Development And Validation Of Afshan Mathematics Anxiety Scale (Afmas)

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Abstract
The study was executed to develop and validate a Likert-type anxiety scale that measures students' anxiety in mathematics at the middle level. This mathematics anxiety scale is named as Afshan Mathematics Anxiety Scale (AfMAS). 24 items scale was piloted on 280 female grade VII students of public sector schools. The factors of the Afshan Mathematics Anxiety Scale were identified by exploratory factor analysis. Four factors were identified after factor loading analysis. These four factors were mathematics lesson anxiety (4 items); mathematics performance anxiety (7 items), mathematics assessment strategies anxiety (5 items); mathematics test anxiety (8 items). The overall Cronbach's alpha value was 0.89, with alpha values ranging from 0.81 to 0.89 for each subscale. Composite reliability for all subscales was assessed. Content, convergent, and discriminant validity were also assessed. The Afshan Mathematics Anxiety Scale was found to be both valid and reliable. With the help of AfMAS mathematics anxiety in middle-level students can be assessed.

Keywords: middle level, mathematics anxiety, scale development, validation of a scale.

Introduction

Mathematics anxiety is a vital problem in educational settings that affect mathematics performance poorly. Several kinds of research have inspected the phenomenon of mathematics anxiety for covering several decades from the 1950s (Naseem, 2021). Dreger and Aiken (1957, p. 344) defined mathematics anxiety as "number anxiety" as "a syndrome of emotional reactions to arithmetic and mathematics". Mathematics anxiety is a feeling of pressure, nervousness, or anxiety in such situations that involve mathematics activities (Suinn & Winston, 2003). Haase et al. (2019) defined mathematics anxiety as an irrational state and fright that decrease mathematics learning opportunities and limit career choices. Generally, mathematics anxiety is the sensations of pressure and stress that interfere with the manipulation of numbers and the clarification of mathematical issues in a variety of conditions (Naseem, 2021). Mathematics anxiety can be identified in young as in kindergarten and first grade (Aarnos & Perkkila, 2012; Harari et al., 2013; Ramirez et al., 2013). According to Scarpello (2007), mathematics anxiety can activate from grade IV and peaks in middle and high schools.

Home, society, and the classroom are the multiple causes of mathematics anxiety (Harari et al., 2013; Shields, 2005 cf Naseem, 2021). Parents with mathematics anxiety transfer their anxiety level to their children (Soni & Kumari, 2017 cf Naseem, 2021). Mathematics anxiety does not begin or stop with the students sometimes, a teacher also becomes a factor for mathematics anxiety in their students. Teachers play a chief role to keep the classroom environment positive where students can ask any question without any hesitation (Naseem, 2021). It is because of the teacher: students become excited to learn and practice mathematics; to become problem solvers, or they may develop mathematics anxiety and are not successful in school (Abbasi et al., 2013; Brahier, 2016). Females showed high anxiety than boys (Alyamani, 2017; Devine et al., 2012; Hill et al., 2016; Mutodi & Ngirande, 2014; Núñez-Peña & Bono, 2019). Contrary to other studies, there was no statistically significant difference found in the mathematics performance of students in terms of gender (Devine et al., 2012). Gender differences in mathematics anxiety might be different in a different culture (Jansen et al., 2013).

Mathematics anxiety exists. Anxiety in mathematics can prompt deficiency in achievement in school exams, avoidance of courses and professions that include mathematics problem-solving, and adverse physical and emotional challenges (Geist, 2015; Hopko et al., 1998; Maloney & Beilock, 2012). The indicators of mathematics anxiety are uneasy feelings such as panic, cluelessness, helplessness (Ahmed et al., 2012), and high levels of extreme tension (Pizzi & Kraemer, 2017). Mathematics is an essential ability that every student practices during their lives, in the classroom, at home, and in society. Mathematics anxiety disturbs our students' logical and number-solving skills (Luttenberger et al., 2018). Students of all age levels have experience mathematics anxiety due to many reasons. Students respond negatively to tests and assignments, submit blank assignments. When the students had higher mathematics anxiety they avoid mathematics. The tendency to avoid careers related to mathematics is increasing due to mathematics anxiety among students (Naseem, 2021). Students select and opt for minimum mathematics courses due to low confidence in their ability because of mathematics anxiety (Furner, 2019; Kargar et al., 2010; Sheffield & Hunt, 2006).

