ratios. The pilot form was administered to 120 secondary school students (Std IX–X) selected through stratified random sampling. Item analysis using the extreme-group t-value method retained 40 items with significant discrimination ($t \geq 1.75$, $p < .05$). The final scale demonstrated high internal consistency (Cronbach's $\alpha = .87$), split-half reliability (.83, Spearman–Brown corrected), and test–retest reliability (.81) over a two-week interval. Content validity (average CVR = .78) and criterion-related validity against an established mathematics anxiety measure ($r = .72$, $p < .01$) supported the scale's validity. The resulting 40-item scale offers teachers, counsellors, and researchers a psychometrically sound, contextually appropriate tool for identifying and addressing mathematics-related mental stress among secondary school students.

Keywords: *mathematics anxiety, mental stress, scale construction, psychometric validation, secondary school students, Gandhinagar district*



1. Introduction

Mathematics occupies a unique position among school subjects: it is compulsory, cumulative, and widely perceived as difficult, which together create fertile ground for subject-specific stress. Stress, in Selye's classical formulation, is the non-specific response of the body to any demand made upon it, while Lazarus and Folkman's cognitive-transactional model frames stress as arising when perceived demands exceed perceived coping resources. Applied to the mathematics classroom, students who repeatedly appraise mathematical tasks, tests, and evaluative comparisons as exceeding their coping capacity experience a recognisable stress syndrome with cognitive (worry, mental blocking), emotional (fear, helplessness), physiological (increased heart rate, sweating), behavioural (avoidance, procrastination) and performance-related (fear of failure, evaluation apprehension) components.

Decades of research on mathematics anxiety — beginning with Richardson and Suinn's Mathematics Anxiety Rating Scale and extended by Ashcraft, Hembree, and others — has established that such anxiety is measurable, distinguishable from general trait anxiety, and consequential for achievement. However, most standardized tools were developed and normed outside the Indian school context and do not fully capture how mathematics-related stress is experienced, expressed, and coped with by Gujarati-medium and English-medium secondary school students functioning under the Gujarat State Secondary and Higher Secondary Education Board syllabus. There is, therefore, a genuine need for a linguistically and culturally appropriate instrument that secondary school teachers, counsellors, and researchers in Gujarat can use with confidence.

The present study addresses this gap by constructing, trying out, and psychometrically validating a Mathematics Subject Related Mental Stress Scale (MSRMSS) specifically for secondary school students of Gandhinagar district.

2. Need and Significance of the Study

Mathematics-related stress, left unaddressed, has consequences that extend well beyond a single subject: it depresses classroom performance, narrows subject and stream choices at the higher secondary stage, and can generalize into broader academic disengagement. Teachers and school counsellors currently have very limited access to short, locally validated diagnostic



tools that would let them identify at-risk students early and plan remedial or counselling interventions accordingly.

- It provides schools in Gandhinagar district with a ready, psychometrically sound diagnostic tool rather than an anxiety measure borrowed from a different cultural or linguistic context.
- It contributes an Indian, district-specific data point to the international literature on subject-specific academic stress.
- It supports the National Education Policy 2020 emphasis on student well-being and stress-free learning environments by operationalizing one specific, measurable construct.
- It offers a foundation instrument that can be extended to other districts, subjects, or grade levels in future standardization work.

3. Review of Related Literature

Selye's general adaptation syndrome provided the physiological foundation for stress research, while Lazarus and Folkman reframed stress as a transaction between the person and the environment, mediated by cognitive appraisal — a model well suited to academic settings where the “demand” (a mathematics test) is constant but individual appraisal of it varies widely. Within mathematics education specifically, Richardson and Suinn's Mathematics Anxiety Rating Scale (MARS) was among the first standardized instruments to demonstrate that mathematics anxiety could be reliably measured and was distinct from general test anxiety. Ashcraft's subsequent work on the cognitive consequences of mathematics anxiety showed that anxious students often possess adequate mathematical competence but underperform because anxiety consumes working-memory resources during problem-solving. Hembree's meta-analysis of over 150 studies confirmed a consistent negative relationship between mathematics anxiety and achievement across grade levels, and further showed that treatment interventions could reduce anxiety and improve performance.

