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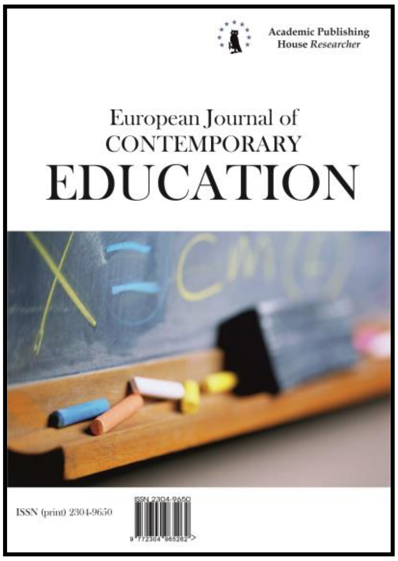


## Psychometric properties of the RMARS Scale in High School Students

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**Abstract**

The purpose of this study was to determine if there is a structure of variables that allows us to understand the level of Anxiety towards Mathematics in high school students from the municipalities of Zacatal and Jamapa, Veracruz, Mexico. This was based on the seminal works of Richardson and Suinn [1972], who developed the Mathematics Anxiety Rating Scale (MARS) instrument with 98 items. This was later modified by Alexander and Martray [1989] to develop the Revised Mathematics Anxiety Rating Scale (RMARS) with only 25 items. For this study, the test was applied to a sample of 200 high school students of first, third and fifth semesters. The reliability of the test was α: 0.934 per item and 0.693 per dimension, which suggests acceptable validity and consistency in terms of what Hair, et al. point out [1979]. For the test of the H1 and H2 hypotheses, Exploratory Factor Analysis with extraction of the Principal Components and the $Chi^2_c$> $Chi^2_t$> statistic suggest that, as a whole, the dimensions of the RMARS scale explain mathematical anxiety. In addition, they indicate that anxiety towards mathematics classes is greater than anxiety towards exams and mathematical tasks; all this accounts for 74 % of the assimilable variance. For H3, the ANOVA test is used to show if there is a difference in means. The results suggest that there are no differences by Gender, Age. Or School Grade, although the MATHTEST dimension in Gender, showed differences in variances.

**Keywords:** beliefs, attitudes, emotions, mathematical anxiety, mathematical exams, numerical tasks, mathematical courses, MARS and RMARS scales.

### 1. Background

One of the policies promoted by the Organization for Economic Cooperation and Development (OECD) is the achievement of economic growth in the field of employment, as well as a better standard of living in member countries. Derived from the above is the Program for the

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International Assessment of Students (PISA), whose main function is to evaluate reading, mathematics, and science competencies in secondary school students.

In the evaluation carried out in 2015, Mexico was ranked 56 out of 70 OECD countries. In learning of mathematical competence in 15-year-old Mexicans, 56.6 % placed in levels 0 and 1, which means that learning is insufficient. 26.9 % placed in level 2 which means minimal learning; 12.9 % in level 3 which means that learning is satisfactory and only 3.5 % placed at level 4 which represents a good or outstanding learning in mathematical competence.

In 2016, PISA reported that the percentage of Mexican students who did not reach the minimum level in mathematical competence remained the same between the years of 2003 and 2015.

With respect to the gender differences that exist in mathematical performance, men outperform women by seven points and the expectation and interest that Mexican students have towards mathematics is low due to anxiety and concern.

Mexico offers high school studies through several different modalities. For example, there are private schools; there are autonomous schools and technological (vocational) schools. There is also a modality called community *Telebachillerato*. These operate in communities with fewer than 2500 inhabitants where there is no nearby high school; thus, they are rural schools. There are three teachers per school, each teaching different subject areas: mathematics, social sciences, and communication skills. They rely on guided lesson plans and audiovisual materials to cover the curriculum.

In 2017, the results of the National Plan for the Evaluation of Learning (PLANEA) indicate that students score above the national average in autonomous schools, in private schools, and in technological schools, with autonomous schools showing the highest score on average. On the other hand, *Telebachillerato* students obtained the lowest score. Likewise, the gender results showed that the men obtained slightly higher scores in mathematics, which coincides with the results obtained by PISA. Anxiety towards the discipline may play a role in these results.

To evaluate mathematical anxiety, Richardson and Suinn [1972] developed the MARS scale that measures mathematical anxiety, since previous studies had shown that many people suffer it when working with numbers and solving problems. Later, Alexander and Martray [1989] reviewed and modified the instrument to 25 items. They named it RMARS.

Mathematical anxiety includes affective, cognitive and behavioral components. Fennema and Sherman [1976] found that a high number of students decide not to study mathematics due to these, with more women than men making that decision. Thus, their concern to create mathematical attitude scales to obtain more information about women's learning in mathematics.

In the educational context, there has been a great interest in analyzing and understanding the cognitive and behavioral traits that facilitate or hinder students' performance in academic matters, and how these relate to their psychosocial development. Understanding the concepts of self-efficacy and anxiety has contributed to improving teaching-learning practices (Contreras et al., 2005).

The phenomenon of anxiety towards mathematics has been explored for decades (Aiken, 1961, 1976, Brasell et al., 1980, Sandman, 1980, Satake, Amato, 1995, Suinn, Winston, 2003; Adelson, McCoach, 2011; García-Santillán et al., 2014, 2015, 2016 and 2017; Navarro-Ibarra et al., 2017). One such study found noticeable math anxiety present in the behavior of some students when they hear the word mathematics, when performing mathematical tasks, when studying the subject, or when solving an evaluation (Eccius, Lara-Barragán, 2016).

Other studies have given evidence that anxiety towards mathematics differs with respect to gender, age, or academic status among other factors of the student's profile. In this regard, Pérez-Tyteca et al. [2007] analyze the anxiety levels presented by students entering the University of Granada when they are faced with mathematical tasks. They found significant differences between men and women, with men reporting less mathematical anxiety.

In this same line, Martínez-Artero and Nortes [2014] demonstrated in a study carried out among students who are training to be teachers of mathematics, that women have more anxiety than men do. Additionally, age makes a difference; that is, students older than 21 report greater anxiety in comparison with those who are younger (<21 years old).

Very similar to the result obtained by the previous authors, is the study carried out by Nortes & Nortes [2017], where they take a sample of 829 second, third, and fourth grade students from future primary school teachers. Their findings show significant differences in gender aspects where the level of mathematical anxiety in academic courses is higher in women than in men.

Likewise, a study by Agüero, Meza, Suárez and Schmidt [2017] with a sample of 3,725 students at the secondary level in public school in Costa Rica, found statistically significant differences in relation to mathematical anxiety by gender, since women apparently have higher levels of anxiety towards mathematics than men do. In addition, another interesting data finding is related to the variable degree of education. The study identified that the level of anxiety differs with respect to the students of the third grade versus those who are in other grades, the latter being the students who showed slightly higher levels of anxiety.

Thus, this study aims to answer the following research questions: How do tests, tasks and courses, all of them associated with mathematics, constitute factors that generate anxiety in the student? Does anxiety differ according to gender, age or degree of study?

General Objective:

● Evaluate how tests, tasks and math courses generate anxiety in the student.