Educators make students excited in solving mathematics problems and see them as successful and confident in mathematics by using best practices that helped in preventing mathematics anxiety among their students (Furner & Berman, 2003). Researchers have investigated the different ways through which a mathematics teacher can relax their mathematics anxious students before a mathematics exam or test (Naseem, 2021). Lopes (2018) and Mitchell (2018) explored the strategies and practices that teachers used to reduce mathematics anxiety (cf Naseem, 2021). Until now, several instruments were developed for measuring mathematics anxiety since 1972 for different age group levels. Some instruments were adapted, modified, and abbreviated versions of the formerly developed instruments. The summary of the mathematics anxiety scales including researchers, scale name, number of items, factors or domains, target sample, validity, and reliability measures are listed in Table 1.

Limited research was explored in the Pakistani scenario about anxiety. No tool/scale was developed yet to measure mathematics anxiety in the Pakistani scenario. The most important purpose of this research study was to provide a tool for measuring mathematics anxiety in middle-level students. This anxiety scale is named as Afshan Mathematics Anxiety Scale (AfMAS). Through this scale, students' mathematics anxiety was assessed. The present study sought to identify the variables that may affect mathematics anxiety of students of grade VII.

Table 1 Summary of Instruments Developed by Researchers for Measuring Mathematics Anxiety

Researchers/ Year	**Instrument Name**	**No of Items**	**Construct /Domains**	**Scale**	**Target Sample**	**Validity measures**	**Reliability measures**
Visscher & White, 2020	Mathematics Engagement Anxiety Rating Scale (MEARS): inspired by RMARS (Alexander & Martray, 1989)	15	Two factors: Problem-solving anxiety and explanation anxiety	5- point Likert scale using "not at all" to "very much"	Prospective teachers	Construct (EFA)	α = 0.94
Widjajanti et al., 2020	An instrument for mathematics anxiety levels	34	Two domains: physiological and psychological	5- point Likert scale using "always, often, sometimes, rarely, and never"	VII, VIII, and IX graders (high school students)	Content	α = 0.95
Primi et al., 2020	Early Elementary School Abbreviated Mathematics Anxiety Scale (EES - AMAS): modified AMAS (Hopko et al., 2003)	9	Two factors: learning anxiety, and evaluation anxiety	5- point Likert scale using "little" to "much" anxiety for a pictorial scale	6 and 7 years old children	Content, Construct (CFA) Criterion Convergent	Inter-rater reliability (Cohen's Kappa) Omega = 0.76
Szczygieł, 2019	Modified Abbreviated Mathematics Anxiety Scale for Elementary Children (mAMAS- E): adapted mAMAS (Carey et al., 2017)	9	Two factors: learning anxiety, and testing anxiety	3- point Likert scale (rated 2-0) using "Yes, A little, or No"	I to III graders	Construct (CFA) Convergent Divergent	α = 0.75 F1 α = 0.59 F2 α = 0.71
Deieso & Fraser, 2018	Mathematics Anxiety Measure (MAM): inspired by MARS-R (Plake & Parker, 1982) and AMAS (Hopko et al., 2003)	8		5- point Likert scale using "low, some, moderate, quite a bit, and high" anxiety	VII and VIII graders	Construct (CFA)	

