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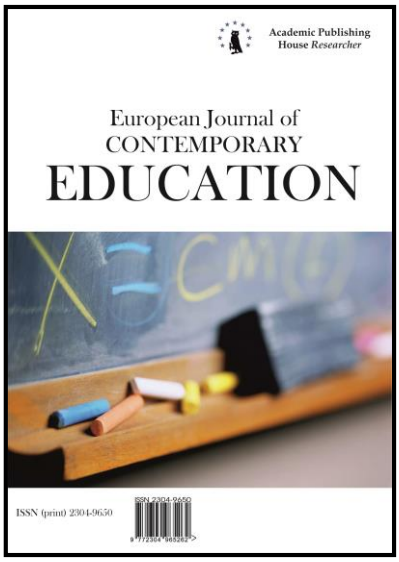

Anxiety Towards Mathematics and Educational Level a Study on Means Diferences

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Abstract

The aim of this research work is to analyze whether there is a difference in the degree of anxiety towards mathematics among students of different educational levels. The study is not-experimental and cross sectional, and it is based on difference of means between groups. The sample is not-probabilistic, and consisted of 226 students from Tuxtepec, Mexico of different educational levels: basic, middle, upper-middle and upper. For this purpose, the questionnaire designed by Muñoz and Mato-Vázquez (2007) was utilized. It comprises five factors: anxiety toward evaluation, anxiety toward temporality, anxiety toward understanding of mathematical problems, anxiety about numbers and mathematical operations, anxiety toward mathematical situations of the real life. The results shows that anxiety toward mathematics is different by level of study, that significant differences exist between groups, and that anxiety toward assessment is higher among upper, upper-middle and middle levels, while for elementary students there is no perceptible anxiety toward mathematics.

Keywords: Anxiety, math, student, study level.

1. Introduction

Setting of the studied phenomena

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As an extension of the study made by García-Santillán, Edward Wurzinger and Tejada-Peña (2015) on the factors that explain anxiety towards the study of mathematics by students of basic level, now, in this study, we look for determining if there are differences in the anxiety level towards mathematics between the students from basic school, junior high school, high school and bachelor level at the region of Tuxtepec, Oaxaca, México.

Following this idea, once more the departure point is the result of the evaluation applied to basic or primary school in Mexico on the academic performance of the students from the sixth grade. It can be seen that, after having applied different tests and questionnaires, is at the mathematics area where 48 % of the students were able to reach a good or excellent level in this subject, while 52 % got an insufficient and basic level, all this, according to data from the National Evaluation of Academic Achievement at Schools (Enlace, 2013).

In that sense, and according to the PISA (2012) (Program of International Students Assessment) results, 55 % of the students are not able to reach the basic competences level according to this indicator. Level 1 means that Mexican students show a delay of almost two years at their educational level, compared to the average of the nations of the OECD, Organization for Economic Cooperation and Development that show an average of 494. Mexico ranks 52 among the 65 countries that took part in the test in 1912, which means an achievement, since in 2003 Mexico ranked 37 among 41 countries that were analyzed. The aforementioned raises questions such as which factors are associated to low performance? Which is the reason for this behaviour? What are the academic authorities doing? These questions lead us to develop an empiric study, with the aim to obtain evidence on the phenomena, departing from the student's attitude towards mathematics and specifically, at basic, junior high school, high school and bachelor degree students.

About the academic authorities, we can point out that the bodies in charge of designing and implementing the educational policies, are focused in transmitting the students the skills so they become able to develop all their potentiality, in a daily basis they might be able to face challenges related to conflicts solution, decision making or managing unexpected situations. Nevertheless, young students are not being trained the right way to count with the mathematics tools that are required in a world economy that is each time more interconnected, since there is a high percentage of scholar incompetence in this area. Some authors (De la Peña, 2002; Velázquez, 2008; Sosa, 2009; Gómez, 2009), have disclosed the higher education students' current situation related to their academic performance.