Specific objectives:

● Identify which of the three factors explain mathematical anxiety in *Telebachillerato* students in the municipalities of Zacatal and Jamapa, Veracruz.

● Analyze if there are significant differences by gender, age and school grade that explain mathematical anxiety.

Working hypothesis:

$H_1$ Examinations, assignments and math courses constitute a structure of latent variables that generate anxiety in the student.

$H_2$ There is at least one factor that explains mathematical anxiety in *Telebachillerato* students in the municipalities of Zacatal and Jamapa, Veracruz.

$H_3$ There are significant differences by gender, age and school grade in the elements that explain mathematical anxiety.

## 2. Literature review

This section seeks to explain from theory how the construct of mathematical anxiety has been defined, from the dimensions of beliefs, emotions and attitudes towards exams, tasks and courses. These last three are an essential part of this research.

When Aiken [1961] decides to investigate the effect of attitudes in mathematics, he discovers that they are related to factors of intelligence and achievement, but not to variables such as temperament. In a later study [1976], this author states that changes in attitude toward mathematics imply an interaction between the characteristics of teachers and students, giving greater emphasis to the behavior that is had in the classroom and the didactic techniques that are used for the teaching of mathematics.

In 1968, Dutton and Blum selected a sample of 342 students to apply an assessment and know what they thought of mathematics. They found that students did not like to work with math problems outside of school, nor did they like to commit arithmetical errors. Most agreed that the best way to accomplish this was to avoid arithmetic whenever possible, since they indicated that mathematics was not useful in daily life and that arithmetic was a waste of time.

In seminal studies by Richardson and Suinn [1972], mathematical anxiety involves feelings of tension and anxiety that interfere with the use of numbers and the solution of mathematical problems in daily life and in academic situations. Their MARS scale consists of 98 statements, which gave rise to six factors: general evaluation anxiety, daily numerical anxiety, passive observation anxiety, performance anxiety, mathematical test anxiety and problem solving anxiety.

Later, Suinn et al. [1972], mention a study by Richardson with a sample of 400 university students. He discovered that 28 % showed high levels of tension associated with mathematical situations or the use of numbers and that more than a third of them sought help through therapy in a counseling center, explaining that the reason for consultation was related to mathematics.

Benz [1978] complements the above, stressing that mathematical anxiety was seen as a psychological problem. Psychologists became very much in demand to help design and implement plans for improvement, which included techniques for the general management of anxiety, modification of irrational beliefs and negative attitudes towards mathematics. The aim was to develop more positive attitudes and self-concepts.

Later, McLeod [1988] studied emotions and feelings about mathematics, analyzed the intervention of attitudes, and found that affective influences in the solution of problems vary in intensity (magnitude) and direction (positive or negative).

In the correlational analysis of Bessant [1995], the author indicated that the interaction between the attitude towards mathematical anxiety and the MARS scale factors depends on the level of anxiety with respect to the experience one has regarding it. It was also found that learning was significant to a specific type of anxiety, to attitudes and to factors of giving instructions. Likewise, the result confirmed the functionality of using teaching-learning theory and instruments to analyze the relationship between the cognitive and affective components in mathematical anxiety.

The results of the meta-analysis research developed by Ma [1999] can be understood as a relationship between mathematical anxiety and performance. Thus, it can be understood as a psychological issue derived from emotional reaction that has beliefs, attitudes, and sensations such as the panic and fear that arise when presented with mathematics.

In this order of ideas, Gil, Blanco, and Guerrero [2005] indicate that positive and negative attitudes have traditionally been studied. However, these authors complement the research with concepts of emotional literacy, which in mathematics education is oriented to the affects, beliefs, attitudes, emotions and feelings as a determining factor to learn, understand and perform in the discipline of mathematics.

Studies conducted by Sánchez, Segovia and Miñán [2011] indicate that teachers' negative attitudes and anxiety can be transmitted to their students. They cite Johnson's [1981] work, and highlight that in his research, the professor's attitude will be reflected in the attitude of the students towards arithmetic and if the attitude is negative, it will cause anxiety and fear. For that reason García-Santillán, Escalera-Chávez and Venegas-Martínez [2013] consider it necessary for the professor to do the work of improving emotional issues so that the student avoids paralyzing himself when he is studying mathematics.

It is important to distinguish between mathematical attitude and attitude towards mathematics. The former refers to the cognitive capacity that the person has; for example, analysis, problem solving, cognitive openness, critical thinking, etc. and the latter has to do with affective capacity, that is, the value and satisfaction that this subject generates (Palacios et al., 2014).

A recent study carried out by Navarro-Ibarra, García-Santillán, Cuevas, and Ansaldo [2017] found a high level of anxiety between mathematics courses and numerical tasks. The students showed less anxiety when they were in mathematics class than when an evaluation was applied and less anxiety between the numerical tasks and the evaluations. They also identified that mathematical attitude is greater when there is a correlation between affective commitment and mathematical confidence followed by the correlation between a commitment behavior and mathematical confidence. Finally, they discovered that the correlation that exists between the affective commitment and the commitment behavior was slightly lower.

It is also important to note that in several studies, anxiety scales towards mathematics have shown a very acceptable Cronbach's Alpha reliability index. Table 1 is an inventory of scales that have been designed to measure this phenomenon of anxiety towards mathematics.

**Table 1.** Reliability index of math anxiety scales

| Year | Author | Anxiety measures test | Items | α |
|---|---|---|---|---|
| 1958 | Saranson , Davidson, Lighthall & Waite | Saranson's TASC | 30 | .85 |
| 1968<br>1988 | Cole & Oetting<br>Frank & Rickard | Scale of anxiety towards the Specific Concepts | 20 | .84/.95 |
| 972 | Richardson & Suinn | MARS | 25 | .78/ .95<br>.96 / 99 |
| 1972 | Richardson & Suinn | MARS-a | 25 | .89 / 96 |

| | | | | |
|---|---|---|---|---|
| 1973 | Sztela | Debilitating anxiety towards mathematics scale | 10 | .83 |
| 1975 | Spielberger & Guerrero | State-Trait Inventory (IDARE-RE) Pre and Post Experimental | 20 | .75 / 95 |
| 1978 | Sepie & Keelin | Mathematics anxiety scale | 20 | .90 |
| 1980 | Cruise & Wilkins | Statistics anxiety scale | 51 | .67 /.94 |
| 1981 | Meece | Mathematics anxiety questionnaire | 19 | .81 |
| 1982 | Plake & Parker | MASC | 22 | .97 |
| 1989 | Alexander & Martray | SMARS | 25 | .71 |
| 2007 | Muñoz & Mato | Mathematics anxiety scale | 24 | .71 |

Source: prepared with data from García-Santillán et al. [2017].

