ANXIETY TOWARD MATHEMATICS ON "TELESECUNDARIA" STUDENTS

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https://doi.org/10.17060/ijodaep.2016.n2.v1.546

Fecha de recepción: 27 Septiembre 2016
Fecha de admisión: 1 Octubre 2016

ABSTRACT

The aim of this study is to measure the level of anxiety toward math among students from a high school located in the city of Veracruz, Mexico. It is an explanatory correlational analysis with a non-experimental cross-sectional study design that supports the questionnaire developed by Muñoz and Mato-Vázquez (2008) and employing the technique of factor analysis to measure five dimensions of anxiety: towards the evaluation, toward temporality, toward understanding problems, numerical operations and toward real-life situations. The instrument was applied to 123 students. The results indicate that of all dimensions evaluated, students feel more anxiety toward evaluation and application of mathematics in real life situations is the dimension that generates less anxiety.

Keywords: mathematics, anxiety, difficulty, learning, high school.

INTRODUCTION

In 2013 the World Economic Forum published a Human Capital Index (HCI) whose objective is to measure a country's capacity in the fields of health, wellbeing, education and employment. México was in placed 58 of 122 countries that were studied, being Switzerland, Finland, Singapore, Holland and Sweden the leaders; in comparison with other Latin American countries, Mexico places itself

under Costa Rica, Chile, Panama, Uruguay and Brazil. Particularly on the learning of mathematics and science aspect Mexico places on 109.

On the other hand, the Organization for Economic Cooperation and Development (OECD), measures with an index the quality of life of its 34 member countries. For the 2013 quality of life index from the OECD, Mexico occupies last place in cognitive reading abilities, mathematics and science.

The results of Program for International Student Assessment (PISA) were also disappointing for Mexico, even though from 2003 to 2012 there was a marked improvement in the mathematics and science levels in our country, Mexico's most recent score in this test was of 417 points, for which it does not even reach basic level in the required competences as an acceptable average is 497 points.

Mathematics is a discipline that requires a certain effort and higher order cognitive strategies for its understanding. In addition to the fact that mathematical learning is cumulative, so are the difficulties. Learning gaps from elementary school are inherited to high school and become insurmountable once reaching higher education level (Hidalgo, Maroto and Palacios, 2004). These "objective" difficulties cannot explain the rejection of mathematics on their own, it is necessary to identify the role that attitudes and aptitudes play on students, as well as the anxiety mathematics produces on some of them.

The attitude is defined as the response given after evaluating this discipline and based on how it is perceived; how it is felt and how they respond to said situation; in other words, it refers to the favorable or unfavorable value of judgment of the three components for attitude: cognition, affection and behavior (Robbins and Judge, 2009). Various authors associate the attitude to the interest for the subject and its learning, and emphasize the affection component more so than the cognitive (Callejo, 1994; Gómez-Chacón, 2000; Hidalgo, Maroto and Palacios, 2004). Basic learning in Mexico comprises the first 9 years of academic formation, which is to say, compulsory education is only elementary school (grades 1 to 6 in Mexico) and middle school or junior high (grades 7 to 9 in Mexico) for which first interactions and attitude development toward any given subject occur within this period of education.

The second concept, aptitude, refers to the capacity of an individual to undertake the diverse tasks that imply completing a job (Robbins and Judge, 2009, p. 52).

Anxiety, on its part, conditions this combination of attitudes and aptitudes of students. A highly anxious student is one that is excessively concerned by his progress in class and one that preoccupies himself for not understanding what the teacher is saying or what is expected of him as a student (Cohen, 1977 and Kazelskis and others, 2000). Authors like Kendall (1990), Fox (1997) and González and Tobal (2011), ask themselves if the anxious student has a bad performance because he is concerned or, on the contrary, is concerned because he can't obtain a good performance and does not know how to improve it (Mato-Vázquez, 2006).

