Anxiety towards Mathematics: A Case of Study in High-School Students

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Abstract

The purpose of the research was to identify the existence of anxiety towards mathematics in high-school students. A quantitative, non-experimental and descriptive study was carried out. The sample was made up by 353 high school students from the city of Rioverde S.L.P. of which 164 were men and 189 were women. A non-probabilistic sampling was used. The Auzmendi test was applied and using only the data corresponding to anxiety. The results indicate that 15.3 % of students present a low level of anxiety, 68.6 % a medium level and 16.1 % a high level, which means that a large number of students feel anguish towards this discipline.

Keywords: Mathematical anxiety, students, upper secondary education, Mexico.

1. Introduction

In Mexico, as in other countries, mathematics plays a fundamental role in any curricular plan of educational institutions because it promotes students' reasoning and analytical thinking (Ramírez, 2014). However, the studies carried out by the National Institute for the Evaluation of Education reveal that students obtain much lower levels of performance than expected, also mentioning that there is a great difference in the learning levels based on the sociocultural contexts of the students (Backhoff, 2011; Larrazolo et al., 2013).

It is important to note that mathematics is necessary in all areas of life, not because it is implicit within a curriculum of almost any degree, or because it is a competence that is acquired in the school environment and it is exclusively applied in that environment, but rather because they are part of daily life (Caballero, Blanco, 2007; Pérez et al., 2009 and PISA, 2012). In the same way PISA (Program for International Student Assessment) in 2015 considers mathematics as a key area for the development of individuals, since it is not only used in a school or professional setting, but in situations that are faced in real life.

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Regarding Mexico, high school students showed a low performance in the results of the PISA tests and in the Evaluation of the Learning (Planea). The results show that more than half of Mexican students are in the lower levels and a minimum percentage of students showed advanced mathematical reasoning and thinking (Flores, Díaz, 2013; Planea, 2015).

However, although mathematics is an indispensable component for the intellectual impulse, some students consider this discipline as a source of frustration and anxiety (Macías, Hernández, 2008). In addition, various studies carried out by pedagogues, mathematicians, psychologists and researchers find anxiety an important factor that hinders mathematical learning. In the same way (Zeidner, 1998 cited by Macías, Hernández, 2008) reports that anxiety towards math exams causes in the student that his skill and knowledge in this discipline to decrease. According to Wood (1988, cited by Pérez et al., 2009) he states that mathematical anxiety is characterized by the absence of comfort that someone could experience when they are required to perform in mathematics. In contrast, Fennema & Sherman 1976 (cited by Pérez et al., 2009), consider that mathematical anxiety consists of a series of feelings of anguish, terror, nervousness and physical symptoms that arise when solving problems related to mathematics. On the other hand, Richardson and Woolfolk, 1980; Cates and Rhymer, 2003 (cited by Cates, Rhymer, 2006) defines anxiety related to mathematics (henceforth, mathematical anxiety) as a state in which a student experiences negative reactions when he finds mathematical concepts or procedures during his mathematical evaluation. Summarizing, mathematical anxiety can be generally defined as the feelings of anxiety that some people experience when confronted with mathematical problems (Sheffield, Hunt, 2006).

The research has revealed several reasons why students experience anxiety towards this discipline and have mentioned that the mathematics course is one of the most difficult, this perception causes prejudices and predispositions to be generated and therefore, a negative attitude leading to a very high anxiety among students that hinders learning (Stubblefield, 2006, cited Kargar et al., 2010; Aliasgari et al., 2010).

According to Ashcraft and Kirk (2001), people with high math anxiety have a particular way of behaving: they take fewer math courses, get grades below average in the classes, demonstrate lower math skills and performance, and displeases the performance of mathematical tasks (Hembree, 1990; Ma 1999; Jung, Kim, 2008; Ko et al., 2011).

Wern (2016) studied how to reduce the level of anxiety in university students, for it he determined the level of anxiety, by comparing the scores of the mean and standard deviation of the Mathematics Anxiety Rating Scale (MARS). Students who had scores below one standard deviation were anxious about this discipline, meanwhile, the level of anxiety was classified as average when the scores were within a standard deviation of the average scores, while the scores that were over a standard deviation of the average scores were considered as high anxiety level, their study presents evidence that a high percentage 41.46 % reflect a high level of anxiety and 27 % show a low level of anxiety.

