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Math Anxiety: Positive and Negative Affects toward Mathematics

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ABSTRACT

Background: The purpose of this study was to examine the relationship between math anxiety and positive and negative affects toward mathematics. **Objective:** So, a sample of 373 male high School students from Tabriz city was selected by multistage-cluster sampling, and mathematics anxiety scale-revised (MAS-R) and mathematics anxiety rating scale-revised (MARS-R) were performed. **Results:** Results of correlation coefficients showed that there is a negative and significant relationship between math anxiety and its dimensions, and positive affect toward mathematics. **Conclusion:** a positive and significant relationship between math anxiety and its dimensions, and positive affect toward mathematics ($\alpha=0.01$). Results of multivariable regression analysis indicated that total of MA, MEA, MLE significantly predict or explain the variance of PA and NA in students.

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INTRODUCTION

Mathematics anxiety influences both directly and indirectly the choice of major based on the amount of mathematics required [24]. Research showed that entering college students who are severely mathematics anxious may enroll in majors that require minimal courses in mathematics such as majors in the humanities, the arts, and social sciences rather than enrolling in more mathematically oriented majors such as the sciences or engineering [53].

Mathematics literacy is regarded as a "civil issue" because of its leverage in mitigating social and economic inequity [46]. Students and educators alike are under unprecedented pressure to achieve state proficiency standards and to close the achievement gaps [18,25, 29,49,52]. Among the many correlates of mathematics achievement, mathematics anxiety has been shown to be a significant factor of learning success [10,8,9,51,50,45,23]. Individuals with high mathematics anxiety tend to perform poorly when presented with mathematics stimuli (Cates & Rhymer, 2003) with a common population correlation estimated at $-.27$ [33,13]. Furthermore, individuals with MA have shown to avoid environments that require the utilization of mathematics skills [2]. Therefore, MA can greatly impacts mathematics education and students' academic future. Research suggested that people who have poor attitudes and negative affect toward math are fearful of mathematics or have intense negative emotions about anything remotely dealing with mathematics [25].

Research indicated that MA is a multidimensional psychological construct that involves complex factors, such as feelings of pressure, performance inadequacy, and test anxiety that interfere with the manipulation of numbers and solving mathematical problems in a wide variety of ordinary life and academic situations [31,34].

Some researchers have linked MA to lack of mathematics preparation [1,2,3,4,8]. Others have examined the relationship of mathematics anxiety to age (Betz, 1978; Gourgey, 1984; Kosbab, 1989) and gender [9,23, 32,1,25,40].

More Iranian students, due to negative affect toward mathematics, fail in solving math tests, such as algebra, practices, numerical issues, and become extremely anxious and fear of it. Because of this issue, we intended to examine it in a research framework. So, the intention of this study was to determine the relationship between math anxiety of students and bidimensional affects, positive and negative toward mathematics, as well as, reply to the question whether math anxiety can predict changes resulting bidimensional affects, positive and negative toward mathematics.

*Method:**Participants:*

The sample consisted of 373 male high School students a range of 13-19 years of age from Tabriz city was selected by multistage-cluster sampling. In this way, two districts from Tabriz educational districts, and one case in a district from female high school students and one in another from male high school students and at next step, four classes from each school were randomly selected and distributed the questionnaires between volunteer students. All questionnaires were administered during the academic year of 2013-2014. However, in the analyses reported in this study, we used primarily this academic year data.

Design:

This study was a type of correlation method. In results analysis, the hierarchical regression analysis was used to determine the most useful combination of math anxiety in explaining the positive and negative affects toward mathematics changes. Likewise, Pearson's correlation analysis was used to examine the common pattern of relations.