As can be observed, this type of scale has shown a good index of reliability and validity as well as high psychometric properties. In addition, when they have been replicated in different contexts, their results have given significant empirical evidence in this field of knowledge. As an example of this, a study by García-Santillán, Moreno-García and Ramos Hernández [2017] demonstrated that the Three-factor model of anxiety towards mathematics of Richardson and Suinn's MARS scale [1972], modified by Alexander and Martray in 1989 into what is now known as the RMARS scale, can be explained by five factors (Fig. 2), as follows:

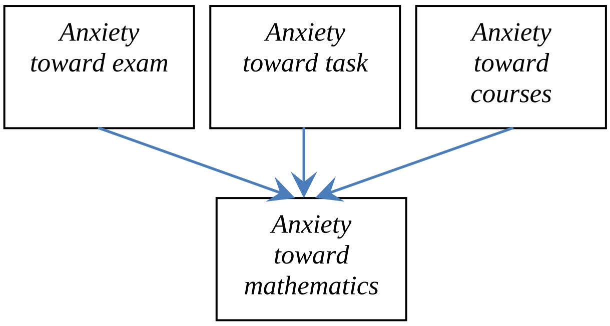


**Fig. 1.** Three factor model of Richardson & Suinn [1972], modified by Alexander & Martray [1989] taken from Navarro-Ibarra et al. [2017].

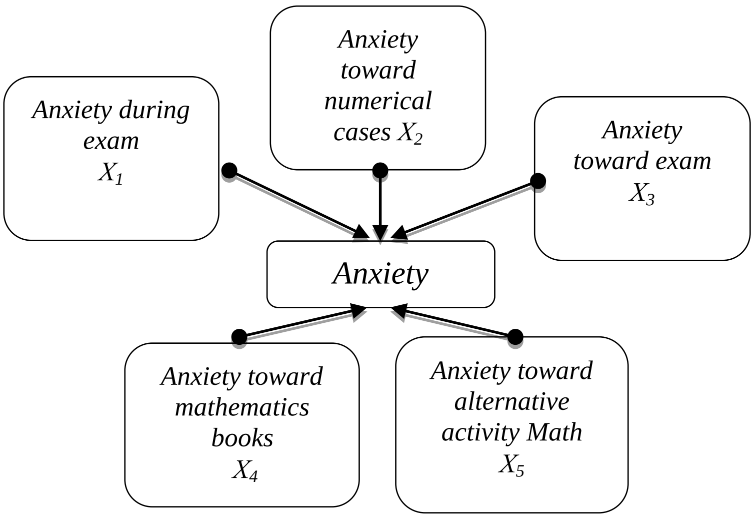


**Fig. 2.** Penta-dimensional model of mathematics anxiety (taken from García-Santillán et al., 2017)

With these theoretical and empirical arguments, the study is carried out according to the following:

## 3. Method

The present empirical research is of non-experimental design since the independent variables will not be manipulated, in order not to condition the results and their generalization. Its design is transversal because the data collection was carried out in a single moment of the study. All the surveys were applied during the month of November, 2017.

Since the study focuses on assessing how exams, tasks and mathematics courses are factors that generate anxiety in the student, it is a correlational explanatory study. It seeks to evaluate and explain the whole of underlying variables that would explain the phenomenon of study.

It also seeks to explain if there are differences in means according to gender, age and school grade with respect to the level of anxiety towards mathematics.

Population

The population under study was applied taking as reference the locality of Jamapa, Veracruz in the *Telebachilleratos* of the rural area of El Zacatal and of the Jamapa municipal area, belonging to the School Supervision Zone of Veracruz [2017] that in turn depends on the General Division of *Telebachillerato*.

The population is constituted by the students enrolled in the regular semester June-December of 2017 of a *Telebachillerato* of the public sector, morning shift, where the level of schooling of the students is first, third and fifth semester.

The characteristics of the population are as follows: ages range from 14 to 20 years of age, 55 students belongs to the *Telebachillerato* of El Zacatal and 155 students belong to the *Telebachillerato* of Jamapa. 104 students are male and 96 students are female.

Within the inclusion criteria are students enrolled in this *Telebachillerato*, who are studying first, third, and fifth semester and have agreed to answer the survey voluntarily. It is important to note that at all times the confidentiality of the student's name was maintained.

Sample

For the study in question, of the total population surveyed, they subscribe to a non-probabilistic convenience sample, since the researcher obtained direct contact with the school's educational authorities and was allowed to apply a survey to all current students in that area and moment. The total sample in this case is 200 students.

Our key informants were the students who were supervised by the teacher in turn and by the interviewer for the correct response of the same. The confidentiality of the students surveyed was requested at all times, obtaining only the demographic data.

Instrument

For the purpose of this empirical study, the RMARS scale of Richardson and Suinn [1972] was used, which was modified in 1989 by Alexander and Martray, and which consists of 25 indicators integrated into three dimensions. Table 2 is described below:

**Table 2.** Structure of the instrument

| Definition | Items |
|---|---|
| Anxiety towards mathematics quizzes | 1-15 |
| Anxiety towards numerical tasks | 16-20 |
| Anxiety towards mathematics courses | 21-25 |

Source: Taken from Alexander & Martray [1989].

The instrument includes the socio-demographic profile: Gender, Age, School Grade and Locality. It consists of a Likert scaling where the student has to choose between Not at all, A Little, Somewhat, A Lot, and Too Much.

Statistical procedure

For the testing of hypotheses H1 and H2, the Exploratory Factor Analysis (AFE) procedure is used with the extraction of Principal Components (CP). First, Bartlett's of Sphericity test is calculated from the transformation of the correlation matrix of the determinant, the same determinant that allows us to identify the power of the correlations according to the following:

$$d_R = \left[ n-1-\frac{1}{6}(2p+5)\ln|R| \right] = -\left[ n-\frac{2p+11}{6} \right] \sum_{j=1}^{p} \log(\lambda_j)$$

Where: N = sample size, ln = natural logarithm, $\lambda_j$(j=1,..., p) values pertaining to R, R= correlations matrix

Likewise, the Chi square test (Chi²), KMO (Kaiser-Meyer-Olkin) and the Sample Adequacy Measure (MSA) with a level of significance α = 0.01; all of the above from the following mathematical expressions (Table 3):

**Table 3**. Mathematical expressions KMO, MSA and Chi²

| Bartlett's test of sphericity | KMO and MSA |
|---|---|
| $\chi^2 = -\left[ n - 1 - \frac{1}{6}\left(2p+5\right) ln\left\|R\right\| \right] = -\left[ n - \frac{2p+11}{6} \right] \sum_{j=1}^{p} log(\lambda_j)$<br>Where<br>n= sample size; p= number of variables; ln=Neperian logarithm R= correlations matrix.<br>Satisfying the following element:<br>$\left[ n - \frac{2p+11}{6} \right] log \frac{\left[ \frac{1}{p-m}\left( trazR^* - \left( \sum_{a=1}^{m} \lambda_a \right) \right) \right]^{p-m}}{\left\|R^*\right\| / \prod_{a=1}^{m} \lambda_a}$ | $KMO = \frac{\sum_{j \neq i} \sum_{i \neq j} r_{ij}^2}{\sum_{j \neq i} \sum_{i \neq j} r_{ij}^2 + \sum_{j \neq i} \sum_{i \neq j} r_{ij(p)}^2}$<br>$MSA = \frac{\sum_{i^1 j} r_{ij}^2}{\sum_{i^1 j} r_{ij}^2 + \sum_{i^1 j} r_{ij(p)}^2}; i = 1, \ldots, p$<br>Where:<br>$r_{ij\ (p)}$ is the partial coefficient of the correlation between the variables $X_i$ y $X_j$ in all cases. |