The objective of the research is to determine the underlying variables that explain anxiety toward mathematics, specifically in Telesecundaria (televised distance learning program for junior high schools) students from the Costa Dorada neighborhood in the city of Veracruz.

From the aforementioned statements arise the following questions: Can anxiety be explained with at least one factor? Is there more than one factor that explains anxiety toward mathematics? Can a group of explanatory factors for anxiety be correlated among themselves? From there derives the following hypotheses:

H_0 = A group of underlying variables that explain anxiety toward mathematics does not exist.

Hi ≠ A group of underlying variables that explain anxiety toward mathematics does exist

H2 = Anxiety toward mathematics can be explained by at least one factor.

LITERATURE REVIEW

The first studies of the relation between attitude and human behavior originated with the French philosopher Auguste Comte, founder of sociology (1798-1857).

By the XX century the first approaches to the subject were conducted from the social psychology discipline, by associating attitudes and behavior of the individual with the interaction of its surroundings, which also includes the field of teaching. Afterward the work of Fennema and Sherman (1976) becomes more specific because it focuses in the attitude of students toward the subject of mathematics; both authors developed a scale of 108 items to be measured by.

Wigfield and Meece (1988), evaluated mathematics anxiety in elementary and middle school students through the application of the Mathematics Anxiety Questionnaire (MAQ) whose items were constructed and adapted based on six dimensions of anxiety, obtaining as a negative component the concerns for the perception of mathematics ability, performance and achievement; and as a positive component the concern for the importance attributed by students to the learning and effort reported. The fact that younger students showed less concern than intermediate level students is worth mentioning.

Quiles (1993), who focused his study in the relation between academic achievement and the study of mathematics, his work revealed the importance of the parents' attitudes toward mathematics. Aside from being a predominant influence for positive attitude development, they are also an influence for achievement, therefore the relation between variables, albeit low, was relevant and positive. Even though in his work the influence of the teachers' attitudes on the students was not relevant, he concludes that the attitudes of students, parents and teachers hold a certain dependency with the students' academic achievement in mathematics.

Galbraith and Haines (1998), analyzed mathematics attitudes related to technology with the implementation of their own scale based on the components from the scale of Fennema and Sherman (1976), with the objective to understand the level of confidence, motivation and commitment of the evaluated students; with the results obtained they proved that the attitude toward mathematics is influenced by technological interaction.

Cubillo and Ortega (2000) utilized La Garanderie's (1983) mental management model to study the influence of the students' attitude toward mathematics, said model was applied in two phases, initial and final. The findings were very similar in both phases concerning internal causes, but in the external causes there was a change: in the initial phase the mathematics learning difficulty was attributed to the subject's intrinsic characteristics, but in the final phase the score changed placing in first place the excess of formal language. Finally, they conclude that the method's application diminished the students' belief in their limitations.

Ramirez (2005) studied the relation between the attitude toward mathematics and the perception of achievement in eighth grade students from Chile, the results of his study highlight the importance of success in mathematics for almost all students; specifically, 90% of them attribute this necessity to external causes. Even so 50% of students have the belief that good luck is what will bring such success, while 40% pin it to an innate talent; on the other hand, 41% consider mathematics to be an easy subject and three fourths of the student population perform satisfactorily. Ramirez concludes that a more realistic perception of the process of learning itself and mathematic abilities must be promoted, and that the variables are independent of socioeconomic level.

Gil, Guerrero and Blanco (2006) aimed to analyze beliefs, attitudes and emotional reactions in the learning process of mathematics using a descriptive study through a survey research strategy consisting of 52 items, which revealed that the students' beliefs, attitudes and emotions toward mathematics are not gender related. Furthermore, they proposed elaborating emotional literacy programs in the mathematics field to improve said attitudes, emotions and beliefs, as well as stressing the importance on the geographic contrast where the student unfolds.

Later on, Muñoz and Mato-Vázquez (2007) also developed a survey to measure the attitude toward mathematics through 24 items grouped in five mathematics anxiety factors: evaluation, temporality, problem comprehension, numbers and operations and real life mathematics.