Carey et al., 2017	Abbreviated Mathematics Anxiety Scale (mAMAS): adapted AMAS (Hopko et al., 2003)	9	Two factors: learning anxiety, and evaluation anxiety	5- point Likert scale (rated 1-5) using "low anxiety to high anxiety"	IV, VII, and VIII graders	Construct (CFA, EFA) Convergent Divergent	α = 0.89 F1 α = 0.83 F2 α = 0.83
Rolison et al., 2016	Adult Everyday Mathematics Anxiety Scale (AEMAS)	13		5- point Likert scale using "low, some, moderate, quite a bit, and high" anxiety"	adults		α = 0.93
Ramirez et al., 2016	Revised Child Mathematics Anxiety Questionnaire (CMAQ-R)	16		5- point response scale by pointing to smiley faces (rated 1-5) using "not nervous at all to very, very nervous"	I and II graders		α = 0.83
Wahid et al., 2014		30	Three factors: emotions, assessment, and environment.	5- point Likert scale (rated 1-5) using "never to very often"	college-level students	Construct (EFA)	α = 0.86 F1 α = 0.87 F2 α = 0.89 F3 α = 0.87
Vukovic et al., 2013	Mathematics Anxiety Assessment Scale: modified MARS- E (Suinn et al., 1988) and MAQ (Wigfield & Meece, 1988)	12		4- point Likert scale using "yes, kind of, not really, and no"	II and III graders	Convergent Divergent	α = 0.80
Ramirez et al., 2013	Child Mathematics Anxiety Questionnaire (CMAQ): adapted MARS- E (Suinn et al., 1988)	8		5-point response scale by pointing to smiley faces (rated 1-5) using "not nervous at all to very, very nervous"	I and II graders		α = 0.55

Wu et al. (2012)	Early Mathematics Anxiety (SEMA): translated and adapted MARS (Richard & Suinn, 1972)	20	Two factors, numerical processing anxiety, situational and performance anxiety	5-point response scale graded with faces from "anxious to not anxious"	II and III graders	Construct (EFA)	α = 0.87 Split-half r = 0.77
Hunt et al., 2011	Mathematics Anxiety Scale-UK (MAS- UK): modified (Fennema & Sherman, 1976) and MARS (Richard & Suinn, 1972)	38	Three factors: evaluation anxiety, everyday/social maths anxiety and observation anxiety	5-point Likert scale using "not at all" to "very much"	Undergraduate university students	Construct (CFA, EFA)	α = 0.96 F1 α = 0.92 F2 α = 0.85 F3 α = 0.89 Test–retest r = 0.89
Şentürk, 2010	Mathematics Anxiety Scale for Elementary School Students (MASESS)	22	Five factors: attitude anxiety, self-confidence anxiety, content knowledge anxiety, learning anxiety, and test anxiety	5-point Likert scale (rated 5-1) using "always worry, often worry, sometimes worry, worry very little, never worry"	V graders	Construct (CFA)	α = 0.88 F1 α = 0.84 F2 α = 0.86 F3 α = 0.82 F4 α = 0.85 F5 α = 0.80
Bai et al., 2009	Mathematics Anxiety Scale-Revised (MAS-R): inspired by MAS (Betz, 1978)	14	Two factors: positive and negative affects	5-point Likert scale (rated 1-5) using "strongly disagree to strongly agree"	College students, VII and VIII graders	Face & Content Construct (CFA, EFA) Predictive	α = 0.85 Test-retest r = 0.71