Source: own

Therefore, if $H_0$ is true, the eigenvalues are worth one, its logarithm is null and the test statistic is zero. Otherwise, with high values of $Chi_2$ and a low determinant, there is evidence of a high correlation. So, if the Critical Value: $Chi_2$ calculated is> $Chi_2$ tables, there is evidence for the rejection of $H_0$. In order to measure the data obtained from the students surveyed, the following is obtained:

**Table 4**. Matrix of the population under study

| Variables |
|---|
| $X_1, X_2, \ldots. X_p$ |
| $X_{11}\ X_{12}\ \ldots. X_{1p}$ |
| $X_{21}\ X_{22}\ \ldots. X_{2p}$ |
| ....... |
| $X_{n1}\ X_{n2}\ \ldots. X_{np}$ |

Source: own

If we assume that the common factors have been standardized or normalized $E(F_i) = 0$, $Var(f_i) = 1$, then the specific factor will have a mean equal to zero and the correlation between both factors is $Cov(F_i,u_j) = 0$, $\forall_i = 1,\dots,k$; $j=1,\dots,p$. With this consideration: if the factors are correlated ($Cov(F_i, F_j) = 0$, if $i\neq j$; $j, i=1,\dots,k$) we will be talking about a model with orthogonal factors, otherwise, if they are not correlated, it is a model with oblique factors. Hence, the equation can be expressed as: $x = Af + u \hat{U} X = FA' + U$

Where:

| Data matrix | Matrix of factorial loads | Factorial matrix |
|---|---|---|
| $x = \begin{pmatrix} x_1 \\ x_2 \\ \dots \\ x_p \end{pmatrix}, f = \begin{pmatrix} F_1 \\ F_2 \\ \dots \\ F_k \end{pmatrix}, u = \begin{pmatrix} u_1 \\ u_2 \\ \dots \\ u_p \end{pmatrix}$ | $A = \begin{pmatrix} a_{11}a_{12}\dots a_{ik} \\ a_{21}a_{22}\dots a_{2k} \\ \dots\dots \\ a_{p1}a_{p2}\dots a_{pk} \end{pmatrix}$ | $F = \begin{pmatrix} f_{11}f_{12}\dots f_{ik} \\ f_{21}f_{22}\dots f_{2k} \\ \dots\dots \\ f_{p1}f_{p2}\dots f_{pk} \end{pmatrix}$ |

With a variance equal to

$$Var(X_i) = \sum_{j=1}^{k} a_{ij}^2 + \Psi_i = h_i^2 + \Psi_i; i = 1,\dots,p$$

Where the commonality and specificity of the variable Xi is given by:

$$h_i^2 = Var\left(\sum_{j=1}^{k} a_{ij}F_j\right) \dots y \dots \psi_i = Var(u_i)$$

The variance of each variable can be divided into two parts: a) in its commonality $h_i^2$ which represents the variance explained by common factors, and b) specificity □I which represents the specific variance of each variable. Hence we obtain

$$Cov(X_i, X_l) = Cov\left(\sum_{j=1}^{k} a_{ij}F_j, \sum_{j=1}^{k} a_{lj}F_j\right) = \sum_{j=1}^{k} a_{ij}a_{lj} \quad \forall i \neq \ell$$

Source: taken from García-Santillán [2017]

To test hypothesis H3, an ANOVA analysis is developed to test the null hypothesis ($H_0$) of the population means of Mathtest, Mathtask and Mathcourses, versus the alternative hypothesis ($H_a$) that at least one of the scores obtained differs with respect to the expected value.

$$Ho: \mu_1 = \mu_2 = \mu_1$$

$$Ha: \ni \mu_l \neq \mu\_\_\_ \; j = 1, 2, \dots, K$$

According to the theoretical criteria, to perform the ANOVA calculation it is required that the assumptions of Normality and Homoscedasticity be met: the populations (probability distributions of the dependent variable corresponding to each factor) are normal; The K samples on which the treatments are applied are independent and the populations have all the same variance (homoscedasticity).

Within the ANOVA procedure, the following elements intervene:

Total Variation: $SCT = \sum_{J=1}^{K}\sum_{i=1}^{nj}(x_{ij} = \bar{X})^2$ Intra-group Variation: $SCD = \sum_{J=1}^{K}\sum_{i=1}^{nj}(x_{ij} - \bar{X}_j)^2$

Global Means: $\bar{X} = \frac{\sum_{J=1}^{K}\sum_{i=1}^{nj} x_{ij}}{n}$. Inter-group Variation: $SCE = \sum_{J=1}^{K}(\bar{X}_j - \bar{X})^2_{nj}$.

Xij being the i-th value of the j-th sample; nj the size of said sample and $\bar{X}$ its mean. When the null hypothesis is true, SCE/K-1 and SCD/n-K are two unbiased estimators of the population variance and the quotient between them is distributed according to a F of Snedecor with K-1 degrees of freedom in the numerator and N-K degrees of freedom in the denominator. Thus, if $H_0$ is true, then it is expected that the quotient between both estimates is approximately equal to 1, so that $H_0$ will be rejected if said quotient differs significantly from 1.

The following section discusses the data analysis.

**4. Data analysis**

To answer the main research question and thereby achieve the purpose of the study, we analyze and discuss the data obtained after the statistical processing of the AFE.

In the first place, we proceeded to the validation of the data, starting from the assumption of normality through the K-S statistic of one sample, which determines the level of asymptotic significance (α> .05). As can be seen in Table 5, the values of the asymptotic (bilateral) significance give evidence of the level of normality or non-normality of the data. In this case, the three variables have a normal distribution (0.943, 0.078 and 0.307).

**Table 5.** Kolmogorov-Smirnov test for one sample

| | | Math Tests | Numerical Tasks | Math Courses |
|---|---|---|---|---|
| N | | 200 | 200 | 200 |
| Normal parameters (a,b) | Mean | 42.5350 | 13.0600 | 13.0550 |
| | Absolute Stan. Dev. | 12.31042 | 4.67393 | 4.71840 |
| Most extreme differences | | .037 | .090 | .068 |
| | Positive | .037 | .090 | .068 |
| | Negative | -.034 | -.042 | -.045 |
| Z Kolmogorov-Smirnov | | .528 | 1.275 | .967 |
| Asymptotic. sig. (bilateral) | | 0.943 | 0.078 | 0.307 |

a) The contrast distribution is Normal. b They have been calculated from the data.
Source: own

As can be seen in Table 5, the normality of the data is present in the three variables of the study phenomenon according to the theoretical criteria (Hair et al., 1979). In addition, to measure the reliability and validity of the test, Cronbach's Alpha index is calculated to obtain the correlations between the items of the instrument whose minimum acceptable value is 0.70 (Oviedo, Campo-Arias, 2005), since the closer to 1 the result, the greater the reliability of the scale used.

For this study, the following coefficients were obtained: individual (0.934), grouped in three dimensions (0.693), in both cases yielding acceptable values, which confirms the validity of the instrument (Table 6).