More recent studies from González-Pienda, Fernández-Cueli, García, Fernández, Tuero-Herrero and Da Silva (2012) analyzed the attitude toward mathematics along the last eight subjects of compulsory education in Brazil as well as in Spain and showed the existence of a significant statistical effect of the gender variable in students, but at the same time indicating that it is not possible to estimate its effect without taking into account other variables.

Finally, García-Santillán, Escalera-Chávez, Moreno-García and Santana-Villegas (2016), ratify the validity of the scale developed by Muñoz and Mato-Vázquez (2007) within the Mexican context being able to identify anxiety as an influencing factor in the performance of the learning process of mathematics, also coinciding with the earlier authors in identifying the relation between attitudes toward mathematics and the student's academic achievement.

METHODOLOGY DESIGN

To research the anxiety felt toward mathematics by the students of Telesecundaria from the neighborhood Costa Dorada in Veracruz city, a correlational study was conducted with a non-experimental cross-sectional methodology design applied during the last week of 2015 classes (December 14 to 18, 2015).

There are 139 Telesecundaria students distributed among the three years of study. The selection criteria for the sample considered students enrolled during the school period August – December 2015 who also had 80% class attendance record.

According to these criteria the sample was comprised of 123 students. The instrument used was the anxiety scale toward mathematics proposed by Muñoz and Mato-Vázquez (2007), with which the five dimension of anxiety were evaluated: toward evaluation (ANSIEVAL), toward temporality (ANSIETEMP), toward problem comprehension (ANSIECOM), toward numeric operations (ANSIENUM) and toward real life situations (ANSIESIT). These are measured by 24 items in a Likert type scale with

values from 1 to 5, being 1 the lowest value and 5 the highest. Table I presents the relation of the items to the evaluated dimension.

Table I. Dimensions of Anxiety toward mathematics scale

Code	Dimensions	Items
ANSIEVAL	Anxiety toward evaluation	1,2,8,10,11,14,15,18,20,22,23
ANSIETEM	Anxiety toward temporality	4,6,7,12
ANSPROBM	Anxiety toward understanding mathematical problems	5,17,19
ANSINUOP	Anxiety toward the number and operations	3,13,16
AMSIMATV	Anxiety toward real life situations	9,21,24

Source: take it from Muñoz and Mato-Vázquez Scale (2007)

The study follows the statistic process proposed by García-Santillán et al (2015,2016) for the hypothesis comparison that guides this study: Bartlett's sphericity test is calculated with the KMO index, and the goodness of fit test for X^2 with *n g l*, sig.=0.05, to validate the technique's relevancy (see table IV).

MSA is obtained from the anti-image matrix, therefore values < 0.5 must be excluded (see table 6). The determinant value is identified from the correlation matrix which values near cero values indicate significant correlations; on the contrary, if the determinant is nearing 1, the correlations would be less significant (see table V).

Finally, calculations are made for the factor loading, communalities, eigenvalues and explained variance (see table VII). Thereafter, the deciding criteria will be, rejecting H_0 if $X^2_c > X^2_t$ otherwise do not reject.

DATA ANALYSIS

For the data processing IBM SPSS statistics software version 19 was used. Firstly, the reliability was validated through Cronbach alpha coefficient, which tells us that the internal consistency is better if the value approximates 1, for this study a value of 0.879 was obtained (individual) and 0.721 (grouped) therefore, according to Hair, Anderson, Tatham, and Black (1999), it is an acceptable value. Table II below shows said result:

Table II. Reliability test

Concept	Cases	%	α
Valid cases	123	100.0	α=0.879
Excluded (a)	0	0.0	
Total	123	100.0	24 ítems
Dimensions	ANSIEVAL, ANSITEM, ANSICOM, ANSINUM, ANSISIMA		α= 0.721 with 5 dimensions

(a) List wise deletion based on all, variables in the procedure
Source: own

Table III shows the description and variance coefficient for each dimension evaluated:

