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Factors That Promote Anxiety toward Math on High School Students

Milka Elena Escalera-Chávez
Universidad Autónoma de San Luis Potosí, MEXICO
Elena Moreno-García
Universidad Cristóbal Colón, MEXICO
Arturo García-Santillán
Universidad Cristóbal Colón, MEXICO
Carlos Alberto Rojas-Kramer
Universidad Cristóbal Colón, MEXICO

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ABSTRACT
Regardless of the social or economic status of a student, it is a fact that math is always present. This discipline is considered as a competitive tool for achieving a more productive life. However, the gap in academic achievement is big. Consequently, in the last decades the research on education has set attention on this point. Therefore, this research aims to prove that there is anxiety toward math on high school students at a private institution Rioverde in San Luis Potosí, México and find if there is a difference in regards to gender. We used Auzmendi sub-scale questionnaire. The results show that there is anxiety toward math on high school students, and that women show more anxiety toward math than men do. Thus, we conclude, for the case under study, that anxiety toward math is a learning issue for high school students, more often for women than for men.
Keywords: Anxiety toward math, student, gender.

INTRODUCTION

Worldwide, education is an important mechanism to boost the economic development of a country, which does not come from a quantitative population, but from the existence of competent human resources. In this context, math is important as it is related to resolution and decision making in virtually any industry. However, a large proportion of students, since their first approach to this discipline, perceive it as a complicated subject, difficult, complex and abstract (Schwartz, 2000, quoted by Dodeen, Abdelfattah, Alshumrani, 2014) specially because it is structured step by step, i.e. starting off with simple subjects until getting to the more complicated subjects.

Correspondence: Carlos Alberto Rojas-Kramer, *Universidad Cristóbal Colón, Carr. La Boticaria Km 1.5 s/n, Col. Militar, 91930 Veracruz, Mexico*
crojask@hotmail.com

State of the literature

- Studies have found that students believe that the math course is one of the most difficult and this perception causes bias and prejudice toward this discipline. This negative attitude leads to a state of very high anxiety that hinders learning.
- Authors defined math anxiety as a state of unrest caused by performing mathematical tasks and which is manifested through feelings of apprehension, aversion, stress, worry, frustration and fear, also point out that environmental factors, intellectual, and personality influence to generate this feeling.
- High school students experience anxiety toward mathematics and women report more anxiety toward mathematics and lower academic achievement than men do.

Contribution of this paper to the literature

- Students at high school level, both men and women show math anxiety.
- The results explain that anxiety among high school students stems from nervousness and discomfort caused by mathematics when students face a problem because they don´t feel self-confidence and this does not allow them to think clearly, accordingly, students are altered when they have to work on math problems.
- With regard to gender, the results show evidence that there is a difference between men and women regarding anxiety toward mathematics, women have more anxiety toward this discipline.

The results of the Program for International Student Assessment, consolidated Mexico on the last place on all the three areas of the assessment, reading, math and science, among the 34 countries that are part of the Organization for Economic Co-operation and Development (OCDE). On the math test, Mexico earned position 34th, the last position of the OCDE, with students who do not reach the basic competences level per indicators.

Nationwide, the Secretaria de Education Publica (SEP) reported the results of the MS Assessment Plan, that evaluates the performance of the students on the last grade of high school in two areas of competence: Language and Communication (reading comprehension) and math. The math evaluation, explores the capacity to identify, interpret, apply, synthetize and evaluate mathematically the environment, using his/her creativity and critical and logical thinking, allowing him/her to solve quantitative problems, with different math tools. The test results are reported on domain level percentages (I-IV) as shown on **Table 1**, which describes each one of these levels.

The results show nationally, that 51.3% are on level 1, 29.9% on level II, 12.4% are on level III and only 6.4% demonstrate the knowledge assessed on level IV. A total of 1,027,016 students were assessed. At state level, in San Luis Potosi, 54.2% of students are on level I, 28% on level II, 11.3% on level III and only 6.5% on level IV out of 29,071 assessed students. Locally, in Rioverde SLP 30% reached level I, 27.8% are on level IV.