De la Peña (2002) demonstrated that 40.5 % of the students at the Autonomous National University of Mexico (UNAM), are not competent in mathematics; In that same sense, Velázquez (2008), remarks that in a mean average of the Management students at the Autonomous University of Chihuahua (76 %) counted with the abilities to solve mathematics problems. On the other hand, Sosa (2009), expressed that a high percentage (90 %) of the students at the Faculty of Accounting and Management of the Autonomous University of san Luis Potosí, UASLP, showed a lack of basic knowledge on mathematics and Gómez (2009), explained that the students of the Universidad Veracruzana, Coatzacoalcos Campus, also showed failures in this field.

Students consider that the mathematics course is one of the most difficult and therefore, there are prejudices towards this discipline that do not allow them to learn the concepts the right way; this negative attitude leads to a very high state of anxiety which impedes learning (Stubblefield, 2006, cited by Kargar, Tarmizi, Bayat, 2010; Aliasgar, Riahini, Mojdehavar, 2010). Richardson and Suinn (1972 cited by Sherman and Wither, 2003), conceptualize the term anxiety as a state of anguish that diminishes mathematic reasoning, performance and the student's attitudes and leads to avoiding or not electing courses with mathematics content (Garry, 2005).

In this idea, Carmona (2004) has found with respect to the anxiety phenomena towards mathematics that many students tend to face mathematics subjects with negative attitudes towards the topic, frequently associated to high levels of anxiety when they face the classes, exercises or tests about these subjects. The same way, we retake a study made by Onwuegbuzie (1993), on the prevalence of anxiety towards Statistics. He estimates that approximately 75 % of the students experience high levels of anxiety.

Is then anxiety towards mathematics the phenomena associated to the student's low academic performance? With the aim to clarify this, we take advantage of Fenemma and Sherman's (1976) study who designed a scale of 108 factors with the aim to assess the anxiety level towards

mathematics in the student and concurrently, inside the topic of mathematics but very specifically in the field of Statistics.

From the initial statement, and taking as a reference the theoretical reasoning exposed, now it is set out the following question: Is there a difference in the anxiety degree towards mathematics among the students from different educational levels? And therefore, we set as an objective analyzing if there is a difference in the anxiety level towards mathematics among the students of different educational levels.

2. Literature review

Researchers have carried out several studies in order to identify structures on latent variables that might permit the understanding of perception, attitude, beliefs and anxiety of the student towards mathematics. As an example, in Mexico, García-Santillán, Venegas and Escalera, (2013), García-Santillán, Venegas, Escalera and Córdova (2013) have carried out studies with the aim of identifying latent variables that might explain attitudes towards mathematics and specifically towards Statistics at some university students, either at public or private universities. Even being true that Statistics is a mathematics branch, and that the students relate both terms as mathematics, it must be clarified that what we are looking for at this study is assessing the level of anxiety towards mathematics in general.

Another research study carried out by Moreno-García, García-Santillán and Cristóbal-Hernández (2014) on evaluation, temporality, numerical skills and daily mathematic calculations, as factors that explain anxiety towards mathematics at junior high school students, the research demonstrated that from the five variables that conform the 24 units of Muñoz's and Mato's scale (2007), anxiety towards calculations with numbers, anxiety towards evaluation and anxiety towards comprehension of mathematics problems, showed the highest factorial weight (0,909, 0,905 and 0,897, respectively) at the extracted component.

On the other hand, Al Mutawah1 (2015), carried out a study about anxiety towards mathematics at students from the 8^{th}, 9^{th}, 10^{th}, and 11^{th}, grades in Malaysia, finding that beginning at the 11^{th} grade, students showed a higher anxiety level and mentions that anxiety increases as the students get to a higher grade.