Indian research on academic stress — including work on general academic stress scales and subject-specific anxiety in Gujarat and neighbouring states — has repeatedly noted that Indian secondary students report examination-linked stress as a dominant concern, but subject-specific instruments validated for regional, vernacular-medium populations remain scarce.



This review of literature therefore points to two consistent conclusions that motivate the present study: mathematics-related stress is a distinguishable, measurable construct with real achievement consequences, and there is a continuing need for instruments normed on Indian, and more specifically Gujarati, secondary-school populations.

4. Statement of the Problem

The problem for the present study is stated as: “Construction and Tryout of a Mathematics Subject Related Mental Stress Scale for Secondary School Students of Gandhinagar District.”

5. Operational Definitions of the Terms

Mathematics-Related Mental Stress

The cognitive, emotional, physiological, and behavioural strain experienced by a student when mathematics-related demands — classwork, homework, tests, or teacher/parental evaluation — are appraised as exceeding available coping resources, as measured by the scores obtained on the MSRMSS constructed for this study.

Construction and Tryout

The systematic process of item generation, expert content validation, pilot administration, item analysis, and reliability–validity estimation undertaken to develop a psychometrically sound measuring instrument.

Secondary School Students

Students studying in Standard IX and Standard X in schools affiliated to the Gujarat Secondary and Higher Secondary Education Board, located within Gandhinagar district.

6. Objectives of the Study

- To construct an item pool for a Mathematics Subject Related Mental Stress Scale (MSRMSS) for secondary school students.
- To establish the content validity of the constructed items through expert opinion.
- To try out the pilot scale on a representative sample of secondary school students of Gandhinagar district.
- To carry out item analysis and retain items with satisfactory discrimination power.
- To estimate the reliability of the final scale (internal consistency, split-half, and test–retest).
- To establish the validity of the final scale (content and criterion-related).



- To prepare the final, administrable form of the scale along with a scoring key.

7. Delimitations of the Study

- The study is delimited to secondary school students (Std IX and X) of Gandhinagar district only.
- The study is delimited to mathematics-related mental stress and does not measure general academic stress or clinical anxiety disorders.
- The tryout sample is delimited to 120 students; large-scale standardization and norm development are treated as a subsequent phase.

8. Methodology

8.1 Research Design

The study followed a standard psychometric scale-construction design comprising four stages: (a) item pool generation and content validation, (b) pilot tryout, (c) item analysis, and (d) reliability and validity estimation of the final scale.

8.2 Population and Sample

The population comprised secondary school students (Std IX and X) studying in schools affiliated to the Gujarat Secondary and Higher Secondary Education Board within Gandhinagar district. A sample of 120 students was drawn through stratified random sampling, with strata formed on gender, school area (urban/rural), and medium of instruction (Gujarati/English), to secure adequate representation for item analysis.

8.3 Construction of the Scale

8.3.1 Component-wise Conceptual Framework

Based on the review of literature and discussion with mathematics teachers and counsellors, mathematics-related mental stress was conceptualized as a five-component construct:

- Cognitive Stress – worry, mental blocking, and negative self-talk related to mathematics tasks.
- Emotional Stress – fear, helplessness, irritability, and dread associated with mathematics.
- Physiological Stress – bodily symptoms such as headache, rapid heartbeat, or sweating before/during mathematics activities.



- Behavioural Stress – avoidance, procrastination, or reluctance to attempt mathematics work.
- Performance-Evaluation Stress – apprehension linked to tests, marks, and comparison with peers.

8.3.2 Item Pool Generation

An initial pool of 60 five-point Likert items (12 per component; response options ranging from “Always” to “Never”, scored 5–1 with reverse scoring for positively worded items) was drafted in simple, age-appropriate Gujarati and English, avoiding clinical or technical vocabulary.

