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Anxiety toward mathematics of undergraduate students of economics: the case of the Universidad Autonoma de San Luis Potosi in Mexico

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Resumen. Las matemáticas juegan un papel esencial en la economía porque muchas ideas, relaciones y definiciones se expresan en fórmulas. Sin embargo, los estudiantes de economía son, con frecuencia, reacios a estudiarlo, lo que afecta su aprendizaje. Esta resistencia podría deberse a la falta de habilidad del maestro, al interés insuficiente del alumno o simplemente al miedo. El objetivo de esta investigación es evaluar la ansiedad hacia las matemáticas de los estudiantes de la Facultad de Economía de la Universidad Autónoma de San Luis Potosí (UASLP) en México. Este estudio es no experimental, transversal y factorial exploratorio. La muestra incluye a los estudiantes universitarios que se especializan en economía en UASLP que estaban tomando cursos de matemáticas en 2015. Auzmendi (1992) se les administra un cuestionario sobre ansiedad y actitud hacia las matemáticas. El principal hallazgo empírico es que los estudiantes de economía en UASLP desarrollan ansiedad hacia las matemáticas.

Palabras clave: ansiedad, modelado estadístico, posgrado, matemáticas, México.
Clasificación JEL: A22, C51.

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Ansiedad hacia las matemáticas de los estudiantes de licenciatura en economía: el caso de laUniversidad Autónoma de San Luis Potosí en México

Abstract. Mathematics plays an essential role in economics because many ideas, relationships and definitions are expressed in formulas. However, students of economics are, frequently, reluctant to study it, which affects their learning. This resistance could be due to the teacher's lack of ability, not enough interest of the student, or simply fear. The aim of this research is to assess anxiety toward the mathematics of the students of the Faculty of Economics at the Universidad Autonoma de San Luis Potosi (UASLP) in Mexico. This study is non-experimental, cross-sectional and exploratory factorial. The sample comprises the college students majoring in economics at UASLP that were taking math courses in 2015. Auzmendi's (1992) questionnaire on anxiety and attitude toward mathematics is administered to them. The main empirical finding is that students of economics at UASLP do develop anxiety toward mathematics.

Keywords: anxiety, statistical modeling, undergraduate, mathematics, Mexico.
JEL classification: A22, C51.

1. Introduction

Education policy-making entities in many countries are focused on transferring skills to young people so they can develop their full potential and be proficient on solving emerging problems in decision-making endeavors. In this context, using mathematics becomes essential in many activities and disciplines. In economics, mathematics plays an important role since the number of topics expressed in mathematical terms has been increasing. Particularly, for many higher-education institutions linked to neoclassical orthodoxy the proportion of such topics is very high. Also, advances in information technologies now make possible to include optimization techniques and statistical methods in most economics

programs. Thus, teaching economics concepts through mathematical language has become essential in theoretical and practical economics.

In Mexico, a large percentage of higher-education students underachieve in mathematics. Several authors, such as De la Peña (2002), Velázquez (2008), Sosa (2009) and Gómez (2009) have shown the current state in students' performance in mathematics. Specifically, De la Peña (2002) found that at least 40.5% of the students of the Universidad Nacional Autonoma de México (UNAM) perform below expectations inmathematics; Velázquez (2008) points out that 76% of the students from the Business Management Faculty of Universidad Autonoma de Chihuahua lack of the skills to solve mathematical problems; Sosa (2009) found 90% of the students of the Faculty of Accounting and Business of the Universidad Autonoma de San Luis Potosi (UASLP) show deficit on basic knowledge of mathematics; and, finally, Gómez (2009) exposed that a large part of students at the Universidad Veracruzana at Campus Coatzacoalcos show severe deficiencies in this field.