Kok (2015) found that Mathematics anxiety has an impact at pre undergraduate students at the mathematics subjects and points out that there is a lineal relation between anxiety and evaluation, this is, when they face exams, besides, there is a relation between anxiety and the daily implementation of this topic. The author mentions that Yousef et al. (2010), got to the same conclusion, because he demonstrated the positive relation between anxiety when facing exams and Mathematics performance.

Harari, Vukovic and Bailey (2013), explored anxiety towards mathematics at students of first grade through a multidimensional construct that included a) negative reactions related to fundamental basic concepts, b) numerical certainty related to calculations ability and worry. His findings let us know that negative reactions and numerical certainty are the most relevant dimensions of mathematic anxiety.

Nuñez, Suarez and Bono (2013) examined at undergraduate students, if anxiety towards affects academic performance, his findings showed that low performance of the student in this subject, was due to anxiety towards this topic. That research also demonstrated that students, who have a background of having studied at a humanistic or social junior high school, show higher levels of anxiety towards mathematics. Besides, they refer that these students also show negative attitudes towards mathematics and therefore, get low grades at their final exams.

Departing from here, it could be demonstrated that anxiety reached its highest level at students from the Tuxtepec high school in Oaxaca when they are evaluated, when they solve a numerical problem or when they have to understand mathematics calculation within a limited time. These situations share that the student could feel an "exposition" during the process of understanding and solving a mathematics problem, and being possible that a student might choose his or her career with the aim of avoiding mathematics, but does not count with the same skill to relief the fear for a numeric problem in real life.

On the other hand, in Spain, Muñoz and Mato (2007), developed a scale in order to measure anxiety towards mathematics at students of mandatory junior high school in that country. The study's population was conformed by 1220 students form public and private schools.

The instrument they got is made of 24 items with a Cronbach's Alpha validity of 0.954 (>.9), very acceptable according to Hair's et al (1999) theoretical criteria, which is conformed by five dimensions: anxiety towards evaluation, anxiety towards comprehension of mathematics problems, anxiety towards numbers and mathematic calculations and finally, anxiety towards real life mathematics.

The results reported by Muñoz and Mato (2007), correspond with the purpose they has set when they began their research on the anxiety test and with this, they identified the theoretical level of this construct. Besides, as an interesting data to be remarked, they found differences in the median distribution of anxiety scores with respect to the factors, turning out to be that exams are responsible of the highest levels of anxiety at the students.

This evidence that they show and considering the importance that the element anxiety has in the field of mathematics, and above all, the role that it has in the student's life, Muñoz and Mato (2007), suggest that it is necessary to count on that kind of valuable information that allows to advise, the best possible way, to the students. Besides, they end suggesting that the scale can be taken as an evaluation platform that might permit making decisions associated to prevention, treatment or instructional change inside the classroom and that at the same time it may favour the improvement of that attitude, besides the fear or emotionalism associated to the mathematics field and whatever is derived from it. But what is anxiety?

feeling of tension and anxiety that interferes with the manipulation of numbers and solving of mathematics problems in a wide variety of daily and academic situations as well.

The factors for low performance of the students in mathematics has been the object of study in many researches, that is the reason why we take the seed works of Fenneman y Sherman (1976), who point out that the affective variables, including attitudes, have an impact not only on the effort that the student is willing to do in order to achieve a mathematical learning, but also determine the subject's motivation when choosing his or her professional studies. This instrument has been chosen duet to the fact it is a reference when measuring attitudes towards mathematics.

About this scale, there are numerous research works, which have made use of it, as an example: (Pérez-Tyteca, 2007; Leedy, LaLonde and Punk, 2003; Martin, 2002; Kloosterman and Stage, 1992). Also considered a seed work, are the studies made by Auzmendi (1992), who designed a scale that seeks measuring anxiety, trust, usefulness, liking and motivation towards that subject. There are other studies like those of Cervini (2001), who emphasizes that during the last two decades, the amount of researches on the factors that influence students' academic performance has extended notably.