**Table 6.** Case processing summary

| | | N | % | α Individual | α Grouped |
|---|---|---|---|---|---|
| Cases | Valid | 200 | 100 | 0.934 | 0.693 |
| | Excluded[a] | 0 | 0 | Items | Items |
| | Total | 200 | 100 | 25 | 3 |

a. The elimination by list is based on all the variables of the procedure.
Source: own

Tables 7 and 7.1 show the mean descriptive statistics and standard deviation of the variables grouped by dimension and individually (25 items): This is the basis for calculating the coefficient of variation to identify the variable (s) with the greatest variation with respect to the rest.

**Table 7.** Descriptive statistics

| | Mean | Standard deviation | Number of analyses | CV=DVµ |
|---|---|---|---|---|
| Math Tests | 42.54 | 12.3104 | 200 | 28.94% |
| Numerical Tasks | 13.06 | 4.6739 | 200 | 35.79% |
| Math Courses | 10.44 | 3.8378 | 200 | 36.76% |

Source: own

**Table 7.1.** Descriptive statistics

| | Mean | Typical deviation | Number of analyses | CV=DVµ |
|---|---|---|---|---|
| Math Course21 | 2.25 | 1.27 | 200 | 56.75% |
| Math Tests12 | 2.63 | 1.37 | 200 | 52.29% |
| Math Course23 | 2.51 | 1.30 | 200 | 51.77% |
| Math Course25 | 3.01 | 1.46 | 200 | 48.63% |
| Numerical Tasks19 | 2.52 | 1.19 | 200 | 47.50% |
| Numerical Tasks18 | 2.50 | 1.17 | 200 | 47.03% |
| Math Tests5 | 2.50 | 1.17 | 200 | 46.94% |
| Math Course22 | 2.68 | 1.25 | 200 | 46.80% |
| Math Course24 | 2.62 | 1.21 | 200 | 46.16% |
| Numerical Tasks17 | 2.45 | 1.13 | 200 | 46.07% |
| Math Tests10 | 2.93 | 1.34 | 200 | 45.72% |
| Math Tests3 | 2.61 | 1.17 | 200 | 44.92% |
| Math Tests7 | 2.67 | 1.20 | 200 | 44.87%* |
| Math Tests11 | 2.69 | 1.18 | 200 | 43.95%* |
| Numerical Tasks20 | 2.60 | 1.13 | 200 | 43.45% |
| Math Tests14 | 2.80 | 1.20 | 200 | 43.09% |
| Math Tests9 | 3.16 | 1.34 | 200 | 42.52% |
| Numerical Tasks16 | 3.00 | 1.26 | 200 | 42.14% |
| Math Tests15 | 2.84 | 1.19 | 200 | 41.83% |
| Math Tests2 | 2.83 | 1.17 | 200 | 41.30% |
| Math Tests13 | 2.94 | 1.21 | 200 | 41.01% |
| Math Tests8 | 3.02 | 1.21 | 200 | 39.97% |
| Math Tests4 | 3.12 | 1.24 | 200 | 39.69% |
| Math Tests6 | 3.08 | 1.20 | 200 | 38.98% |
| Math Tests1 | 2.76 | 1.03 | 200 | 37.44% |
| Mean coefficient of variation | | | | 44.83%* |

Source: own

The results of Table 7 show that numerical tasks and mathematical courses have a higher coefficient of variation with respect to mathematical exams. Table 7.1 shows items of the Mathcourse dimension (items 21, 23 and 25) that show the greatest variation with respect to the others and above the mean (44.83 %) are several of the items grouped by the NumericalTask dimension (items 19, 18, 17).

On the other hand, we must justify that the AFE is a suitable technique for data analysis. Hence, Table 8 and 8.1 show the values obtained from Bartlett's test of Sphericity with Kaiser

(KMO), Chi square with n gl, the significance α <0.01 as well as the Sample Adequacy Measures by variable (MSA), all by grouped dimensions and by items (25 items).

**Table 8**. KMO Test and Bartlett's test of Sphericity (by grouped dimensions)

| | | | MSA | |
|---|---|---|---|---|
| Kaiser-Meyer-Olkin measure of sampling adequacy | | 0.720 | | |
| Bartlett's Sphericity Test | Approx. Chi-squared | 218.036 | Math test | 0.730[a] |
| | gl | 3 | Math task | 0.734[a] |
| | Sig. | 0.000 | Math courses | 0.697[a] |

Source: own.

**Table 8.1.** KMO Test and Bartlett's test of Sphericity (by items)

| | | | MSA |
|---|---|---|---|
| Kaiser-Meyer-Olkin measure of sampling adequacy | | 0.917 | |
| Bartlett's Sphericity test | Approx. Chi-squared | 2679.407 | The values range are between of 0.96[a] (MathTest10) to 0.81[a] (MathCourse23) |
| | df | 300 | |
| | Sig. | .000 | |

Source own

In the previous table, acceptable values of the KMO (0.720), Chi² with 3 degrees of freedom (218.036) are observed, as well as the significance <0.00 and the MSA values, the latter all exceed the theoretical threshold that establishes that they should be > 0.5 (0.730a , 0.734a; 0.697a), all by grouped dimensions and Table 8.1 shows the values KMO (0.917), Chi² with 300 degrees of freedom (2679.407), as well as the significance <0.00 and the MSA values, all exceeding the theoretical threshold that states that they should be > 0.5

On the other hand, the linear correlations between the analyzed variables are shown, both grouped and individually. In addition, the correlation matrix in Table 9 provides evidence of positive and significant correlations (> 0.5), although the determinant is not as close to zero as suggested by the theoretical criteria (Hair et al., 1979).

**Table 9**. Correlation matrix[a]

| | | MathTests | NumericalTasks | MathCourses |
|---|---|---|---|---|
| Correlation | MathTests | 1.000 | .584 | .630 |
| | NumericalTasks | | 1.000 | .626 |
| | MathCourses | | | 1.000 |

a. Determinant = .331
Source: own.

Likewise, Table 9.1 shows positive correlations in all the items, as well as the value of the determinant close to zero. This provides evidence of significant correlations as suggested by the theoretical criteria (Hair et al., 1979).