Measures:

The entire students completed two questionnaires: first, the mathematics anxiety scale-revised (MAS-R). The instrument selected for adaptation was MAS-R [36], consisting of 14 items on a five-point Likert scale. Questions included in MAS were intended to identify the Bidimensional affects, positive and negative, toward mathematics. In MAS-R, the first five items were positively worded and the last five items negatively worded. Positively worded items were reversed for scoring so that a high score indicates high anxiety [36]. Pajares and Urdañ pointed out that the MAS-R has acceptable stability and internal consistency and reported to have a Cronbach's alpha coefficient assessing the internal consistency of the instrument for the total scale was found to be .91. The two identical items, Items 9 and 14, used for checking response consistency, were found to have a correlation of .87. Factor structure (Construct validity): Using a set of criteria, e.g., eigenvalue (> 1.00), scree plot, and variance explained (> 60%), the exploratory factor analysis identified two factors (see Table 2). The two factors explained 66.7% of the total variance of the 14 items. The factor loadings ranged from .67 to .89 for the negative-affect factor and from .67 to .87 for the positive-affect factor. The substantial amount of variance explained and the significantly large loadings suggest that the 14-item bidimensional scale, MAS-R, is a valid instrument to measure mathematics anxiety with both positive and negative affects.

Second, the Revised Mathematics Anxiety Rating Scale (Revised MARS) is a 24-item version of the Mathematics Anxiety Rating Scale (MARS)[39]. The original MARS, a five-point Likert scale containing 98 items, has been widely used as a diagnostic tool in the treatment of mathematics anxiety. Its test-retest reliability has been reported at .85. Coefficient alpha reliability has been estimated at .97. A factor analysis of MARS revealed two factors: Mathematics Test Anxiety, relating to learning, studying, or being tested about mathematics from a classwork perspective; and Numerical Anxiety, relating to day-to-day use of mathematics and computation[44]. Plake and Parker identified 24 items from MARS that measured anxiety in statistics courses and evaluated the resulting, statistics-specific subset (Revised MARS) in a study of 170 graduate students in introductory statistics classes at a large Midwestern university[39]. The 24-item Revised MARS showed internal reliability with a coefficient alpha of .98. The correlation between the Revised MARS and the original MARS was .97. Factor analysis revealed two factors: (1) Learning Mathematics Anxiety (16 items) and (2) Mathematics Evaluation Anxiety (8 items).

Procedure:

This study was carried out as a research design for the Iranian high school students in Tabriz city. 373 selected students replied in the class after distributing questionnaires for everyone. For this purpose, the math teachers were asked to help administering the program. They were instructed to provide an information sheet to anyone interested in participating and to verbally describe the study in the terms described in the information sheet. Participants interested in receiving a summary of the study results provided contact details on the final page of the questionnaire, which was separated from the questionnaire prior to data entry. This study complied with ethical principles of the five Tabriz districts of education.

Results:

Criterion variables included positive and negative affects toward mathematics, and predictive variable consisted of math anxiety and its subscales (learning mathematics anxiety and mathematics evaluation anxiety).

Table 1: Descriptive statistics of positive and negative affects, and math anxiety and its subscales.

	N	Minimum	Maximum	Mean	Std. Deviation
MLE ¹	373	12.00	80.00	51.7024	15.96804
MEA ²	373	9.00	53.00	25.8713	8.86940

TotalMA ³	373	6.00	116.00	77.3003	19.59608
PA ⁴	373	3.00	36.00	23.2681	8.29257
NA ⁵	373	3.00	35.00	24.2520	7.89758
Valid N (listwise)	373				

1-learning mathematics anxiety, 2- mathematics evaluation anxiety, 3-total of math anxiety,
4- positive affects and 5- negative affects

M and SD are 51.7024 and 15.96804 for MLE, 25.8713 and 8.86940 for MEA, 77.3003 and 19.59608 for TotalMA, 23.2681 and 8.29257 for PA and 24.2520 and 7.89758 for NA (Table 1).

Research hypotheses:

Correlation coefficients were applied to test hypotheses (Table 2).

Table 2: Correlation coefficient of positive and negative affects, and math anxiety and its subscales.