Table 1. Description of the new mathematic domain levels

Level	Description
I	Student at this level only show ability to solve direct problems requiring to perform basic operations with whole numbers in order to identify graphic elements.
II	On level two, students are able to apply simple arithmetical and geometric procedures for the comprehension of different situations that are somehow similar to those studied in the classroom. They perform operations with fractions, percentages o grouping signs, graphically representing a series of numbers, or describing the behavior of numerical series and its relation among each other. Transforming mathematic models of algebraic or geometric nature enouncing in common language an algebraic expression and vice versa, they also solve bi-dimensional and three-dimensional geometric problems involving transformations and the handling of the elements of the shapes. They have to solve system equations and identify the combination of necessary procedures to solve different exercises.
III	Besides dominating knowledge and abilities from level II, students on this level area able to analyze the relations among two or more variables of a contextualized problem, in order to estimate or get a result. They solve problems related with social or natural processes involving variables and physical units, and perform calculations with reasons and proportions. They solve mathematical problems using different approaches, either requiring the equations approach, the application of the Pythagorean Theorem or concepts as the least common multiple and the greatest common divisor, or require estimating solutions for arithmetic, and geometric problems. They retrieve information from tables or graphs to solve problems involving operations. However, they show poor dominance of the tasks listed in level IV.
IV	In addition to mastering the knowledge and skills of levels II and III, students at this level are able to assess the environment and integrate data obtained using different mathematical procedures, to contrast with established models or real situations. They read and interpret tables, graphics and textual information when solving application problems that require estimates, conversions, and analysis of graphic information or successions. They quantify and mathematically represent the magnitudes of space to solve problems involving the handling of flat and three-dimensional shapes, and geometric properties of incomplete figures. They perform calculations using two linear or quadratic functions shown independently and using numeric, textual, graphical representations or tabular.

Source: Planea (2015) SEP

The results show nationally that 51.3% are at level 1, 29.9% are at Level II, 12.4% are located in the level III and only 6.4% demonstrate the knowledge assessed at Level IV. The number of students tested was 1, 027.016 students. At state level (San Luis Potosi), 54.2% of students are at Level I, 28% at level II, 11.3% at level III and only 6.5% is in the level IV of a total of 29.071 students tested. Locally (Rioverde S.L.P.), 30% reached level I, 27.08% are at level II, the 19.47% level III and 23.47% at level IV of 199 evaluated students (PLANS, 2015).

This arises statements such as: What factors are associated with underperformance? What is the cause of this behavior? Regarding the first question, the team PISA (2012) indicates that a high percentage of students (40%) assessed, have been being late to school at least once before the PISA test and 22% have missed some classes and this is reflected at least in a

decrease of 10 points in their evaluation. In regards to the behavior, they have indicated that a high degree of math anxiety has negative consequences, among them is the tendency of students to avoid them, depriving themselves of the opportunity to study careers related to this matter.

The origin of this situation is that this discipline generates anxiety. Students believe that the math course is one of the most difficult and this perception causes bias and prejudice toward this discipline. This negative attitude leads to a state of very high anxiety that hinders learning (Stubblefield, 2006, quoted Kargar, Tarmizi, Bayat, 2010, Aliasgar, Riahini, Mojdehavar, 2010). Richardson and Suinn, (1972) point out that a state of mathematical anxiety decreases reasoning, performance and attitudes in the student.

With regards to this phenomenon, Carmona (2004) has referred that many students often come to these subjects with negative attitudes and usually with high levels of anxiety, which affects performance when they face classes, exercises or tests. Similarly, to take up a study of Onwuegbuzie (1993) on the prevalence of anxiety, it is seen that approximately 75% of student's experience high levels of anxiety.

Seng (2015) researched on pre-university students, their results show that anxiety causes them low academic performance and anxiety when they have to apply mathematics in everyday life. At this point, the level of anxiety that Mexicans manifested toward mathematics is high: "more than 75% of student's state that they have difficulties in math classes" and almost half of the students feel anxious when trying to solve math problems. These data show that the rate of math anxiety in Mexico, as the highest among all OECD countries. Given the results by gender in Mexico by comparing a man with a woman with the same performance in mathematics, women show more anxiety toward mathematics and have less confidence in their math abilities.