**Table 9.1**. Correlation matrix ([a])

| | Math Tests1 | Math Tests2 | Math Tests3 | Math Tests4 | Math Tests5 | Math Tests6 | Math Tests7 | Math Tests8 | Math Tests9 | Math Tests10 | Math Tests11 | Math Tests12 | Math Tests13 | Math Tests14 | Math Tests15 | Numerical Tasks16 | Numerical Tasks17 | Numerical Tasks18 | Numerical Tasks19 | Numerical Tasks20 | Math Course21 | Math Course22 | Math Course23 | Math Course24 | Math Course25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Math Tests1** | 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| **Math Tests2** | 0.57 | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| **Math Tests3** | 0.47 | 0.62 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| **Math Tests4** | 0.48 | 0.52 | 0.5 | 1 | | | | | | | | | | | | | | | | | | | | | |
| **Math Tests5** | 0.34 | 0.21 | 0.3 | 0.3 | 1 | | | | | | | | | | | | | | | | | | | | |
| **Math Tests6** | 0.44 | 0.42 | 0.4 | 0.4 | 0.3 | 1 | | | | | | | | | | | | | | | | | | | |
| **Math Tests7** | 0.37 | 0.3 | 0.2 | 0.4 | 0.3 | 0.5 | 1 | | | | | | | | | | | | | | | | | | |
| **Math Tests8** | 0.45 | 0.33 | 0.3 | 0.5 | 0.3 | 0.4 | 1 | 1 | | | | | | | | | | | | | | | | | |
| **Math Tests9** | 0.46 | 0.34 | 0.3 | 0.4 | 0.3 | 0.5 | 1 | 0.7 | 1 | | | | | | | | | | | | | | | | |
| **Math Tests10** | 0.36 | 0.24 | 0.2 | 0.3 | 0.4 | 0.4 | 1 | 0.5 | 1 | 1 | | | | | | | | | | | | | | | |
| **Math Tests11** | 0.45 | 0.43 | 0.4 | 0.5 | 0.3 | 0.5 | 0 | 0.4 | 0 | 0 | 1 | | | | | | | | | | | | | | |
| **Math Tests12** | 0.4 | 0.42 | 0.3 | 0.4 | 0.2 | 0.4 | 0 | 0.5 | 0 | 0 | 0 | 1 | | | | | | | | | | | | | |
| **Math Tests13** | 0.35 | 0.38 | 0.3 | 0.4 | 0.3 | 0.4 | 0 | 0.5 | 1 | 0 | 1 | 0 | 1 | | | | | | | | | | | | |
| **Math Tests14** | 0.54 | 0.38 | 0.3 | 0.3 | 0.5 | 0.5 | 1 | 0.6 | 1 | 1 | 1 | 0 | 1 | 1 | | | | | | | | | | | |
| **Math Tests15** | 0.47 | 0.44 | 0.3 | 0.4 | 0.4 | 0.4 | 0 | 0.5 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | | | | | | | | | | |
| **Numerical Tasks16** | 0.38 | 0.31 | 0.2 | 0.3 | 0.3 | 0.3 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | | | | | | | | |
| **Numerical Tasks17** | 0.31 | 0.3 | 0.2 | 0.2 | 0.4 | 0.2 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | | | | | | | | |
| **Numerical Tasks18** | 0.35 | 0.25 | 0.2 | 0.2 | 0.3 | 0.2 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | | | | | | | |
| **Numerical Tasks19** | 0.34 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | | | | | | |
| **Numerical Tasks20** | 0.28 | 0.19 | 0.2 | 0.2 | 0.3 | 0.3 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | | | | | |
| **Math Course21** | 0.38 | 0.32 | 0.4 | 0.3 | 0.4 | 0.2 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Math Course22 | 0.41 | 0.25 | 0.3 | 0.3 | 0.5 | 0.3 | 0 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | | | |
| Math Course23 | 0.26 | 0.4 | 0.4 | 0.4 | 0.2 | 0.2 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | | |
| Math Course24 | 0.32 | 0.28 | 0.3 | 0.2 | 0.3 | 0.3 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | |
| Math Course25 | 0.31 | 0.18 | 0.1 | 0.2 | 0.4 | 0.2 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |

Determinant = 7.42E-007
Source: own

Next, Table 10 shows the matrix of component and communalities under the criterion of eigenvalue > a 1. The table shows the factorial weights obtained by each of the dimensions of the RMARS scale used, as well as the proportion of the variance represented by their communalities, whose sum represents the self-value and the total percentage of the variance explained. It is also observed that the only extracted component collects factorial weights> to 0.5 of each of the three factors.

**Table 10.** Component matrix[a] and extraction of communalities

| Variables | Component 1 | Commonalities |
|---|---|---|
| MathTests | 0.856 | 0.732 |
| NumericalTasks | 0.854 | 0.729 |
| MathCourses | 0.875 | 0.766 |
| Eigenvalues | 2.227 | |
| Total variance explained | 74.223% | |
| Extraction method: analysis of main components. | | |
| [a] 1 extracted components | | |

Source: own.

As can be seen in Table 10, the factorial weights are > 0.5 and the square of them shows the proportion of the variance represented by their commonality (Ψ). The three factors integrate a component whose weight of 2.227 of the Eigenvalue accounts for 74% of the total variance explained by anxiety towards mathematics. The variables that explain the component are hierarchized in the following way: MathCourses (0.875) followed by MathTest (0.856) and finally MathTasks (0.854).

In the same way, the extraction of the main components was carried out, using the Varimax rotation method with Kaiser Standardization. The rotated components show a perfect order as indicated by Alexander and Martray [1989). That is, the dimensions of Anxiety towards tasks, exams and courses, all associated with mathematics, constitute a set of variables that explain the phenomenon of mathematical anxiety, as shown in Table 11.

**Table 11**. Matrix of rotated components[a]

| | Component | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| NumericalTasks | .917 | | |
| MathTests | | .916 | |
| MathCourses | | | .902 |

Extraction method: analysis of main components. Rotation method: Varimax with Kaiser normalization.
The rotation has converged in 5 iterations.

Source: own.

With the previous analysis, we can say that hypotheses $H_1$ and $H_2$ are checked. If there is a set of latent variables that explain mathematical anxiety, the value of the calculated $Chi^2$ gave evidence of this assertion, since the calculated $Chi^2$ exceeds the theoretical criterion of theoretical $Chi^2$ in both cases. In addition, anxiety is explained by at least one factor as indicated in Table 10 and in the rotated matrix described in Table 11.

Now, according to the three-factor model of Alexander and Martray [1989] and the resulting model of five factors of García-Santillán et al [2017], the extraction analysis is now carried out by the factors criterion. Table 11.1 shows the matrix rotated by items.

**Table 11.1**. Matrix of rotated components ([a])

| | Component | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Math Tests9 | 0.777 | | | |
| Math Tests7 | 0.743 | | | |
| Math Tests8 | 0.731 | | | |
| Math Tests14 | 0.679 | | | |
| Math Tests13 | 0.643 | | | |
| Math Tests6 | 0.639 | | | |
| Math Tests11 | 0.596 | | | |
| Math Tests10 | 0.566 | | | |
| Math Tests15 | 0.530 | | | |
| Numerical Tasks18 | | 0.839 | | |
| Numerical Tasks19 | | 0.802 | | |
| Numerical Tasks20 | | 0.765 | | |
| Numerical Tasks17 | | 0.749 | | |
| Math Tests3 | | | 0.744 | |
| Math Tests2 | | | 0.718 | |
| Math Course23 | | | 0.676 | |
| Math Tests4 | | | 0.600 | |
| Math Course21 | | | 0.540 | |
| Math Course22 | | | | 0.780 |
| Math Course25 | | | | 0.687 |
| Math Course24 | | | | 0.575 |
| Math Tests5 | | | | 0.575 |

Extraction method: analysis of principal components. Rotation method: Varimax with Kaiser normalization.

Source: own

The result is surprising; unlike the models shown in Fig. 1 and 2, four components are now obtained. This fact leads us to think that the RMARS scale, applied in Latin contexts, reclassifies the items into other components. Table 12 describes the extracted components resulting from the rotated matrix.