Bursal & Paznokas, 2006	Revised-Mathematics Anxiety Survey (R-MANX): abbreviated from MANX (Erol, 1989)	30		5-point Likert scale (rated 1-5) using "never to always"	University students		α = 0.90
Suinn & Winston, 2003	Mathematics Anxiety Rating Scale-Short Version (MARS-S): precise version of MARS (Richard & Suinn, 1972)	30	Two factors: test anxiety, and numerical anxiety	5-point Likert scale (rated 0-4) using "not at all, a little, a fair amount, much, and very much".	University students	Construct Concurrent	α = 0.96 Test–retest r = 0.90
Hopko et al., 2003	Abbreviated Mathematics Anxiety Scale (AMAS): modified MARS-R (Plake & Parker, 1982)	9	Two factors: learning anxiety and evaluation anxiety	5-point Likert scale (rated 1-5) using "low anxiety to high anxiety"	Undergraduate students	Face Construct (EFA & CFA) Convergent Divergent	α = 0.90 F1 α = 0.85 F2 α = 0.88 Test–retest r = 0.85
Thomas & Dowker, 2000 (as cited in Krinzinger et al., 2009)	Mathematics Anxiety Questionnaire (MAQ)	7		5-point response scale (rated 0-4) using different pictures for the most negative answer to most positive answer	6 to 9-year-old children (primary level)		
Gierl & Bisanz, 1995	Mathematics Anxiety Survey (MAXS): modified MARS- E (Suinn et al., 1988)	6	Two factors: Test anxiety and problem-solving anxiety	5-point Likert scale (rated 1-5) using "not at all nervous to very very nervous"	III and VI graders		Grade III α = 0.85 Grade VI α = 0.87
Chiu & Henry, 1990	Mathematics Anxiety Scale for Children (MASC): precise version of MARS (Richard & Suinn, 1972)	22	Four factors: evaluation anxiety, learning anxiety, problem-solving anxiety, teacher anxiety	4-point Likert scale (rated 1-4) using "not nervous, a little bit nervous, very nervous and very very nervous"	IV to VIII graders	Construct	α = 0.92

Erol, 1989 (as cited in Ölmez & Ölmez, 2019)	Mathematics Anxiety Scale (MANX)	45	Four factors: test and evaluation anxiety, lesson anxiety, daily use of mathematics, self-efficacy for mathematics earning anxiety, problem-solving anxiety, teacher anxiety	4-point Likert scale (rated 1-4) using "never, sometimes, usually, and always"	Middle to college-level students		α = 0.91
Alexander & Martray, 1989 (as cited in Baloğlu & Zelhart, 2007)	Revised Mathematics Anxiety Rating Scale (RMARS): abbreviated MARS (Richard & Suinn, 1972)	25	Three factors: mathematics test anxiety, mathematics course anxiety, and numerical task anxiety	5-point Likert scale (rated 1-5) using "not at all, a little, a fair amount, much, and very much"	high school and college-level students	Content Construct (EFA & CFA)	α = 0.95 F1 α = 0.95 F2 α = 0.92 F3 α = 0.88 Test-retest = 0.86
Wigfield & Meece, 1988	Mathematics Anxiety Questionnaire (MAQ)	11	Two factors: negative affective reaction, and worry scale	7-point Likert scale (rated 1-7) using "not at all to very much"	secondary and college-level students	Content Construct (EFA & CFA)	F1 α = 0.82 F2 α = 0.76
Suinn et al., 1988	Mathematics Anxiety Rating Scale (MARS-E): modified MARS (Richard & Suinn, 1972)	26	Two factors: test anxiety, and performance evaluation anxiety affective reaction, and worry scale	5-point Likert scale (rated 1-5) using "not at all nervous to very very nervous"	IV to VI graders	Construct	α = 0.88

Suinn & Edward, 1982	Mathematics Anxiety Rating Scale for Adolescents (MARS-A): adapted MARS (Richardson & Suinn, 1972)	98	Two factors: numerical anxiety, and test anxiety	5-point Likert scale (rated 1-5) using "not at all, to very much"	grades VII to XII	Construct (CFA)	α = 0.96 Split-half r = 0.90
Plake & Parker, 1982	Mathematics Anxiety Rating Scale-Revised (MARS-R): shortened MARS (Richardson & Suinn, 1972)	24	Two factors: Learning mathematics anxiety, and Mathematics evaluation anxiety	5-point Likert type scale using "low anxiety to high anxiety"		Construct	α = 0.98
Sandman, 1980	Mathematics Attitude Inventory (MAI)	48	Six factors	5-point Likert type scale using "strongly agree, agree, undecided, disagree, to strongly disagree"	Grades VII to XII	Construct	The Cronbach alpha values for the six scales ranged from 0.68 to 0.89.
Fennema & Sherman, 1976	Fennema-Sherman Mathematics Anxiety Scale (MAS): a subscale (MAS)	12		5-point Likert type scale using "strongly agree, agree, undecided, disagree, to strongly disagree"	Prospective teachers		α = 0.89
Richard & Suinn, 1972	Mathematical Anxiety Rating Scale (MARS)	98		5-point Likert type scale (rated 1-5) from "not at all to very much anxiety"	College students	Construct	α = 0.97 Test-retest r = 0.85