Moreover, González (2000) shows that students' attitude determines their willingness to learn, which influences their behavior. Also, Caballero and Blanco (2007) pointed out that attitude could be related to deficient learning of mathematics; affective and emotional factors influence learning. Regarding attitude and ability in Mathematics, the National Council of Teachers of Mathematics (NCTM) of the United States of America (2004) recognizes two categories: attitudes toward mathematics and mathematics skills. The former is more influenced by the affective component and the latter by the cognitive one. Based on these ideas, Auzmendi (1992) proposed a series of factors (usefulness, likeness, anxiety, motivation, and confidence) for measuring the attitude toward mathematics. From this model emerges the main question of this research: Is there a set of variables that ascertain attitudes toward mathematics of students of the Faculty of Economics of the Universidad Autonoma de San Luis Potosi (UASLP)? Hence, to answer this question, this research objective is to identify the attitude of the students of the Faculty of Economics of the UASLP toward mathematics and, thus, to have a broader panorama that allows teachers to generate more efficient strategies focused on learning. This research aims to get information that helps in guiding both teachers and students to a better teaching and

learning of mathematics in economics, as well as to give skills and tools to the student for his better academic and professional performance, as proposed by Gil *et al.* (2005), and Cardoso *et al.* (2012).

This investigation starts with presenting a short review of the specialized literature on students' attitude toward mathematics; section 2 depicts the theoretical framework for measuring up attitude and anxiety in mathematics; section 3 describes the statistical method, the sample and the instrument applied for the factor analysis; section 4 provides presents the results; and, finally section 5 offers conclusions highlighting the limitations of this research.

2. A short review of literature

Although mathematics has great importance in preparing students as future professionals, they consider that these courses are the most difficult; therefore, they are sometimes afraid of this discipline and, as consequence, have difficulty in learning new concepts (Aliasgar *et al*. 2010). This unfavorable position leads to a state of anxiety, sometimes high, which hinders learning (Stubblefield, 2006, and Kargara *et al*. 2010). Sherman and Wither (2003) conceptualize the term anxiety as a state of anguish that diminishes mathematical reasoning, performance and attitudes in the students, and leads them to avoid or not choose courses with mathematical content. Among the main causes of anxiety toward mathematics are low self-esteem and fear of failure, which diminishes the student's ability to process the information received and, therefore, the student hinders himself to solve problems related to Mathematics. Other studies have revealed a significant relationship among mathematical reasoning, mathematical anxiety and mathematical attitudes, and have shown that students with a positive attitude toward this discipline are more motivated and engaged in their classes, as well as understand the material more easily, unlike students who maintain an adverse position (Scarpello, 2005).

The performance in mathematical skills is focused on knowledge, procedural ability, attitude and meta-cognitive dimension. Additionally, it is considered the social and psychological dimension of mathematical competences and their corresponding teaching. Table 1 shows some studies regarding this subject and the different proposed approaches.

TABLE 1
Approaches to mathematics per different authors

Author	Year	Research Focus	Implications
Pólya	1945	The determination to face failure and the willingness to continue with the task influence the ability to solve mathematical problems.	Attitudinal factors influence the ability to solve mathematical problems.
Schoenfeld	1985	Use of heuristic strategies, the nature of mathematical thinking, the beliefs of students, and the relevance of meta-cognitive strategies in problem solving.	Methods and ways of dealing with mathematics determine the relevance of resolution strategies.
Carpenter and Fennema	1992	Beliefs such as teachers' attitudes toward mathematics influence the achievement of their students.	The focus on how math is taught influences student achievement.
Gravemeijer and Doorman	1999	Relevance of considering real or realistic situations that encourage students to construct mathematical models.	Educational conditions affect the ability of students to build models.
Lesh, and Zawojewski	2007	Mathematical anxiety in pre-college grades is apparent in most study subjects; however, 27% of them develop their first stress situation in math in their first year of college.	Anxiety about mathematics increases at the university level.
Jackson and Leffingwell	1999		
Evans	2000	There is a clear relationship between feelings (attitudes) of the person and results that he obtains in Mathematics. This relation is called "mathematical anxiety" or "anxiety toward Mathematics".	Toward mathematics are linked to Attitudes manifest anxiety about them.
Hancock	2001	The university students perform less well as more evaluation conditions in the classroom abound; although students with anxiety are more adversely affected.	Anxiety about math is associated with assessment conditions.
Perry	2004	The anxiety among university students, especially in evaluative situations, is the most common. Defines different types of mathematical anxiety in university students: moderate and variant mathematical anxiety.	The anxiety about mathematics in university students has different manifestations.