**Table 12**. Extracted components

| Component 1 | Component 2 | Component 3 | Component 4 |
|---|---|---|---|
| 9.- Think about an upcoming math exam one hour before (0.777)<br>7.- Think about an upcoming math exam one week before (0.743)<br>8.- Think about an upcoming math exam one day before (0.731)<br>14.- Study for a math exam (0.679)<br>13.- Open a math or physics textbook and see a page full of problems (0.643)<br>6.- Receive an assignment with several difficult problems which must be turned in the following class (0.639)<br>11.- Grab a math book to start a difficult task that involves reading mathematical theory (0.596)<br>10.- Realize you have to take math classes during the three years of middle and high school (0.566)<br>15.- The moment you receive a test during a math class (0.530) | 18.- Receive a series of subtraction problems to solve (0.839)<br>19.- Receive a series of multiplication problems to solve (0.802)<br>20.- Receive a series of division problems to solve (0.765)<br>17.- Receive a series of numbers to add on paper (0.749 | 3.- Present a quiz during a math class (0.744)<br>2.- Present the math section of an institutional exam(0.718)<br>23.- Register for a math class (0.676)<br>4.- Present the final exam during a math class (0.600)<br>21.- Buy a math textbook(0.540) | 22.- Watch the teacher solve a math equation on the board (0.780)<br>25.- Enter math class (0.687)<br>24.- Listen to another student explaining a math problem to someone else (0.575)<br>5.- Grab a math book to start an assignment (0.575) |

Source: own

Under the criterion of factorial loads > 0.5 in the component extraction procedure, the following items are left out: item 1 (Study for a mathematics test), item 3 (Present a quiz in a mathematics course), item 16 (Do mental calculation). In this way the rotated component matrix is made up of four components, which are explained in the final discussion section of the results and conclusions.

Thus, for the test of H3 hypothesis of difference of means with respect to gender, age and school grade, the result shown in Table 13 is obtained.

**Table 13.** Test of homogeneity of variances by Gender, Age, and School Grade

| | Levene's test | gl1 | gl2 | Sig. |
|---|---|---|---|---|
| | Gender | | | |
| MATHTEST | .080(a) | 1 | 198 | .777 |
| MATHTASK | .334(b) | 1 | 198 | .564 |
| MATHCOURSES | .008(c) | 1 | 198 | .928 |
| | Age | | | |
| MATHTEST | .302(a) | 1 | 197 | .583 |
| MATHTASK | 1.378(b) | 1 | 197 | .242 |

| | | | | |
|---|---|---|---|---|
| MATHCOURSES | 3.461(c) | 1 | 197 | .064 |
| | School grade | | | |
| MATHTEST | 1.147(a) | 2 | 197 | .320 |
| MATHTASK | 2.147(b) | 2 | 197 | .120 |
| MATHCOURSES | .059(c) | 2 | 197 | .943 |

a Groups with a single case will be ignored when calculating the homogeneity of variance test for MATHTEST.
b Groups with a single case will be ignored when calculating the homogeneity of variance test for MATHTASK.
c Groups with a single case will be ignored when calculating the homogeneity of variance test for MATHCOURSES.

Source: own

Table 13 shows the Levene statistic that allows us to test the hypothesis of equality of population variances. Since the value of significance is greater than 0.05, the null hypothesis of equality of variances is accepted. That is, the sampled populations have the same variance, which leads us to reject the alternative hypothesis that states that there is a difference of means in at least one of the populations.

On the other hand, Table 14 shows the ANOVA analysis, with the F statistic with its level of significance for each group (gender, age and school grade), which are greater than 0.05. This allows us to accept the null hypothesis, that is, there is sufficient evidence to indicate that there is no significant difference between the groups in terms of the elements that explain mathematical anxiety. However, the value of the significance for the MATHTEST dimension in relation to gender seems to present a difference in their means as indicated by the F statistic (3.739) and the significance less than 0.05 (0.025). This makes us suppose that if there is a difference. The Levene statistic suggests the rejection of the alternative hypothesis, that is, that there is no evidence to reject the null hypothesis of equality of variances.

**Table 14.** ANOVA

| Factor | | F | Sig. |
|---|---|---|---|
| MATH TEST | Gender | 3.739 | .025 |
| MATH TASK | | .869 | .421 |
| MATH COURSES | | .565 | .569 |
| | Age | | |
| MATH TEST | | .020 | .980 |
| MATH TASK | | .030 | .971 |
| MATH COURSES | | .433 | .649 |
| | School grade | | |
| MATH TEST | | .006 | .994 |
| MATH TASK | | .618 | .540 |
| MATH COURSES | | .281 | .755 |

Source: own

## 5. Discussion and conclusions

Based on the purpose of the study, we focused on evaluating the factors that underlie the phenomenon of anxiety towards mathematics. The foregoing based on the data revealed by the OECD in the evaluation carried out in 2015, where Mexico ranks 56 out of the 70 OECD member countries in terms of learning and mathematical competence among 15-year-olds. 56.6 % is at level 0 and 1 which means that learning is insufficient, 26.9 % is at level 2 which means minimal learning, 12.9 % is at level 3, which means that learning is satisfactory and only 3.5 % is at level 4, which represents good or outstanding learning in mathematical competence.

These figures are not entirely satisfactory; if we consider that the average age of access to high school ranges from 15 to 17 years, and is the prelude to entry to higher education.

In this study, we used the RMARS scale, which presented acceptable indicators of internal consistency with Cronbach's Alpha scores for all items of 0.934 and a grouped 0.693, which shows a concordance with the reliability indexes collected in studies by García-Santillán et al. [2017].

Among the important findings in this empirical study carried out among *Telebachillerato* students from the municipalities of Zacatal and Jamapa in the state of Veracruz Mexico, they show empirical evidence to affirm that mathematical anxiety depends on 74.22 % of the variables, mathematical exams, numerical tasks, and mathematical courses. This means that if these variables are present in *Telebachillerato* students the level of anxiety towards mathematics will be high.

However, undoubtedly the most important finding appeared when analyzing the data through the statistical procedure of extraction of components by the factor criterion. This refers to the matrix of rotated component obtained (Table 11.1), since the data aligned to a model of four factors, not the three of Alexander and Martray, nor the five factors that García-Santillán et al [2017] obtained as shown in Fig. 1 and 2.

Now, analyzing the indicators that were grouped in each one of the extracted components, we could think that the sense and interpretation that the students give to each one of these items, changes depending on the context; that is a population studied in Mexican territory may differ in interpreting.

In this way, considering the original items that integrate each dimension of the scale used by Alexander and Martray [1989], versus the accommodation or reclassification obtained in this study, the following is shown in Table 15: the result obtained from the four factors in the rotated component matrix.

It is important to note that the extraction test of rotated components was done using the Varimax method with loads greater than 0.55, so items that did not present loads higher than this criterion are excluded in the procedure (1, 12, 16 and 23).