At pre-university level, mathematics plays an important role, Sheriff (s/f) Professor of Economics indicates that a high percentage (80%) of the subjects are expressed by a set of mathematical terms. One of the main reasons is the increase of technology, as it has expanded the advantage of this science through the most comprehensive application of mathematical and statistical techniques.

Having located the phenomenon of study in its reality, the following research question arises: is there anxiety toward mathematics in high school level students enrolled in a private institution at S.L.P. Rioverde? And in terms to gender, is there a difference in anxiety toward mathematics? These questions lead to consider the following research objectives: check for math anxiety in students enrolled in high school level in a private institution of Rioverde S.L.P. and if there is difference in relation to gender.

Nationally, mathematics achievement is often associated with the country's economic future, for this reason, this research aims to gather information and data more accurately, educational authorities at this level, to have sustainable arguments to establish and align

strategies to guide teachers and students to better development of the teaching-learning process and thus increase academic performance, so that the student can have the necessary skills required for the next academic level or to use in their daily lives.

LITERATURE REVIEW

Regardless of the social or economic status of the student, it is a fact that math is always present. This discipline is considered a competitive tool, to achieve a more productive life, however, the gap in academic achievement is big, therefore in the last decades, and the research on education has set attention on this point. Some authors have pointed out different factors (race, socioeconomic status, self-efficacy, and anxiety) that are responsible for the low capacity, noting that one of the most important factors is the anxiety that the student feels toward this discipline.

Smith (1997) has defined anxiety toward mathematics as the anxiety that students experience when performing mathematical operations and anguish of failing in an examination of this discipline. Other authors Richardson and Suinn (1972) describe the mathematical anxiety as a feeling of nervousness that prevents the use of numbers, in order to solve mathematical operations in everyday life as well as in academic spaces.

In this sense, Devine, Fawcett, Szucs, & Dowker (2012), specified Mathematics Anxiety (MA) as a state of unrest caused by performing mathematical tasks and which is manifested through feelings of apprehension, aversion, stress, worry, frustration and fear, also point out that environmental factors (negative experiences in class), intellectual (degree of thought), and personality (self-esteem, learning style, attitude and confidence) influence to generate this feeling in students and therefore students are unable to develop their full capacity. Within this framework, Fennema and Sherman (1976, cited by Perez Castro, Segovia, Fernandez and Cano, 2009) indicate that math anxiety lies in "a series of feelings of anxiety, fear, nervousness and associated physical symptoms arise when doing math."

Many students suffer the negative effects of anxiety toward mathematics from poor performance in courses, to lose confidence in the future on how to solve practical math issues (Armstrong, 1985; Chinn, 2009). On the other hand, Strand (2003, cited by Dodeen, Abdelfatta, and Alshumrani, 2014) reveals that a moderate level of anxiety is useful to motivate a student to a better understanding, keeping in mind, that if a higher level is generated, it can harm performance negatively.

Pérez, Castro and Segovia (2009) provide evidence that students have a level of math anxiety, and argue that there are significant differences between men and women, men suffer less anxiety when faced with mathematical tasks. They also demonstrated that there are significant differences between students from different areas of knowledge.

Devine et al. (2012) showed that high school students experience anxiety toward mathematics and showed that women report more anxiety toward mathematics and lower academic achievement than men.

Similarly, Kesici and Erdogan (2010) disclose their results, students at midlevel suffer from anxiety toward mathematics and those who demonstrate a high sense of achievement have increased anxiety, also showed that students with low self-esteem have higher anxiety.

Macías Hernández (2008) found that male students enrolled in high school tend to have overall higher averages than their female counterpart, no differences were detected in the test scores of mathematics associated with gender, shift or technical career chosen as specialty. No significant gender-related differences were found in terms of anxiety levels when applying the Stroop test, both show anxiety toward this discipline. Cheema and Galluzzo (2013) also investigated the health toward mathematics and showed that anxiety and self-efficacy contribute significantly to explain the variation in performance in mathematics.

METHODOLOGY

This research is of a quantitative nature, not experimental, transect, with mild difference between groups because this research aims to analyze the difference and statistical significance between genders of students. For purposes of this investigation the sample is not probabilistic because the choice of the elements does not depend on the probability, but it is related to the characteristics of research (Hernández, Fernández, Baptista 2010).