After having set the phenomena of the study in its theoretical and empiric reality, it is confirmed the question on: Is there a difference in the level of anxiety towards mathematics at the different educational levels? Its objective is: Determining if there is a difference between the students of the different educational levels and anxiety towards mathematics.

3. Methodology

The study is no experimental trans- sectional, of median differences between groups, because it is of interest for this research, analyzing the difference and statistical significance between five dependant variables based in a cluster of categorical variables that act as predictors (Hair, 1999). It is transversal considering that data obtaining is given only once during a determined time.

For this research's purposes the sample is not probabilistic because the selection of the elements does not depend of the probability, but of causes related with the research's characteristics (Hernández, Fernández, Baptista 2010). The study sample was conformed by 226 students from different educational levels: basic, junior high school, high school and higher education from Tuxtepec, Oaxaca. The research makes use of the questionnaire designed by Muñoz and Mato (2007), which includes five factors: anxiety towards evaluation, anxiety towards temporality, anxiety towards comprehension of mathematics problems, anxiety towards numbers and mathematics calculations and anxiety towards daily life mathematics situations (Table 1).

Table 1. Dimensions of anxiety towards mathematics

KEY	DIMMENSION	ITEMS
Y_1	Anxiety towards evaluation	1, 2, 8, 10, 11, 14, 15, 18, 20, 22, 23
Y_2	Anxiety towards temporality	4, 6, 7, 12
Y_3	Anxiety towards comprehension of mathematics problems	5, 17, 19
Y_4	Anxiety towards numbers and calculations	3, 13, 16
Y_5	Anxiety towards daily life mathematics situations.	9, 21, 24

Cronbach Alfa Reliability Quotient was used, which itself is not a statistical proof, but a way to test the reliability of the instrument and data collection, in order to validate the stability and consistency of the measurements.

This reliability or internal consistency coefficient takes values between 0 and 1. Table 2 shows that all the variables have values higher than 0.5. For data processing it was used the SPSS v23 Program.

Table 2. Reliability Statistics

Variable	Cronbach Alfa
Y_1	0.803
Y_2	0.838
Y_3	0.700
Y_4	0.710
Y_5	0.745
X	0.810

Hypothesis

There is a difference at the anxiety level towards mathematics between the students of different educational levels. The hypothesis representation is as follows:

$$H_0 = \sigma_1^2 = \sigma_2^2 = \sigma_3^2 = \sigma_4^2$$

$$H_1 = \sigma_i^2 \neq \sigma_j^2 \text{ for some } i \neq j$$

The conceptual model is represented in Figure 1.

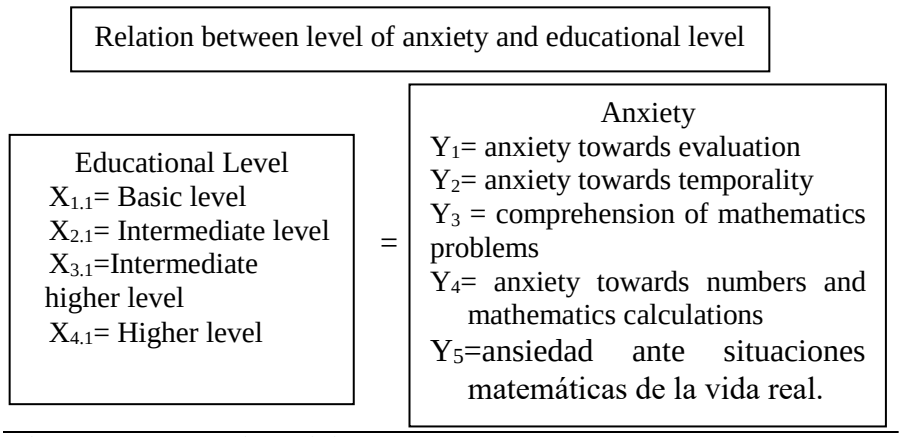

Fig. 1. Conceptual Model

Findings

In first place, the independent variables are described, their levels, including the values labels and number of cases at each group.