On the other hand, Haciomeroglu (2017) shows the relationship between anxiety and attitude, his findings revealed that higher levels of attitude towards mathematics mean lower levels of anxiety. It is believed that mathematical anxiety (MA), is closely associated with the attitude since a state of displeasure in the performance of mathematical tasks - of a large amount of the population – leads later to an anxiety that is going to have a negative and significant effect in the performance, even though the size of the effect is low. On the other hand, Delgado, Espinoza and Fonseca (2017) reveal that university students present a medium level of mathematical anxiety, and this anxiety is more present in women, and they point out that students who come from a private school have a lower level of anxiety, therefore their performance is higher, unlike students who come from public schools. In the same idea, Agüero, Gómez, Suárez, and Schmidt (2017) carried out a study on mathematical anxiety in middle school students in Costa Rica and whose results showed that women have moderately higher levels of anxiety than men.

Campbell and Stanley (1963) defines anxiety as the acquired behavioral dispositions that were the result of past experiences that make a person to see the world in a particular way. Sarason and Wine define (cited Leibfritz 1990) anxiety as a phenomenon of attention, therefore, the highly anxious individual pays more attention to environmental signals than to the task at hand. According to Speilberger 1972 (cited by Leibfritz 1990), anxiety is a process that involves cognitive, behavioral and affective components. Hence, Speilberger 1972 (cited by Leibfritz, 1990) proposes the theory of anxiety based on the attributes of the attitude that indicates that anxiety is first

activated by external or internal stressors. These stimuli are cognitively evaluated whether induced internally or externally. For a well-learned or simple task, the optimal level of anxiety is quite high, however, when the individual is just learning a task or when the task is extremely complex, the optimal level of anxiety is much lower (Figure 1).

Auzmendi (1992) developed a scale to measure the attitude towards mathematics and statistics that consists of five factors: anxiety, like, utility, motivation and confidence. Like refers to the taste or enjoyment that causes the mathematical work; anxiety describes the feeling of anguish, stress, fear that the student manifests towards mathematical problems; the utility of mathematics refers to the perception of importance or value that the student gives to mathematics in everyday and professional life; confidence is related to the confidence and security that the person has when facing mathematics and motivation refers to the component that maintains, guides or moves the use and study of mathematics (Hurtado, 2011), for this study only the anxiety construct was taken.

When reviewing the previous research and the results provided by PISA and SEP -which reflect a low performance in mathematics in high school students- the following question arises: Do high school students show high levels of anxiety towards mathematics?

To answer this question, the research objective is to identify the anxiety level towards mathematics in high school students.

The results will provide useful information so that the educational authorities, as well as professors and students, can suggest strategies that allow the students to conduct themselves to a better performance besides diminishing this feeling of fear to this discipline.

2. Methodology

The method used in this research is hypothetic-deductive, in this method the proposed hypotheses are exposed after obtaining information about the object of study and will determine and guide the other observations. The general hypothesis of the present study indicates that the level of anxiety of high school students has a score greater than or equal to 16, at a level of significance of 0.05. Thus, the statistical hypothesis that governs this research at a level of significance of 0.05, is formulated as follows:

$$Ho: X \geq 15$$
$$H1: X < 15$$

Anxiety levels could be determined using the mean and the standard deviation. When the scores were below one standard deviation of the mean scores, the level of anxiety was classified as low. The level of anxiety was classified as average if the scores were within one standard deviation of the average scores. Meanwhile, the scores that were above a standard deviation of the mean scores, the anxiety level was classified as high.

The t-test of paired samples was used to compare the averages before and after for the same group. The mean differences in the t-test were determined using the p-value that was 5 % of the level of significance (Park, 2009). However, there is no control group included in this study. It was used to determine if there were significant differences in the mean for students' general anxiety level in pre and post-test. In addition, it was used to examine if there were significant differences of the mean for pre and post-test for students with low, average and high level of anxiety, respectively.