The randomly selected sample was formed by 353 students from the middle level of a private school who attend first and second grade, with 46.7% men and 53.3% women, aged between 15 and 18 years old. The study was conducted in the city of Rioverde S.L.P. data were collected using the Scale of Auzmendi (1992) Scale questionnaire on their attitudes toward mathematics of 25 items, with five subscales established: Anxiety, liking, utility, confidence and motivation.

On the scale of Anxiety, includes the items listed in **Table 2**, the score to measure the attitude are coded from 1 to 5, strongly disagree (TD), which is coded 1; disagreement (D), 2; neither agree nor disagree (N), 3; Agreement (A), 4 and strongly agree (TA), 5.

Table 2. Auzmendi actitudes scale. Anxiety sub-scale

X_2	I am pretty bad at math
X_3	Studying or working with math scares me a lot.
X_7	Math is the scariest subject
X_8	I do not have self-confidence when I´m facing a math problem
X_{12}	When I face a math problem, I feel incapable to think clearly
X_{13}	I am nervous and anxious when facing a math problem.
X_{17}	Working with math makes me feel nervous
X_{18}	I get upset when I have to work with math problems
X_{22}	Math make me feel awkward and nervous

The questionnaire was applied in an educational institution supported by the psychology department of the institution, in March of 2016. For data analysis SPSS 23 and AMOS 23 statistical packages were used.

RESULTS

Table 3. Descriptive statistics and correlation of variables

	X_{17}	X_8	X_{13}	X_{22}	X_{18}	X_{12}
X_{17}	1.000					
X_8	.454	1.000				
X_{13}	.457	.450	1.000			
X_{22}	.433	.342	.360	1.000		
X_{18}	.407	.392	.483	.354	1.000	
X_{12}	.479	.355	.402	.355	.351	1.000
MEDIA	3.3	3.42	3.26	3.14	3.28	3.41
SD	1.049	1.056	.968	.994	1.043	1.067

Although normally, the model of factorial analysis does not allow making any assumptions about a mild difference between the variables. However, Sörbom (1974) showed that it is possible to infer, as long as they are analyzing data from more than one population. According to Sörbom´s approach, we cannot estimate the average of all factors for each population, but we can estimate the average population factors among populations.

From what Sörbom proposed (1974), we proceeded to build a model to prove that students- women and men have the same level of anxiety toward math (**Figure 1**).

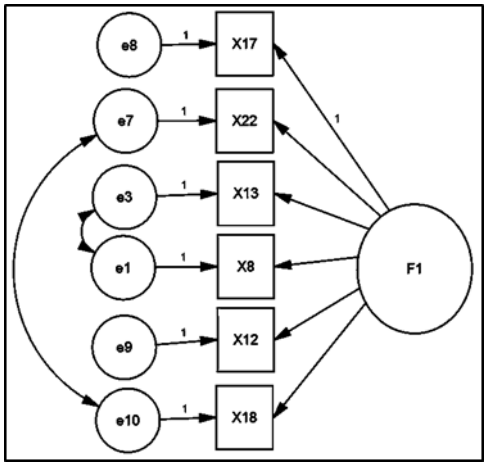

Figure 1. Model Research

Table 4 shows the rates of the model and indicate that the model is a model with a good adjustment.

Table 4. Indices and research model values

INDICES	X^2	GI	p	GFI	CFI	RMESA
Valor	9.674 7	7	0.208	0.991	0.996	0.034

According to the statement made by Sörbom the average was set at zero, in the group of men. **Figure 2** and **3** shows the solution of these two models: men and women.