8.3.3 Content Validity

The item pool was submitted to eight subject experts — mathematics educators, educational psychologists, and school counsellors — who rated each item as “essential,” “useful but not essential,” or “not necessary” for measuring the intended component, following Lawshe’s content validity ratio (CVR) procedure. Items with CVR below the critical value for eight raters (.75) were revised or dropped, and expert suggestions on wording and reading level were incorporated. The average CVR of the retained 60-item pilot form was .78.

8.4 Tryout and Item Analysis

The 60-item pilot form was administered to the tryout sample of 120 students under standard, untimed classroom conditions. Total scores were computed and the extreme-group method was used for item analysis: the upper 27% ($n = 32$) and lower 27% ($n = 32$) scorers were identified, and an independent-samples t -value was computed for each item comparing the mean item score of the high- and low-stress groups. Items with $t \geq 1.75$ (significant at .05 level with $df = 62$) were retained as possessing satisfactory discriminating power. Table 1 summarises the outcome of item analysis; representative items with their t -values are shown in Table 2.

Component	Items Drafted	Items Retained After Tryout	Retention %
Cognitive Stress	12	8	66.7
Emotional Stress	12	8	66.7
Physiological Stress	12	8	66.7



Component	Items Drafted	Items Retained After Tryout	Retention %
Behavioural Stress	12	8	66.7
Performance-Evaluation Stress	12	8	66.7
Total	60	40	66.7

Table 1: Component-wise Distribution of Items Before and After Tryout

Item No.	Component	Mean (High Group)	Mean (Low Group)	t-value	Decision
3	Cognitive Stress	4.28	2.41	6.84	Retained
7	Cognitive Stress	4.02	2.63	5.19	Retained
11	Cognitive Stress	3.35	2.98	1.42	Rejected
15	Emotional Stress	4.44	2.30	7.65	Retained
22	Physiological Stress	3.91	2.55	4.87	Retained
28	Physiological Stress	3.20	2.87	1.21	Rejected
35	Behavioural Stress	4.15	2.48	6.02	Retained
42	Behavioural Stress	3.05	2.79	0.98	Rejected
50	Performance-Evaluation Stress	4.36	2.20	7.98	Retained
56	Performance-Evaluation Stress	4.09	2.66	5.34	Retained

Table 2: Item Analysis — Representative Items with High–Low Group Means and t-values ($df = 62$)

Forty items with t-values ranging from 3.82 to 8.10 were retained across the five components (eight items per component), yielding a balanced final scale as summarised in Table 1.

8.5 Reliability of the Final Scale



Reliability of the 40-item final form was estimated on the tryout data using three methods: internal consistency (Cronbach's alpha), split-half reliability (odd–even split, Spearman–Brown corrected), and test–retest reliability (re-administered to a sub-sample of 40 students after a two-week interval). Component-wise and overall coefficients are presented in Table 3.

Component	No. of Items	Cronbach's α	Split-Half (S-B)	Test–Retest
Cognitive Stress	8	.79	.76	—
Emotional Stress	8	.81	.78	—
Physiological Stress	8	.77	.74	—
Behavioural Stress	8	.75	.72	—
Performance-Evaluation Stress	8	.80	.77	—
Total Scale (40 items)	40	.87	.83	.81

Table 3: Reliability Coefficients of the Final MSRMSS (N = 120; Test–Retest sub-sample n = 40)

8.6 Validity of the Final Scale

Content validity was established through the expert-panel procedure described in section 8.3.3 (average CVR = .78 for the items retained in the final scale). Criterion-related (concurrent) validity was estimated by correlating MSRMSS scores with scores on an established, previously translated mathematics anxiety measure administered to the same tryout sample; the obtained correlation was $r = .72$ ($p < .01$), indicating substantial convergence. Construct validity was further supported by a significant difference in mean MSRMSS scores between students independently rated by teachers as “high-stress” versus “low-stress” in mathematics (known-groups validity), summarised in Table 4.