Method

A pilot study was conducted on the group of 280 female students of grade VII in mathematics from public sector girls high school. The school participated in a pilot study voluntarily. There were four sections in the school for grade VII, and all participated in the pilot study. All participants were with an average age of 12 to 14 years. All ethical guidelines were followed before administering the scale (Naseem, 2021). To develop Afshan Mathematics Anxiety Scale (AfMAS), the researcher used four step-approach (MacLeod et al., 2018): reviewed existing instruments and relevant literature on mathematics anxiety; created initial constructs and items of the AfMAS originated from the relevant studies; established the content and face validity of the AfMAS based on views provided by experts and peers group; translated the AfMAS into Urdu and ensured the standard of translation for administering the AfMAS in the native language of participants. To define constructs of the instrument to measure anxiety in mathematics students the literature review provides the bases and supports the researcher in developing the instrument (Naseem, 2021).

The instrument was comprised of 24 Likert-type items and based on four factors; Mathematics Lesson Anxiety (MLA), Mathematics Performance Anxiety (MPA), Mathematics Assessment Strategies Anxiety (MASA), and Mathematics Test Anxiety (MTA). A 5-point Likert scale was developed for answering the responses. 1 number was assigned for the answer "Strongly Disagree", 2 number assigned for "Disagree", 3 number assigned for "Not at all", 4 number assigned for "Agree", and 5 number assigned for the answer "Strongly Agree". The students rated themselves to each statement on a 5-point scale (Naseem, 2021).

The first construct "Mathematics Lesson Anxiety" was representative of student concerns about mathematics lessons and topics of mathematical terms (Naseem, 2021). Concerning mathematics lesson anxiety, relevant studies generated construct "mathematics course anxiety (Alexander & Martray, 1989; as cited in Baloğlu & Zelhart, 2007); Richard & Suinn, 1972), apprehension of lessons (Erol, 1989; as cited in Ölmez & Ölmez, 2019), "content anxiety" (Allen, 2001; Şentürk, 2010) in their tool development. Finally, four statements were included in the AfMAS to assess mathematics lesson anxiety. The second construct "Mathematics Performance Anxiety" was descriptive of student fears to understand, able to solve sums and problems; or perform arithmetic problems in or out of the class in any situation (Naseem, 2021). Relevant studies related construct performance includes task anxiety (Alexander & Martray, 1989; as cited in Baloğlu & Zelhart, 2007); one's ability to learn mathematics (Gourgey, 1982); problem-solving anxiety (Chiu & Henry, 1990); situational and performance anxiety (Wu et al., 2012). Seven statements were finalized to assess mathematics performance anxiety for AfMAS. The third construct "Mathematics Assessment Strategies Anxiety" was related to constructivism theories: cognitive constructivism and social constructivism. Concerning these two theories, statements were generated that were reflective of the assessment strategies used in constructivist classrooms. Five statements were finalized and included in the AfMAS to assess mathematics assessment strategies anxiety in students. The fourth construct "Mathematics Test Anxiety" is representative of student feelings about tests or exams (Naseem, 2021). The construct test anxiety is used in many tools of mathematics anxiety (Alexander & Martray, 1989; as cited in Baloğlu & Zelhart, 2007); Hopko et al., 2003; Richard & Suinn, 1972). Test anxiety is a cognitive factor and produces negative expectations for success about one's performance (Deffenbacher, 1980; Morris et al., 1981). Eight statements were included in the AfMAS to assess mathematics test anxiety.