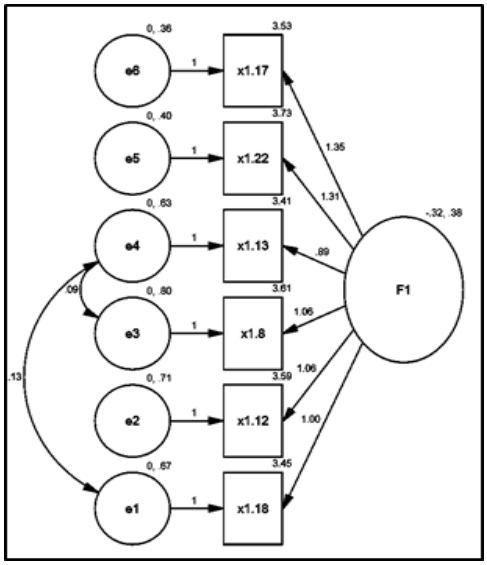

Figure 2. Men Research Model

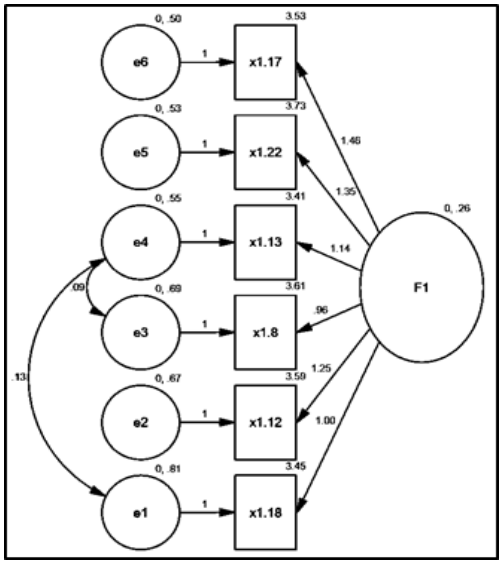

Figure 3. Women Research Model

The results show that the models are significant because of the value of chi square (X2) is 36,023, with 25 degrees of freedom and a probability level of 0.71. For this research, the main

interest is to estimate the difference between men and women in relation to anxiety toward mathematics, rather than the other parameters, however, it is desirable that all estimates are analyzed to ensure they are reasonable.

We are mainly interested in the estimates difference between men and women regarding anxiety toward mathematics, and not so much in the estimates of other parameters. However, as always, all estimates should be inspected to ensure they are reasonable.

The estimated math anxiety in women, average is -0.32, the values also allow to provide evidence of the significant difference between men and women (**Table 5**).

Table 5. Women group average

	Estimate	S.E	C.R.	P	Label
Anxiety toward math	-.316	.077	-4.113	***	par_19

The average anxiety toward mathematics group of women have a critical ratio of -4.113, which is greater than the critical value of 1.96 and is significant at the 0.05 level. In addition, the critical difference between the two groups gives a value of 0.00 for the group of men and 1,109 for the group of women, indicating that women show 1,109 units, more math anxiety than men.

CONCLUSIONS

This study is aimed to check for math anxiety in students enrolled high school level in a private institution of Rioverde S.L.P. and if there is a difference in relation to gender. These objectives are projected from the negative results reported by different agencies and research in this discipline.

Regarding the presence of anxiety toward mathematics, students at this level, both men and women show math anxiety. The results explain that anxiety among high school students stems from nervousness and discomfort caused by mathematics when students face a problem because they don´t feel self-confidence and this does not allow them to think clearly, accordingly, students are altered when they have to work on math problems.

From the evidence derived from this work, strategies can be generated in the teaching-learning process, because if it fosters in students the self-confidence, it decreases nervousness and the student may think more clearly when faced with a mathematical problem.

Thus, high school students, when entering an upper level, will have the ability to assess the environment and integrate data obtained using different mathematical procedures, to contrast with established models or actual situations and not stay stuck at a level where they only show ability to solve problems requiring direct performance of basic operations with whole numbers and identifying graphic elements. The results of this research are relevant to

different authors (Carmona, 2004; Kesici and Erdoğan, 2010; Seng, 2015) who showed that anxiety is common in students in senior high levels.

With regard to gender, the results show evidence that there is a difference between men and women regarding anxiety toward mathematics, women have more anxiety toward this discipline, authors like Frenzel and Goetz (2007) argue that this difference is due to emotions and beliefs that women have of themselves since adolescence. The results of this study are consistent with those of the authors (Strand, 2003; Devine, Fawcett, Szucs & Dowker, 2012, PISA, 2012) explaining that women show more anxiety toward mathematics than its counterpart.

One of the limitations of this analysis lies in the object of study, ie, it would be appropriate to conduct studies including at least other institutions of higher average level of the region to define, if also anxiety toward mathematics is recurrent in other institutions private and public. In future research it is recommended to conduct studies of other schools of higher states and other parts of the country.

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