Source: Perry (2004).

The observations presented in Table 1 highlight that there are diverse approaches for explaining the relation of mathematics with various factors affecting student performance in mathematics. Regarding the theory of mathematical anxiety, Fennema and Sherman (1978) considered mathematical anxiety as part of the attitude, and mathematical anxiety is a subconstruct within the attitude toward mathematics. These authors showed that mathematical anxiety develops with "a feeling of anxiety, terror, nervousness and associated physical symptoms that arise when performing mathematical tasks". In their empirical research, they point out that students who are less anxious about mathematics also had a more favorable attitude toward it. Finally, these authors indicate that a student's disposition toward mathematical learning is not enough for succeeding, since their abilities to pursue logical procedures must be considered as well. In the same vein, Cardoso *et al*. (2012) elucidate that anxiety toward mathematics is the behavior that manifests in students who live in dread of making mistakes, decreasing the degree of attention, which originates inconclusive reasoning.

Motivation is defined as the behavior of a person directed to a preferred activity. The linking toward mathematics refers to the happiness degree of a student with the study of such tasks. (Mandler, 1989; Santrock, 2010; and Alvarez and Ruiz, 2010). Confidence refers to a person's firm assurance or hope of an object or himself in a given situation, and usefulness is the value an individual assigns to an object (the value a student gives to mathematics).

To examine the attitude toward mathematics, this research is based upon the theory of Weiner (1985), which is useful to explain behavior in various anxiety situations. This theory explains that an overall positive or negative reaction occurs depending on how success or failure is perceived, and a series of different emotions arise (pride, hopelessness, guilt, anger, self-esteem, trust, motivation). In addition, this work is also based on the model proposed by Auzmendi (1992) which allows evaluating the emotions that Wiener (1985) pointed out in his theory. Auzmendi (1992) propose a structure of five constructs that allow measuring the attitude toward statistics: a construct for the cognitive component concerning usefulness, and four of the elements that measure the affective part (anxiety, confidence, likeness and motivation). This model is shown in figure 1. In this regard, it is also important to mention the work from García-Santillan

et al. (2013a) and (2013b), and Escalera-Chávez *et al*. (2013), (2014) and (2016) regarding anxiety toward statistics.