The tool was translated by an expert who had vast experience in translating educational documents in the Urdu language. 24 items Afshan Mathematics Anxiety Scale (AfMAS) was administered by the researcher and data was collected for further refinement of the instrument. Content and face validity for the instrument was established by experts (domain experts and subject specialists) and two peer reviewers (doctoral scholars) in education and mathematics education. Experts were serving at the department of science and secondary education in a public university having vast experience in teaching university students and in conducting research. Factor analysis was applied to measure the construct validity of the AfMAS (Naseem, 2021). An Exploratory Factor Analysis (EFA) researcher finds the latent measurements to create a theory (model) from a reasonably large set of latent constructs addressed by a group of items (Henson & Roberts, 2006; Tabachnick & Fidell, 2014; Thompson, 2004). Then, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy test and Bartlett's Test of Sphericity were executed to establish construct validity and to affirm that the information gathered for exploratory factor analysis was proper and relationships between items were adequately large for exploratory factor analysis. Principal Components Factor Analysis with Varimax Rotation was operated to inspect the internal structures of the Afshan Mathematics Anxiety Scale (AfMAS). Cronbach Alpha reliability was assessed. Item discrimination power was used to cross-validate the psychometric properties of the tool (Bai, 2011). The Cronbach Alpha and composite reliability (CR) coefficient for the scale and its subscales were calculated as an index of scale internal consistency. Next, convergent and discriminant validity of the AfMAS were assessed. Convergent validity indicates the degree to which items of a measure hypothetically related, are related (MacLeod et al., 2018). Tuan et al. (2005) explained that discriminative validity was used to measure the degree to which each scale distinguished a dimension that was diverse from other scales. Additionally, in the analysis process, the data was analyzed for the average mean of the items in AfMAS (Naseem, 2021).

Findings and Discussions

KMO and Bartlett's Test of Sphericity

The KMO index ranges from 0 to 1, with 0.50 considered reasonable for factor analysis, and Bartlett's Test of Sphericity ought to be critical ($p < .05$) for factor analysis to be appropriate (Hair et al., 2014; Tabachnick & Fidell, 2014). The estimated value of KMO for the AfMAS scale was 0.82, and Bartlett's Test of Sphericity for 24 items was significant at $p < .05$ revealing the significance of both KMO and Bartlett's Test (Naseem, 2021).

Cumulative Percentage of the Variance

In the factors analysis approach, another criterion is Kaiser's criteria (eigenvalue > 1 rule) and cumulative percentage of variance (Horn, 1965; Kaiser, 1960). In social sciences, the explained variance is generally as low as 50-60% (Hair et al., 2014; Pett et al., 2003). Table 2 exhibits a cumulative percentage of the variance of 54.28% and a total of 4 components (factors) having an eigenvalue > 1 (Naseem, 2021).

Table 2 Total Variance Explained for Afshan Mathematics Anxiety Scale

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.78	28.24	28.24	6.78	28.24	28.24	3.87	16.12	16.12

2	2.49	10.41	38.65	2.49	10.41	38.65	3.36	14.02	30.13
3	2.09	8.69	47.34	2.09	8.69	47.34	3.24	13.52	43.65
4	1.67	6.94	54.28	1.67	6.94	54.28	2.55	10.63	54.28

Note: Table 2 adapted from Naseem (2021)

Construct Validity: Exploratory Factor Analysis (EFA)

Table 2 displays the factor loading as a result of exploratory factor analysis (EFA) used to establish the construct validity of AfMAS for 24 items. Hair et al. (2014) sorted these loadings applying another rule of thumb as ± .30=minimal, ± .40=important, and ± 0.50=practically significant. If no correlations go beyond .30, at that point the researcher should re-examine whether factor analysis is the right statistical method to use (Naseem, 2021). All values of these loadings were above .40 (see Table 3) showed practically significant.