Hence, this research is "ex post facto" – because facts and variables already occurred-, observing variables and relationships between them in their context. The variables that are intended to be observed are those that allow to show the anxiety that students feel towards mathematics during the teaching-learning process. To carry out the study, we used a sample of 353 students who were in the mathematics department, which is made up of 364 men and 189 women belonging to a private high school in Rioverde S.L.P. The type of sampling was non-probabilistic. The test designed by Auzmendi (1992) was applied. It contains 25 items that can be answered with five options, five numbers: 1. Strongly disagree 2. Disagree 3. Neutral, neither agree nor disagree 4. Agree 5. Strongly agree, they measure 5 factors named: Utility (items 1, 6, 11, 20 and 21), Anxiety (2, 7, 12, 13, 17 and 22), Trust (3, 8, 18 and 23), Like (4, 9, 14, 19 and 24) and Motivation (5, 10, 15, 20 and 25). Even though the whole questionnaire was applied, only the anxiety scale was used for this research. The Cronbach's Alpha reliability coefficient was 0.916. An analysis of a difference in means was used to identify the significant variables that allow measuring the object of study, for which the data were obtained from the statistical program SSPS 23.

3. Results and discussion

The following section shows the results of the anxiety level of the students. Figure 1 shows that 46.5 % of the students surveyed are men and 53.5 % are women, their age ranges between 15 and 18 years, 31.7 % are 15 years, 48.7 % are 16 years old, and 19 % are 17 years and only 0.6 % of students are 18 years as shown in Figure 2
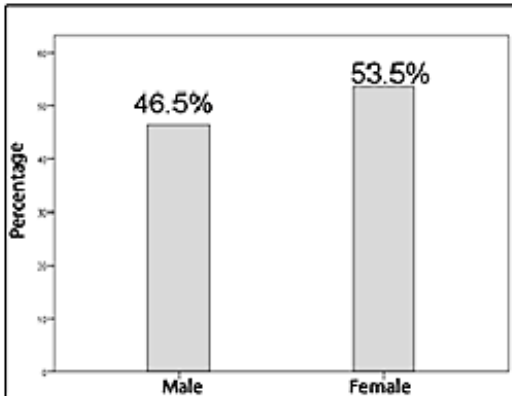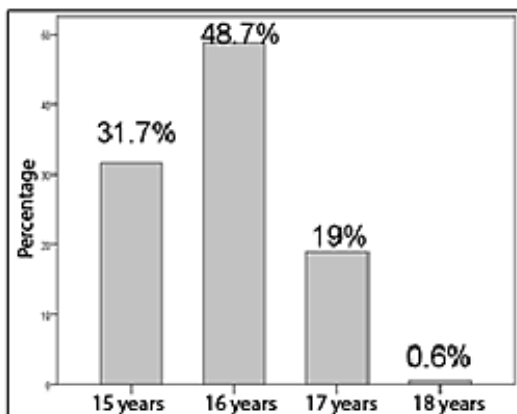
Fig. 1. Gender

Fig. 2. Age

Regarding the grade level, Figure 3 shows 53.3 % of students belong to the second grade, while 46.7 % of students are in the fourth grade.
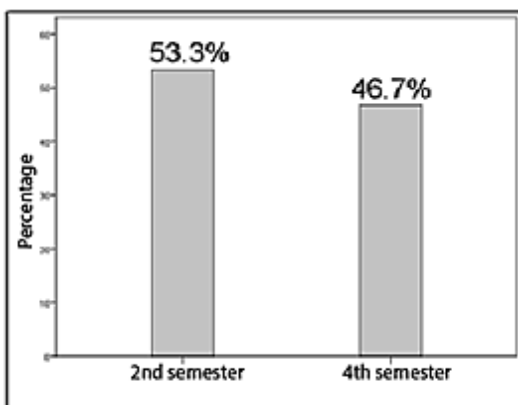
Fig. 3. Grade

Table 1 shows mean, standard deviation, and percentages of students by anxiety level.