Table III. Descriptive, μ, Sd and VC

	μ	Standard deviation	N	VC = Sd/μ	μ
ANSIEVAL	33.4390	8.44767	123	25.26%	33.4390
ANSIETEMP	10.7073	3.47056	123	32.41%	10.7073
ANSIECOM	6.3333	2.68471	123	42.39%	6.3333
ANSIENUM	7.8455	2.88306	123	36.75%	7.8455
ANSIESIT	5.2033	2.76974	123	**53.23%**	5.2033

Source: own

To find the internal consistency, the relevancy of the technique was tested with Bartlett's Sphericity test with Kaiser (KMO), X^2, with significance level ($p < 0.01$). Table IV shows the values obtained for KMO, X^2, and their significance level. The general sampling adequacy measure (0.764) is within the acceptable value (>0.5), indicating a correlation between the variables.

Table IV. Measure Sample Adequacy KMO and Bartlett test of Sphericity

Measure sampling adecuacy Kaiser-Meyer-Olkin		0.875
(X^2)	Chi-squared	1257.558
	GI	10
	Sig.	.000

Source: own

We can observe in table V the correlation values of the analyzed dimensions. Because only three present higher values (>0.5) it is possible to think in a consistency between the dimensions of evaluation and temporality, evaluation and numeric operations, as well as problem comprehension and numerical operations. In relation to the determinant value (0.184), it is less than < 0.5, which also indicates the presence of significant correlations.

Table V. Correlations Matrix

		ANSIEVAL	ANSITEM	ANSICOM	ANSINUM	ANSISIMA
Correlations	ANSIEVAL	1.000				
	ANSITEM	**.699**	1.000			
	ANSICOM	.480	.378	1.000		
	ANSINUM	**.545**	.499	**.564**	1.000	
	ANSISIMA	.308	.307	.366	.278	1.000

(a) Determinant = .184
Source: own

Table VI shows the measure of sample adequacy (MSA) by dimension from the anti-image matrix diagonal. These values must be as close to a value of 1 as possible to demonstrate that the model is relevant for the data explaining, therefore, values ranging from 0.724 to 0.854 are significant to explain the studied phenomenon.

Table VI Anti-image Matrix

		ANSIEVAL	ANSITEM	ANSICOM	ANSINUM	ANSISIMA
Correlation anti-image	ANSIEVAL	.735[a]				
	ANSITEM	-.568	.724[a]			
	ANSICOM	-.195	.041	.770[a]		
	ANSINUM	-.195	-.183	-.393	.806[a]	
	ANSISIMA	-.047	-.117	-.229	-.013	.854[a]

a. Measure of sampling adequacy

Table VII shows the factor loading matrix for each of the analyzed dimensions, as well as the communalities or variance proportions. The sum of the squares of each factor load gives us the eigenvalue (2.806) which represents the explanatory power that turns into the total variance percentage of the studied phenomenon.

Table VII. Components Matrix, Communalities, Eigenvalue and total Variance

	Component 1	Communalities
ANSIEVAL	.836	.699
ANSITEM	.792	.627
ANSICOM	.745	.556
ANSINUM	.789	.622
ANSISIMA	.550	.302
Eigenvalue	2.806	
Total Variance	56.11%	

Source: own

Finally, table VIII confirms the presence of a component that can explain the total variance of 56.11% (Table VII) because the eigenvalue is higher than 1 (2.806). The represented data in component 1 for each dimension show a factor load >0.5 with the exception of dimension ANSIESIT

(0.550) that has a factor load within 0.5. Respectively, ASIEVAL (0.836) represents the highest factor load (anxiety toward evaluation) followed by ANSIETEMP (0.792) (anxiety toward temporality), ANSIENUM (0.789) and ANSIECOM (0.745) in that order.