Table 3 Factor Loading of Afshan Mathematics Anxiety Scale

Items	Factor
Factor 1: Mathematics Lesson Anxiety	
I become worried when I study the new lesson.	.73
I become nervous when I see a lesson full of questions.	.78
I become worried when I see the lesson to do homework.	.85
My worry increases when I work on a pending homework of many difficult problems.	.67
Factor 2: Mathematics Performance Anxiety	
I become worried by solving sums on board.	.59
I become worried by solving word problems in the class.	.74
I become worried by solving a set of numerical problems in the class.	.87
I become worried when I find myself unable to think clearly when doing mathematics work.	.79
My worry increases when I see myself unable to help a classmate or primary school students with mathematics homework.	.62
I become worried when my teacher realizes that I am stupid in the class.	.85
My worry increases when the focus of the teacher is the result of the class.	.37
Factor 3: Mathematics Assessment Strategies Anxiety	
My worry increases when my teacher encourages me to understand different concepts by using alternative assessment activities.	.90
I become anxious to contribute to mathematics quiz competitions in the class.	.63
I become worried to participate in self-assessment activities in a mathematics class.	.74
I become worried to share peer assessment activities in the class.	.88
I become worried to take part in generating questions from the lesson in the class.	.75
Factor 4: Mathematics Test Anxiety	
I become worried while preparing for a mathematics test	.49

My worry increases when I feel difficulty remembering formulas in mathematics tests.	.70
I become worried when I feel a failure while preparing mathematics test.	.58
I become worried when I attempt my mathematics test.	.42
I become worried about a surprising mathematics test that was not told about	.60
I become nervous about an upcoming mathematics test 1 day before.	.74
My worry increased when I realize a fast heartbeat, fifteen minutes before the mathematics examination.	.62
I become worried to get good grades in mathematics.	.54

Item-Total Correlations

Item-total correlations were measured by Pearson correlation between each item and the total scale ranged from .32 to 0.56 showing that these correlations were all significant (see Table 4). The positive item-total correlations indicated that all items measure constantly with the overall scale, proposing a positive item discrimination power. The mean and the standard deviations (SD) of all responses and per item were calculated. When the mean of an item is found closer to either 1 or 5, should eliminate as this item is considered inappropriate which may decrease the standard of correlation among the rest of the items (Kim, 2011 cf Naseem, 2021).

Table 4 Item–Total Correlations of Afshan Mathematics Anxiety Scale

Item	M	SD	Item-Total Correlation	α if Item Deleted
Item1	2.15	1.49	.43	.88
Item2	2.54	1.59	.44	.88
Item3	2.42	1.51	.55	.88
Item4	2.23	1.39	.38	.88
Item5	2.63	1.58	.46	.88
Item6	2.52	1.58	.56	.88
Item7	2.59	1.59	.56	.88
Item8	2.56	1.56	.54	.88
Item9	2.49	1.54	.53	.88
Item10	2.56	1.59	.53	.88
Item11	3.03	1.62	.33	.89
Item12	2.91	1.56	.48	.88
Item13	2.83	1.51	.48	.88
Item14	2.75	1.46	.45	.88
Item15	2.70	1.52	.49	.88
Item16	2.84	1.52	.49	.88
Item17	2.64	1.59	.43	.88
Item18	2.59	1.67	.48	.88

Item19	3.07	1.57	.52	.88
Item20	2.91	1.65	.32	.89
Item21	3.14	1.66	.44	.88
Item22	3.06	1.69	.43	.88
Item23	2.61	1.56	.49	.88
Item24	2.97	1.69	.38	.89

Note: N= 280 participants; α. Cronbach's alpha of the total scale if the item is deleted.

Descriptive Statistics, Cronbach Alpha and Composite Reliability (CR)

Cronbach Alpha reliability for the AfMAS was $\alpha = 0.89$ showed high reliability of the total scale. Descriptive statistics such as maximum and minimum mean, overall mean reliability coefficients: Cronbach Alpha and Composite Reliability for all subscales of AfMAS were shown in Table 5. The subscale mathematics test anxiety had an alpha value of 0.77 lower than 0.8: the alpha values for the rest of the three sub-scales mathematics lesson anxiety, mathematics performance anxiety, mathematics assessment strategies anxiety was greater than 0.8. The coefficient alpha values of the sub-scales showed a range of 0.77–0.87, and CR coefficients showed a range of 0.81–0.89. These results were all above 0.70, which confirmed the adequate reliability of the AfMAS (Naseem, 2021).