**Table 15.** Comparison of components vs. Extracted components

| Dimension | Items of the original scale | Extracted components | Concordance |
|---|---|---|---|
| MATHTEST | 1-15 | 6, 7, 8, 9, 10, 11, 13, 14, 15 | Coincide |
| MATHTASK | 16-20 | 17, 18, 19, 20 | Coincide |
| MATHCOURSES | 21-25 | 2, 3, 4, 21, 23 | 2, 3, and 4 are reclassified |
| Mathematic interaction | | 5, 22, 24, 25, | Items that are reclassified in a new component associated with mathematical interaction |

Source: own

As can be seen in the previous table, the items of the MATHTEST component coincide with that presented by Alexander and Martray, as does the MATHTASK component. However, items 2, 3 and 4 of the MATHTEST component are now aligned to the MATHCOURSES component, which leads us to think that presenting a quick quiz or exam, a final institutional exam in the mathematics course, associates it with the dimension of anxiety towards the mathematics course.

Regarding the fourth component, observing a teacher solving an algebraic equation on the blackboard, entering the math class, listening to another student explaining a mathematical formula to someone else and grabbing a math book to start an assignment, could well be interpreted as an interaction with mathematics. The reclassification of these items in the fourth component leads us to think that the Latino student perceives in a different way the items of the scale designed by Alexander and Martray [1989].

Other important findings are shown in Tables 16, 17 and 18, which refer to the descriptive statistics by gender, age and school grade, respectively, where the mean and standard deviation are specified, which allows the coefficient of variation to be obtained algebraically (Ds / μ), and in this way identify the greater variation that they present with respect to the rest of the variables.

**Table 16**. Descriptive statistics by gender

| | Gender | Number | Mean | Standard deviation | CV=DVμ |
|---|---|---|---|---|---|
| MathTests | Male | 104 | 40.27 | 12.61 | 31.32% |
| | Female | 96 | 44.97 | 11.54 | 25.67% |
| | Total | 200 | 42.53 | 12.31 | 28.94% |
| NumericalTasks | Male | 104 | 12.65 | 4.75 | 37.58% |
| | Female | 96 | 13.51 | 4.56 | 33.83% |
| | Total | 200 | 13.06 | 4.67 | 35.79% |
| MathCourses | Male | 104 | 12.87 | 4.81 | 37.38% |
| | Female | 96 | 13.25 | 4.63 | 34.96% |
| | Total | 200 | 13.05 | 4.71 | 36.14% |

Source: own.

The results of Table 16 indicate that males have a higher coefficient of variation with respect to mathematical exams, numerical tasks and mathematical courses. So specifically in this population we can highlight that this finding is in contrast with studies shown by Pérez-Tyteca et al. [2007], Rosário et al. [2008], Martínez-Artero and Nortes [2014] and Agüero et al. [2017], where they point out that males have a lower level of anxiety than women.

Findings of the descriptive statistics by Age are shown in Table 17:

**Table 17**. Descriptive statistics by Age

| | Age | Number | Mean | Standard deviation | CV=DVμ |
|---|---|---|---|---|---|
| MathTests | from 12 to 15 | 92 | 42.5 | 12.60 | 29.67% |
| | >15 < to 20 | 107 | 42.54 | 12.16 | 28.59% |
| | >20 < to 23 | 1 | 45 | 0 | 0.00% |
| | Total | 200 | 42.53 | 12.31 | 28.94% |
| NumericalTasks | from 12 to 15 | 92 | 13.09 | 4.42 | 33.75% |
| | >15 < a 20 | 107 | 13.03 | 4.92 | 37.75% |
| | >20 < a 23 | 1 | 12 | 0 | 0.00% |
| | Total | 200 | 13.06 | 4.67 | 35.79% |
| MathCourses | from 12 to 15 | 92 | 12.94 | 4.28 | 33.08% |
| | >15 < to 20 | 107 | 13.18 | 5.08 | 38.57% |
| | >20 < to 23 | 1 | 9 | 0 | 0.00% |
| | Total | 200 | 13.05 | 4.71 | 36.14% |

Source: own.

In this table we can see that the highest coefficient of variation for the mathematical exams is the age of 12 to 15 years. That is, those who are in this age range generate greater mathematical anxiety when they know that they are going to take an exam, while for numerical tasks and mathematical courses it is age > 15 < to 20. This means that those who are in these ages represent a higher level of anxiety when doing numerical tasks and attending mathematical courses (math class). These results coincide with the research of Martínez-Artero and Nortes [2014] which found that at higher age the level of mathematical anxiety increases.

Finally, in Table 18 we find the descriptive statistics by School Grade:

**Table 18**. Descriptive statistics by School Grade

| | Grade | Number | Mean | Standard deviation | CV=DVμ |
|---|---|---|---|---|---|
| MathTests | First | 113 | 42.61 | 13.12 | 30.80% |
| | Third | 68 | 42.42 | 11.08 | 26.13% |
| | Fifth | 19 | 42.42 | 12.07 | 28.48% |
| | Total | 200 | 42.53 | 12.31 | 28.94% |
| NumericalTasks | First | 113 | 13.23 | 5.03 | 38.08% |
| | Third | 68 | 12.58 | 4.06 | 32.25% |
| | Fifth | 19 | 13.73 | 4.55 | 33.17% |
| | Total | 200 | 13.06 | 4.67 | 35.79% |
| MathCourses | First | 113 | 13.16 | 4.71 | 35.83% |
| | Third | 68 | 12.73 | 4.58 | 36.04% |
| | Fifth | 19 | 13.52 | 5.33 | 39.46% |
| | Total | 200 | 13.05 | 4.71 | 36.14% |

Source: own.

The results of Table 18 indicate that the highest coefficient of variation for the mathematical exams and for the numerical tasks is found in the students who attend the first semester. This means that those who have just entered *Telebachillerato* suffer greater mathematical anxiety, unlike those in the Fifth Semester who show a higher coefficient of variation when taking the subject. This is related to the studies of Agüero et al. [2017] by identifying significant differences in mathematical anxiety between one school grade and another.

Final considerations and future research

Finally this result leads us to a reflection, especially if we consider that the three-factor model of Alexander and Martray [1989] is met with some items that are grouped in the dimensions described in Table 2 (MATHTEST, MATHTASK, MATHCOURSES), but in the extraction of rotated components it has four components, which leads to a reclassification of the original items, as previously discussed.

Of course, these findings are significant and should lead to empirical studies in other populations. That is, it would be convenient to carry out research to discover how mathematical anxiety is present in the teachers of that sector evaluated (*Telebachillerato*) in order to demonstrate how it influences students.

Similarly, it would be convenient to investigate if there are elements that explain mathematical anxiety in rural contexts at all educational levels, both in students and teachers, in order to have elements that justify and allow us to design strategies to improve the teaching-learning of the mathematics in those populations.

Finally it is suggested to extend the research to another context, for example, the family. Within the family, it would be interesting to know how this apparent rejection towards mathematics is present, and if it generates anxiety towards mathematics in other family members. This could give evidence of whether or not it is a significant factor affecting what young people think regarding exams, numerical tasks, and mathematical courses.

The current challenge of education focused on the national strategy of the new educational model, seeks among other things, to reduce the gap that exists in the use of mathematical skills in the Mexican student. Hence, the importance of knowing and understanding the beliefs, attitudes and emotions that cause anxiety towards mathematics. This would lead us to develop action plans in the search to increase the level of understanding and mathematical ability in teaching-learning. Getting students to understand mathematical benefits and their multiple applications in daily life in the mind of the student would help change thoughts and feelings of rejection, to acceptance.

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