Table 3. Level of studies

Grade	Value label	N
1	Primary	23
2	Secondary	64
3	High school	63
4	Professional	76

Afterwards, at table 4, descriptive statistics of the variables anxiety towards mathematics and the level of studies of the students that were object of this research, are shown.

At table 4, it is observed that there is variability between the total medians of each variable that conforms the anxiety construct. It can be seen that there is a variation between the variables anxiety towards temporality (Y_2) and anxiety towards numbers and mathematics calculations (Y_4) referring to level of studies; whereas between the variable comprehension of mathematics problems (Y_3) and anxiety towards numbers and mathematics calculations (Y_4) there is not a big variation related to the level of studies. The difference between the medians is showing that depending on the student's level of studies is the level of anxiety towards mathematics.

Table 4. Anxiety towards mathematic and level of studies

Grade		Y_1		Y_2	
	N	Median	σ	Median	σ
Primary	23	4.8241	.59338	2.2075	.30841
Secondary	64	5.9986	.74604	2.6236	.31233
High school	63	5.7062	.73695	2.5329	.31576
Professional	76	5.6235	.66897	2.4553	.29211
Total	226	5.6714	.77075	2.4994	.32650
Grade		Y_3		Y_4	
	N	Median	σ	Median	σ
Primary	23	7.0435	2.61948	7.1304	2.76840
Secondary	64	10.2969	2.79273	10.5313	2.70196
High school	63	10.0000	2.60892	9.7937	2.81218
Professional	76	8.9474	2.65779	9.3289	2.52131
Total	226	9.4292	2.83734	9.5752	2.82782
Grade		Y_3			
	N	Median	σ		
Primary	23	6.5652	2.62551		
Secondary	64	9.2969	3.74454		
High school	63	8.8889	3.18824		
Professional	76	8.6184	3.22890		
Total	226	8.6770	3.38455		

Information for the diagnosis at the MANOVA

Hair (1999), points out the importance of the conditionals that MANOVA must accomplish in order that their procedures can be valid. The author mentions that three rules must be accomplished: 1) The observations must be independent, 2) variance and co- variance matrixes must be equal for all the groups and 3) the cluster of the p independent variables must follow a normal distribution. At table 5 it is shown the variance and co- variance matrix and the correlations (indicated between parentheses) of the variables that permit to verify that there is not dependence between them, this is, it proves the assumption of independence since all of them are positive and none has a very close value to one.

Table 5. Homogeneity Contrasts

	Group 1 Primary				
	X_1	X_2	X_3	X_4	X_5
X_1	**.352**	(.695)	(.709)	(.711)	(.492)
		.127	1.103	1.169	.766
X_2		**.095**	(.826)	(.712)	(.557)
			.667	.608	.451
X_3			**6.862**	(.639)	(.783)
				4.630	5.383
X_4				**7.664**	(.433)
					3.150
X_5					**6.893**

Table 5. Homogeneity Contrasts (cont.)

	Group 2 Secondary				
	X_1	X_2	X_3	X_4	X_5
X_1	**.557**	(.888)	(.787)	(.815)	(.601)
		.207	1.641	1.642	1.678
X_2		**.098**	(.791)	(.731)	(.631)
			.690	.616	.738
X_3			**7.799**	(.772)	(.755)
				5.824	7.895
X_4				**7.301**	(.747)
					7.554
X_5					**14.022**

In relation to the second assumption of equality of the matrixes of covariance between the groups, table 5 shows that the matrixes of covariance of the variables of this research are equal. This assumption is proved with the test statistic M of Box (table 4), its value (0.009) indicates that the matrixes of variance – covariance are equal for all the groups.

Table 5. Homogeneity Contrasts (cont.)