Validity Type	Method	Coefficient / Result	Interpretation
Content Validity	Expert panel (n = 8), Lawshe's CVR	CVR = .78	Satisfactory
Criterion-related (Concurrent)	Correlation with established mathematics anxiety measure	$r = .72^{**}$	High convergence
Construct (Known- Groups)	t-test, teacher-rated high- vs low-stress groups	$t = 5.46^{**}$	Significant, $p < .01$

Table 4: Validity Evidence for the Final MSRMSS (** $p < .01$)

8.7 Norms

Preliminary raw-score norms (percentiles and stress-band classification — Low, Moderate, High) were computed from the tryout sample of 120 students. Given the modest sample size, these norms are treated as provisional; the authors recommend large-scale standardization on a district- or state-representative sample as a natural extension of the present study.

9. Results and Discussion

Item analysis retained two-thirds of the original item pool (40 of 60 items), evenly distributed across the five conceptual components, indicating that the initial conceptualization of mathematics-related mental stress as a five-component construct was empirically defensible for this population. The retained items showed clear discrimination between high- and low-stress groups, with t-values for retained items exceeding the critical value of 1.75 by a wide margin in most cases (Table 2), suggesting the final item set is sensitive to real variation in student-reported stress rather than to response-style artefacts.

The overall internal consistency of .87 compares favourably with reliability coefficients reported for established mathematics anxiety instruments internationally, and the split-half and test-retest coefficients (.83 and .81 respectively) indicate that the scale yields stable scores across both item-sampling and time. Component-wise alphas ranging from .75 to .81 (Table 3) are acceptable for eight-item sub-scales intended for diagnostic screening rather than clinical classification.



The moderately high concurrent validity coefficient ($r = .72$) with an established mathematics anxiety measure supports the interpretation that the MSRMSS is measuring a closely related but not identical construct — mental stress specific to the subject of mathematics, encompassing physiological and behavioural components beyond anxious affect alone. The significant known-groups difference further supports the scale's ability to distinguish students independently identified by teachers as experiencing high versus low mathematics-related stress, lending practical credibility to its use as a screening tool in Gandhinagar district schools.

10. Description of the Final Scale

- Total items: 40, distributed across five components (8 items each).
- Response format: Five-point Likert scale (Always–Often–Sometimes–Rarely–Never), with reverse scoring for positively worded items.
- Score range: 40 (minimum stress) to 200 (maximum stress).
- Administration: Group or individual; untimed; approximately 20–25 minutes.
- Language: Available in parallel Gujarati and English forms.
- Scoring: A separate researcher/teacher-use scoring key with component-wise sub-totals and provisional stress-band classification (Low / Moderate / High) accompanies the administrable form.

11. Educational Implications

- Mathematics teachers can use the MSRMSS as a quick screening tool at the start of a term to identify students who may need additional academic or emotional support.
- School counsellors can use component-wise sub-scores to design targeted interventions — for example, relaxation techniques for students high on Physiological Stress versus study-skills coaching for those high on Cognitive Stress.
- Curriculum planners and teacher educators can use aggregate findings to inform pedagogical approaches that reduce evaluation-linked stress without diluting academic rigour.
- The scale offers researchers a validated instrument for further studies relating mathematics-related stress to variables such as gender, school area, family type, and achievement.



12. Conclusion

The present study successfully constructed and tried out a 40-item Mathematics Subject Related Mental Stress Scale for secondary school students of Gandhinagar district. The scale demonstrated satisfactory item discrimination, high reliability across three independent methods, and encouraging content, concurrent, and construct validity evidence. While the provisional norms are based on a modest tryout sample and warrant expansion through large-scale standardization, the MSRMSS in its present form already offers teachers, counsellors, and researchers in Gandhinagar district — and, with local adaptation, elsewhere in Gujarat — a psychometrically sound, culturally appropriate tool for identifying and responding to mathematics-related mental stress among secondary school students.

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