Table 1. Mean, standard deviation, and percentages of students

Anxiety level	Mean	Standard deviation
	15.098	1.64
	Percentage	Score
Low	15.4	10-13
Medium	44.3	14-15
High	39.3	16-22
Total	100.0	
Value of t	Significance	Difference between means
0.284	0.776 ($_{352df}$)	0.00850

Source: own.

Of the sample, there are 15.4 % of students scoring between 10 and 13, a low level of anxiety, while 44.3 % are within first standard deviation (for a mean of 15.098 and a standard deviation of 1.64) scoring between 14 and 15, a medium level of anxiety. The remaining 39.3 % of the students got scores of 16 and above, meaning high level of anxiety towards mathematics.

To test the hypothesis that the anxiety level of high school students is greater than or equal to 15, the *t* test for a sample was used. As shown in Table 1, the got *t* value is 0.284 at a significance level of 0.05, which is lower than the critical value of t_{352df} (1.69), rejecting thus the null hypothesis. Consequently, it is concluded that the students of the school under study suffer of anxiety towards mathematics.

Regarding differences in anxiety levels between men and women in the sample, the Mann-Whitney U test was applied. As shown in Table 2, the resulting significance level of (0.006) is less than 5 %, so the hypothesis of equal averages should be rejected, hence concluding that the level of anxiety is significantly different between genders.

Regarding whether there is a difference in anxiety levels between grades, the Mann-Whitney U test yields a level of significance (0.675) that is greater than 5 %, as shown on Table 2. The hypothesis of equal averages should not be rejected, hence concluding that students of both grades show similar anxiety levels towards mathematics.

Table 2. Mann-Whitney U test

Variable	Gender	N	Grade	N
	Male	164	First	188
	Female	189	Second	165
	Total	353	Total	353
	Mann-Whitney U	12877.00	15111.00	
Anxiety Level	Z	-2.752	-.419	
	Asymptotic Significance (bi-serial)	.006	.675	

Source: own.

4. Conclusion

An important aspect to consider in this research is the high degree of anxiety shown by students at this level, since they are a level prior to university level, which demands more mathematical applications, this shows that it is necessary to search for alternatives to solve problems and avoid the emotional effects generated by this discipline, the use of cognitive strategies contribute to face anxiety. Worth to point out that strategies should be differentiated among gender, according to the unequal anxiety levels observed.

Lazarus and Folkman 1986 (cited by Cano et al., 1994), affirm that when the subject perceives that his resources are not sufficient to face an aversive situation, anxiety appears. Similarly, authors Mato and De la Torre (2009) mention that negative attitudes, such as anxiety, have a

significant influence on academic performance, as Macías and Hernández (2008) indicate the presence of mathematical anxiety in students.

It is also important to mention that the preparation of teachers in this discipline focuses more on aspects of content, than on attitudes and feelings, for this reason it is necessary that teachers learn to diagnose and implement them through institutional designs.

5. Research limitations

This research work based on a sample of students from a single private high school that has operations in a single city in Mexico. The results were useful for the school and gave several clues about what might be happening in other private schools in the same region. However, it is necessary to repeat the same study in other public and private schools, to verify if the observed phenomenon occurs in the region and in the country, and to find differences between the regions.

References

Agüero et al., 2017 – *Agüero, E., Gómez, L. G., Suárez, Z. y Schmidt, S.* (2017). Estudio de la ansiedad matemática en la educación media costarricense. *Revista Electrónica de Investigación Educativa*, 19(1), 35-45. DOI: https://doi.org/10.24320/redie.2017.19.1.849

Aliasgari et al., 2010 – *Aliasgari, M., Riahinia, N., Mojdehavar, F.* (2010). Computer-assisted instruction and student attitudes towards learning mathematics. Journal of Education, Business and Society: Contemporary Middle Eastern, 3(1), 6–14. DOI: https://doi.org/10.1108/17537981011022779

Ashcraft, Kirk, 2010 – *Ashcraft, M.H., Kirk, E.P.* (2001). The relationships among working memory, math anxiety, and performance. *Journal of experimental psychology: General*, 130(2), 224. DOI: https://doi.org/10.1037//0096-3445.130.2.224

Auzmendi, 1992 – *Auzmendi, E.* (1992). Las actitudes hacia la matemática-estadística en las enseñanzas medias y universitarias. Bilbao: Mensajero.