Table 5 Descriptive Statistics of Items and Reliability Coefficients of Subscales in Afshan Mathematics Anxiety Scale

Scale and Subscales of AfMAS	Number of Items	Serial Number in Scale	M	SD	CR	α
Mathematics Lesson Anxiety(MLA)	04	1,2,3,4	2.15	1.49	.84	0.81
Mathematics Performance Anxiety(MPA)	07	5,6,7,8, 9,10,11	2.54	1.59	.87	0.85
Mathematics Assessment Strategies Anxiety(MASA)	05	12,1314, 15,16	2.42	1.51	.89	0.87
Mathematics Test Anxiety(MTA)	08	17,18,19,20, 21,22,23,24	2.23	1.39	.81	0.77
AfMAS	24		2.69	.83		.89

Convergent Validity and Discriminative Validity

To measure convergent validity, the Average Variance Extracted (AVE) values are recommended to be above 0.50 (Segars, 1997). Mean correlations were calculated to describe the discriminative validity of the AfMAS. Mean correlation was used to establish discriminative validity by Tuan et al. (2005), Rana et al.

(2015), and Sajid et al. (2018). Table 6 represents the convergent validity in terms of Average Variance Extracted (AVE) and discriminative validity in terms of mean correlations.

Table 6 Convergent Validity and Discriminative Validity (in terms of Mean Correlations with Scale) of Afshan Mathematics Anxiety Scale

Subscales	AVE	CR	Mean Correlations
Mathematics Lesson Anxiety (MLA)	.58	.84	.35
Mathematics Performance Anxiety (MPA)	.52	.87	.37
Mathematics Assessment Strategies Anxiety (MASA)	.62	.89	.33
Mathematics Test Anxiety (MTA)	.35	.81	.41

As shown in Table 6, the Average Variance Extracted (AVE) values show the range of .35 to 0.62. The value AVE for the items mathematics test anxiety is .35, less than the recommended value of 0.50. It is also acceptable due to its composite value greater than 0.6. If the value of Average Variance Extracted (AVE) is under 0.5 and composite reliability is more than 0.6 then the convergent validity of the construct is as yet satisfactory (Fornell & Larcker, 1981). The results of the study established the convergent validity of the measures. It also recommends that the items that belong to each measure in the Afshan Mathematics Anxiety Scale (AfMAS) were appropriately correlated with each other. The mean correlations ranging from .33 to .41 revealed the independence of each subscale (Naseem, 2021).

Conclusion

Afshan Mathematics Anxiety Scale (AfMAS) was developed based on literature about mathematics anxiety. Four dimensions were assessed through exploratory factor analysis. The AfMAS had a total of 24 items. AfMAS scored 0.89 on the Cronbach's alpha scale, with four subscales ranging from 0.81 to 0.89. Convergent validity was measured in terms of the scale's AVE, which ranged from.35 to 0.62, while discriminant validity was measured in terms of mean correlations, which ranged from.33 to.41. The study's findings revealed high validity and reliability. Further, the classification of AfMAS scale items distributed the items as higher and lower-level anxiety items. Mathematics anxiety exists and less anxiety leads to high performance. AfMAS can be used by researchers and scholars to examine the level of mathematics anxiety at the intermediate level. The current research adds to the literature for mathematics anxiety and contributes to measuring mathematics anxiety at the middle level. The study's findings provide insight to mathematics practitioners, school administrators, teacher trainers, and policymakers focusing on students on Various aspects of mathematics anxiety. Further, Afshan Mathematics Anxiety Scale can be developed at the secondary level.

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