		MLE	MEA	TotalMA	PA	NA
MLE	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	373				
MEA	Pearson Correlation	.125 [*]	1			
	Sig. (2-tailed)	.015				
	N	373	373			
TotalMA	Pearson Correlation	.875 ^{**}	.549 ^{**}	1		
	Sig. (2-tailed)	.000	.000			
	N	373	373	373		
PA	Pearson Correlation	-.145 ^{**}	-.374 ^{**}	-.295 ^{**}	1	
	Sig. (2-tailed)	.005	.000	.000		
	N	373	373	373	373	
NA	Pearson Correlation	.388 ^{**}	.207 ^{**}	.415 ^{**}	-.321 ^{**}	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	373	373	373	373	373

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

H1. *There is a negative and significant relationship between math anxiety and its dimensions, and positive affect toward mathematics.*

Table 2 indicated that correlation coefficients are -0.145 between MLE and PA, -0.374 between MEA and PA, and -0.295 between total of MA and PA at the level of 0.01. The data suggested there is a negative and significant relationship between math anxiety and its dimensions, and positive affect toward mathematics, and this hypothesis was approved.

H2. *There is a positive and significant relationship between math anxiety and its dimensions, and negative affects toward mathematics.*

Table 2 indicated that correlation coefficients are 0.388 between MLE and NA, 0.207 between MEA and NA, and 0.415 between total of MA and NA at the level of 0.01. The data suggested there is a positive and significant relationship between math anxiety and its dimensions, and positive affect toward mathematics, and this hypothesis was approved.

Research question:

The central question of this study was that: "Can predictive variables (math anxiety and its dimensions) predict or explain criterion variables (positive and negative affects toward mathematics)? And how much is each one?"

Table 3: Results of multivariable regression analysis of PA and NA in terms of total of MA, MEA, MLE.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.390 ^a	.152	.145	7.66706
2	.420 ^a	.177	.170	7.19526

a. predictors: (Constant), total of MA, MEA, MLE

b. criterion variables: PA and NA

Total of MA, MEA, MLE variables predict or explain 39% of the variance of PA, and 42% of the variance of NA in students (Table 3).

Table 4: The summary of ANOVA of multivariable regression of PA and NA in terms of total of MA, MEA, MLE.

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	3889.985	3	1296.662	22.058	.000 ^a
Residual	21691.205	369	58.784		
Total	25581.190	372			

2	Regression	4098.549	3	1366.183	26.389	.000 ^a
	Residual	19103.762		51.772		
	Total	23202.311	372			

a. predictors: (Constant), TotalMA, MEA, MLE

b. criterion variables: PA and NA

Total of MA, MEA, MLE variables ($F(3, 372) = 22.058$, $p < 0.000$) significantly predict PA in students. Similarly, the predictors ($F(3, 372) = 26.389$, $p < 0.000$) significantly predict NA in students (Table 4).

Conclusion and Discussion:

The results of hypotheses showed that math anxiety has a negative and significant relationship with positive affect toward math; that is, when a student gains positive affect toward math, changes her/his attitudes to it and less suffers from learning mathematics anxiety and mathematics evaluation anxiety. Contrariwise, math anxiety has a positive and significant relationship with negative affect toward math. Then, the increase of negative affect causes to augment math anxiety in students.

The present study is consistent with performed research by [10,1,4,3,44,35,23,52,28,31,7].

The findings of the present study are consistent with Watson's (1988) research in which was pointed out that positive affect reflected a degree of pleasurable interaction with the environment, whereas negative affect reflected an adverse response to the environment. The items of negative affect toward mathematics indicate feelings of discomfort, restlessness, uneasiness, and confusion; positive affect toward mathematics indicate a sense of ease, a lack of discomfort, and the absence of fear [31]. To better understand the construct of mathematics anxiety so as to find better intervention strategies to reduce anxiety, the inclusion of the positive affect of mathematics anxiety would be helpful. Mathematics anxiety clearly calls a bidimensional factor that would capture both positive and negative affects of the latent construct of mathematics anxiety.

Future research may examine the causal relationship between mathematics anxiety and positive and negative affects across other female population. For example, it would be of interest to design intervention programs aiming at reducing mathematics anxiety and to investigate its effect on mathematics learning. Given the bidimensionality of the scale, it is important to note that interventions designed to reduce negative affect may not increase positive affect [40]. Further investigation is also needed to replicate the bidimensionality of the affects across different subject matters and various demographic groups.

Facing math anxiety is a combination of coaching and counseling, provided for adults by people with credentials in both counseling and math education. In it, the reasons for anxiety are addressed, as well as the mathematical skills which are lacking. New coping skills are introduced and practiced, so that fear, distaste or other negative emotions do not block math learning.

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