	Group 3 High school				
	X_1	X_2	X_3	X_4	X_5
X_1	**.543**	(.812)	(.684)	(.696)	(.651)
		.189	1.315	1.442	1.530
X_2		**.100**	(.710)	(.698)	(.717)
			.585	.620	.722
X_3			6.806	(.739)	(.758)
				5.419	6.306
X_4				**7.908**	(.652)
					5.848
X_5					**10.165**

Table 5. Homogeneity Contrasts (cont.)

	Group 4 Professional				
	X_1	X_2	X_3	X_4	X_5
X_1	**.448**	(.747) .146	(.635) 1.129	(.584) .985	(.602) 1.300
X_2		**.085**	(.590) .458	(.436) .321	(.529) .499
X_3			**7.064**	(.619) 4.151	(.520) 4.460
X_4				**6.357**	(.587) 4.781
X_5					**10.426**

Once the basic assumptions have been proved, we proceeded to value the global adjustment, table 6 shows the findings of the interaction, the four criteria indicate that the effect of the interaction is meaningful; this means that the differences according to the level of study are different regarding to anxiety. The univariate contrasts confirm the findings, besides, the statistic power is 1.0.

Table 6. Homogeneity tests

Variable	Test of Levene		M of Box	
	F	Mean.	F	Mean.
X1	0.400	0.753		
X2	0.059	0.981		
X3	0.420	0.739		
X4	0.654	0.581		
X5	3.314	0.021		
Global			74.166	0.009

It can be concluded that the median vectors of the groups, this is, the variables, the anxiety towards mathematics, varies according the studies level.

Table 7. MANOVA's Summa

Contrast name	value	F	Between Groups	Within - Groups	Sig.
Pillai's Trace	.226	3.589	15.000	660.000	0.0
Wilks Lambda	.781	3.754	15.000	602.203	0.0
Hotelling's Trace	.270	3.904	15.000	650.000	0.0
Roy's Bigger Root	.229	10.076	5.000	220.000	0.0

MANOVA's test of statistical power

	Size Effect	Power
Pillai's Trace	.075	1.000
Wilks Lambda	.079	0.999
Hotelling's Trace	.083	1.000

F Test Univariate

Variable	Squares Addition	*gl*	Average Quadratic	F	Sig.
X_1	23.615	3 y 222	7.872	15.880	0.000
X_2	3.165	3 y 222	1.055	11.251	0.000
X_3	217.262	3 y 222	72.421	10.086	0.000
X_4	203.581	3 y 222	67.860	9.441	0.000

Table 7 shows in a summarized way (Turkey's method) the findings from the multiple comparisons, those groups whose measures do not differ between them are gathered at the same sub cluster and those groups whose measures differ, conform a different cluster. It can be seen that in the Primary group, anxiety towards evaluation differs from the groups of secondary, high school and professional (Sig= 0.057). In relation with anxiety towards temporality, it can be seen that there is a difference between the primary or basic school and the other three groups (secondary or junior high school, high school and professional), but also there is a difference between the groups of secondary and high school with the professional group, related to anxiety towards numbers and mathematic calculations.

About anxiety towards mathematics for real life situations, there is also a difference between the primary group and the other three groups.

Table 8. Turkey HSD

	Y_1		Y_2		
Grade	1	2	1	2	3
X_1	4.8241		2.2075		
X_2		5.6235		2.4553	
X_3		5.7062		2.5329	2.5329
X_4		5.9986			2.6236
Sig.	1.000	0.057	1.000	.622	.494

	Y_3		Y_4	
Grade	1	2	1	2
X_1	7.0435		7.1304	
X_2		8.9474		9.3289
X_3		10.0000		9.7937
X_4		10.2969		10.5313
Sig	1.000	.080	1.000	.145

Table 8. Turkey HS (cont.)