Table VIII. Explained total variance

	Initial Auto-values			Sums of the squared extraction loadings		
Component	Total	Total	Total	Total	% de varianza	% acumulado
1	2.806	56.112	56.112	2.806	56.112	56.112
2	.816	16.327	72.439	.816	16.327	72.439
3	.681	13.621	86.060			
4	.409	8.190	94.250			
5	.287	5.750	100.000			

Extraction method: Main component analysis

Source: own

THE DISCUSSION

It is important to point out the coincidences with the latest studies by authors García-Santillán, Edwards Wurzinger and Tejeda-Peña (2015), because by applying the scale of Muñoz and Mato-Vázquez (2007) within the same context, (Mexican students from middle school level) the results show similarities by fronting the anxiety toward evaluation dimension and in last place the dimension for anxiety toward real life situations.

Contrasting with the study done by Mato-Vázquez, Muñoz and Chao (2014), the results point to three correlations between variables significant to the student: (1) evaluation and problem comprehension, (2) temporality and numeric operations and (3) evaluation and temporality in that order of importance. Also, in this study one of the significant correlations obtained was between the dimensions of evaluation with temporality, but differs from the Spanish student in that, with Mexican students this correlation is shown to be the one with highest significance.

Given that educational systems differ in Latin America; this last statement leads us to think if the anxiety toward evaluation is exclusive to the Mexican student or if the applied scale is only pertinent for the particular characteristics of a Mexican student.

This study contributes through its results to explain the mathematics anxiety experienced in the Telesecundaria of the Costa Dorada Neighborhood, located in the northern part of Veracruz port. The evidence suggests that the anxiety toward evaluation in mathematics is the most anxiety producing component among students (0.836), which also represents the higher communality or variance proportion (0.699). Followed by the anxiety toward temporality (0.792), with 0.627 communality value.

While the instrument has shown an acceptable internal consistency, it also allowed favorable results due to the fact that there is a successful alignment between the applied technique and the given objectives in this study.

The evidence found in the data allows for H_0 to be rejected and answer the main question because the phenomenon of anxiety in the Telesecundaria students can be explained from underlying variables. Variables that correspond to the five dimensions that produced a component with positive factor loads and give understanding to said phenomenon.

Furthermore, the results also allowed to demonstrate H_2, which is to say, anxiety toward mathematics is explained by just one component that encompasses values from each of the five dimensions, even when the dimension anxiety toward mathematics in real life situations obtained the lowest factor load (0.550). The value is above the required limit, which suggests that it surpasses the theoretical threshold of >0.5.

It is worth to mention that at the moment of the instrument's application, students from different grade levels showed doubts in the items referring to anxiety toward mathematics in real life situations. This could be attributed to the socioeconomic level of the students and the possibility that they found the questionnaire's writing complicated. This observation coincides with the expressed by authors Gil, Guerrero and Blanco (2006) who also considered important to take into account the geographic location where the student unfolds. However, this contrasts with the affirmation of Ramirez (2005) who, in his study with students from Chile, discusses that the variables are independent from their socioeconomic level.

RECOMMENDATIONS

All components point at being linked in a positive way, because the rise in anxiety on one will trigger the anxiety on others, as well as inversely, the diminishment in anxiety on the component with the highest value will allow the reduction in the subsequent components.

It is clear that the discipline of mathematics is associated to difficulty, tedium and frustration, which in the student can produce general anxiety and therefore, motivate in then a lack of interest to perform in this particular field in the future.

One strategy to reduce such anxiety suggests to redesign the process of student evaluation, specifically in the subject of mathematics through the diversification of the evaluation instruments. Proof of that are the studies that undertake a methodology that focuses on the improvement of learning in mathematics which are gathering positive results (Cubillo and Ortega, 2000; Chamdimba, 2007).

Also a noteworthy fact is that, on occasion, the anxiety toward mathematics and academic achievement holds a relation to technological interaction (Galbraith and Haines, 1998). Also related are the parents' and teachers' attitudes just as much as the student's attitudes (Quiles, 1993; Chamdimba, 2007). It would be interesting to know the level of influence of each of these elements in a future time.

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