Backhof, 2011 – *Backhoff, E.* (2011). La inequidad educativa en México: Diferencias en el aprendizaje de la comprensión lectora en educación básica. *Profesorado. Revista de Currículum y Formación de Profesorado,* 15(3), 87-102. Recuperado de [Electronic resource]. URL: https://www.redalyc.org/articulo.oa?id=56722230006

Caballero, Blanco, 2007 – *Caballero, A. y Blanco, L.J.* (2007). Las actitudes y emociones ante las Matemáticas de los estudiantes para Maestros de la Facultad de Educación de la Universidad de Extremadura. Comunicación presentada en el Grupo de Trabajo "Conocimiento y desarrollo profesional del profesor", en el XI SEIEM. Simposio de Investigación y Educación Matemática, celebrado en la Universidad de La Laguna los días 4 al 7 de septiembre de 2007.

Campbell, Stanley , 1963 – *Campbell, D. T., Stanley, J.C.* (1963). Experimental and Quasi-Experimental Designs For Research, Dallas, TX: Houghton Mifflin.

Cates, Rhyme, 2003 – *Cates, G. y Rhyme, K.* (2003). Examining the Relationship Between Mathematics Anxiety and Mathematics Performance: An Instructional Hierarchy Perspective. Journal of Behavioral Educación, 12, (1) pp 23–34. DOI: https://doi.org/10.1023/A:1022318321416

Delgado, et, al, 2017 – *Delgado, I., Espinoza, J., Fonseca, J.* (2017). Ansiedad matemática en estudiantes universitarios de Costa Rica y su relación con el rendimiento. Académico y variables sociodemográficas. Propósitos y Representaciones 5(1), 275-324 DOI: http://dx.doi.org/10.20511/pyr2017. v5n1.148.

Flores y Diaz, 2013 – *Flores, G. y Díaz, M.* (2013). México en PISA 2012. Recuperado de [Electronic resource]. URL: http://www.sems.gob.mx/work/models/sems/Resource/11149/1/images/Mexico_PISA_2012_Informe.pdf

Haciomeroglu, 2017 – *Haciomeroglu, G.* (2017). Reciprocal relationships between mathematics anxiety and attitude towards mathematics in elementary students. Acta Didactica Napocensia, 10(3), 59-68. [Electronic resource]. URL: https://eric.ed.gov/?id=EJ1160567

Hembree, 1990 – *Hembree, R.* (1990). The nature, effects, and relief of mathematics anxiety. Journal for research in mathematics education, 33-46. DOI: http://dx.doi.org/10.2307/749455

Hurtado,2011 – *Hurtado, L.* (2011). Validación de una escala de actitudes hacia las matemáticas. Investigación Educativa. 15 (28), 99–108. [Electronic resource]. URL: http://www.acuedi.org/ddata/4001.pdf

Jung, Kim, 2008 – *Jung, J.Y., Kim, S.J.* (2008). A study on the factors of mathematics anxiety of mathematical underachievers in the elementary school. Journal of the Korean School Mathematics Society, 11.

Kargar et al, 2010 – *Kargar, M., Tarmizi, R. A., Bayat, S.* (2010). Relationship between mathematical thinking, mathematics anxiety and mathematics attitudes among university students. Procedia-Social and Behavioral Sciences, 8, 537-542. DOI: https://doi.org/10.1016/j.sbspro.2010.12.074.

Ko, Yi, 2011 – *Ko, H.K., Yi, H.S.* (2011). Development and validation of a mathematics anxiety scale for students.Asia Pacific Education Review, 12(4), 509-521. DOI: https://doi.org/10.1007/s12564-011-9150-4.

Larrazolo et al, 2013 – *Larrazolo, N., Backhoff, E., Tirado F.* (2013). Habilidades de razonamiento matemático de estudiantes de educación media superior, Revista Mexicana de Investigación Educativa, 18, (59), 1137-1163. [Electronic resource]. URL: http://www.scielo.org.mx/pdf/rmie/v18n59/v18n59a6.pdf

Leibfritz, 1990 – *Leibfritz, W.E.* (1990). The influence of knowledge about the nature of mathematics anxiety on the level of mathematics anxiety for elementary preservice teachers (Doctoral dissertation, The Ohio State University).