Grade	Y_5	
X_1	1	2
X_2	6.5652	
X_3		8.6184
X_4		8.8889
Sig		1.000

4. Conclusions

A MANOVA analysis was made for determining how the level of studies (grade) that the student is attending and anxiety towards mathematics vary. The findings allow seeing that anxiety towards mathematics is different depending on the level of studies, this is, there is a meaningful difference between the groups, besides, the practical significance indicates that anxiety towards evaluation is the one that contributes the most, to anxiety at students of secondary (junior high school), high school and professional. On the other hand, at the primary students there is not any kind of anxiety towards this subject.

Therefore, it is concluded that at Tuxtepec, Oaxaca, students suffer anxiety towards mathematics and consequently it is an element to be considered within the learning-teaching process. It can be inferred then, that if students were able to reduce their anxiety level, they would take more advantage, in theory and practice.

The contributions of this study provide to the enrichment of the theoretical model proposed by Muñoz and Mato (2007), besides, the findings of this study are consistent with the findings of Cardoso, Venegas and Cerecedo (2012), who proved that the subject is useful but complicated and generates anxiety and also with the findings delivered by Álvarez and Ruíz (2010).

In summary, our work supports the evidences of Al Mutawah1 (2014), that mention that at the students from basic level, there is not anxiety towards mathematics, but there is when they get to another level. This research also shows evidence supporting Kok's work (2015), which affirms that students from high school (pre undergraduate) show anxiety towards mathematics as well as those from Nuñez, Suarez and Bono (2013) who mention that anxiety at undergraduate students (professional level) increases students' performance.

One of this study's limitations lies in the sample's size, since it is convenient to carry out studies with bigger samples in order to clarify which of the factors is more recurrent. For future researches, it is recommended to conduct the studies specifically to other areas of social sciences at other higher education schools and at other states of the Mexican Republic.

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Instrument (English translation)
Test for measuring anxiety towards mathematics
Muñoz and Mato (2007)

Instructions: For each one of the following statements, mark the classification category that indicates most how you currently feel about that statement. Please respond to all the questions.

Degree / grade: _____ Man_____ Woman_____

Means nothing 1	A few times 2	Neutral 3	Most o the time 4	Always. A lot. 5

Item	1	2	3	4	5
1. Do I get nervous (a) when I think of the mathematics exam the day before?					
2. Do I feel nervous when they give me the questions for the mathematics exam?					
3. Do I get nervous when I open the mathematics book and I find a page full of problems?					
4. Do I feel nervous when I think of the mathematics exam when there is an hour before doing it?					
5. Do I feel nervous when I listen how other co-students solve a mathematics problem?					
6. Do I get nervous when I realize that the next year I will still have a mathematics course?					
7. Do I feel nervous when I think of the mathematics exam that I will take the next week?					
8. Do I get nervous when somebody looks at me when I am doing the mathematics homework?					

9. Do I feel nervous when I review the purchase receipt after having paid?					
10. Do I feel nervous when I get to study for a mathematics exam?					
11. Do mathematics exams get me nervous?					
12. Do I feel nervous when they assign me difficult problems to do at home and that I have to deliver done for the next session?					
13. Does it get me nervous doing mathematics calculations?					
14. Do I feel nervous when I have to explain a mathematics problem to the teacher?					
15. Do I get nervous when I am doing the final mathematics exam?					
16. Do I feel nervous when they give me a list of mathematics exercises?					
17. Do I feel nervous when I try to understand another co-student who is explaining a mathematics problem?					
18. Do I feel nervous when doing an mathematics evaluation exam?					
19. Do I feel nervous when I see/ listen my teacher explaining a mathematics problem?					
20. Do I feel nervous when I get the final grades of the mathematics exam?					
21. Do I feel nervous when I want to find out the change at the grocery store?					
22. Do I feel nervous when they give us a math problem and a co-student finishes it before me?					
23. Do I feel nervous when I have to explain a problem at the mathematics class?					
24. Do I feel nervous when I begin doing my homework?					