Ma, 1999 – *Ma, X.* (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. Journal for research in mathematics education, 520-540. DOI: https://doi.org/10.2307/749772

Macías, Hernández, 2008 – *Macías, Martínez, D., Hernández, M.* (2008). Indicadores conductuales de ansiedad escolar en bachilleres en función de sus calificaciones en un examen de matemáticas. Universitas Psychologica, 7 (3), 767-786. [Electronic resource]. URL: https://revistas.javeriana.edu.co/index.php/revPsycho/article/view/391.

Mato, De la Torre, 2009 – *Mato, M, y De la Torre, E.* (2009). Evaluación de las actitudes hacia las matemáticas y el rendimiento académico. PNA, 5(1), 197-208. [Electronic resource]. URL: https://dialnet.unirioja.es/servlet/articulo?codigo=3629028.

Park, 2009 – *Park, H.M.* (2009). Comparing Group Means: t-tests and one-way ANOVA Using Stats, SAS, R, and SPSS. Technical Working Paper, The University Information Technology Services (UITS) Centre for Statistical and Mathematical Computing, Indiana University. [Electronic resource]. URL: http://hdl.handle.net/2022/19735

Pérez et al. 2009 – *Pérez Tyteca, P., Castro Martínez, E., Segovia Álex, I., Castro Martínez, E., Fernández García, F. R., Cano García, F.* (2009). El papel de la ansiedad matemática en el paso de la educación secundaria a la educación universitaria. PNA: Revista de Investigación en Didáctica de la Matemática, 4(1), 23-35. [Electronic resource]. URL: https://core.ac.uk/download/pdf/12341208.pdf.

PISA, 2012 – PISA, O. (2012). Results in focus.2014-02-17]. [Electronic resource]. URL: http://www.oecd.org/pisa/keyfindings/pisa-2012-results-o-verview.pdf

PLANEA, 2015 – PLANEA (2015). Consulta los resultados nacionales de PLANEA 2015. [Electronic resource]. URL: http://www.educacionyculturaaz.com/noticias/consulta-los-resultados-nacionales-de-planea-2015

Ramírez, 2014 – *Ramírez, N.A.* (2014). Las habilidades del pensamiento y el aprendizaje significativo en matemática, de escolares de quinto grado en Costa Rica. Revista Electrónica" Actualidades Investigativas en Educación,14 (2), 1-30. [Electronic resource]. URL: https://www.redalyc.org/pdf/447/44731371005.pdf.

Rhymer, Cates, 2006 – *Rhymer, K.N., Cates, G.L.* (2006). Student performance on and preferences for mathematics word problems: An investigation of the effects of explicit timing and interspersing procedures. School Psychology Quarterly, 21(1), 34. DOI: http://dx.doi.org/10.1521/scpq.2006.21.1.34.

Richardson, Woolfolk, 1980 – *Richardson, F.C., Woolfolk, R.L.* (1980). Mathematics anxiety. Test anxiety: Theory, research, and application, 271-288.

SEP, 2015 – SEP (2015). Resultados Nacionales de Planea en Educación Media Superior. México, 2015. [Electronic resource]. URL: http://planea.sep.gob.mx/ms/.

Sheffield, Hunt, 2006 – *Sheffield, D., Hunt, T.* (2006). How does anxiety influence maths performance and what can we do about it? *MSOR CONNECTIONS,* 6(4), 19. [Electronic resource]. URL: http://icse.xyz/mathstore/headocs/6419_anxietymaths.pdf.

Wern Lin, 2016 – *Wern Lin, Y.* (2016). Reducing anxiety level in mathematics learning using pedagogical agent (Order No. 10748380). Available from ProQuest Dissertations & Theses Global. (2027471096). [Electronic resource]. URL: http://0-search.proquest.com.millenium.itesm.mx/docview/2027471096?accountid=11643.