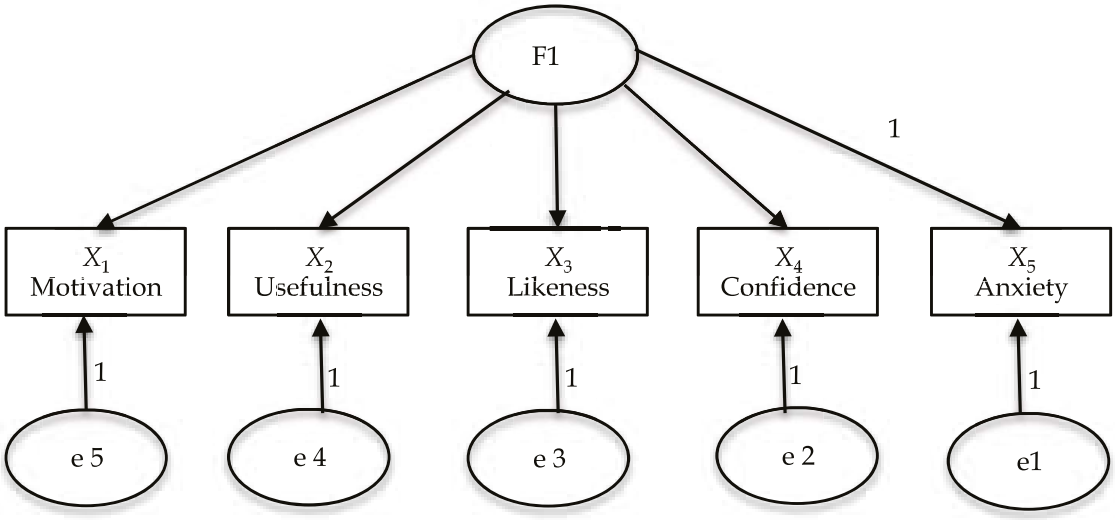


FIGURE 1
Auzmendi's model (1992)

3. PROPOSED STATISTICAL METHOD

This study is non-experimental, cross-sectional and exploratory factorial since the interest in this research is to analyze the correlation among a group of variables and explain them in terms of their dimensions (Hair, 1999). It is a cross-sectional study because the data is obtained once in a determined time window.

For the purposes of this research, the sample is non-probabilistic because the choice of elements does not depend on probability, but on causes related to the characteristics of the investigation (Hernández *et al*. 2010). The sample of this study consists of 175 students from the UASLP Faculty of Economics of the bachelor's degree in economics in the first half of 2015 that were taking math classes and were willing to answer the survey.

The criteria for student selection included students that had completed at least one subject in the curriculum of mathematical courses from the economics undergraduate at UASLP that were available at the school and

consented to take the survey. Motivation (items 5, 10, 15, 20 and 25), anxiety (items 2, 7, 12, 17 and 22), likeness (items 4, 9, 14: the Auzmendi (1992) questionnaire consisting of five factors used, 19 and 24), confidence (items 3, 8, 13, 18 and 23) and usefulness (items 1, 6, 11, 20 and 21). The scale range is measured from 1 (low) to 5 (very high). SPSS v22 software was used for data processing. Table 2 describes each of the indicators, concept and codification used.

Table 2
Description and coding of the constructs

Item	Conceptualization	Coding
Motivation	The attitude the student presents toward solving a situation that involves the use of mathematics	X_1
Usefulness	It is the value that the student gives to mathematics, as well as the usefulness that he perceives that math has in his future professional life.	X_2
Likeness	It refers to the fear or liking that the student expresses toward the mathematics subject	X_3
Confidence	The notion of confidence in the student that lead to the accomplishment of a mathematical task.	X_4
Anxiety	Refers to the feeling of anxiety; fear that the student manifests toward the subject of mathematics.	X_5

Source: own elaboration.

4. Empirical results

First, the correlation matrix was calculated for this group of variables (table 2) to determine whether factor analysis is viable to apply. Table 3 shows that out of the 10 variables, 8 are significant (at 90%), indicating that it is an adequate basis for the following empirical analysis.

TABLE 3
Correlations matrix

Variables	X_1	X_2	X_3	X_4	X_5
X_1	1	0.452**	0.450**	0.267*	0.378**
X_2		1	0.167	0.485**	0.588**
X_3			1	0.521**	0.489**
X_4				1	0.629**
X_5					1

Source: own elaboration.

The correlation matrix was contrasted with the Bartlett test. The values of c^2 (130.056) and its significance (sig. = 0.00) demonstrate that it is feasible to perform this technique (table 4).

TABLE 4
KMO and Bartlett tests

Kaiser-Meyer-olkin sampling adequacy measure		**0.647**
Bartlett sphericity test	Aprox. C^2	130.056
	Degrees of freedom	10
	Significance	0.000

Source: own elaboration.

Additionally, the Kaiser-Meyer-Olkin test of sampling adequacy was also contrasted. The value of this parameter (0.647) is within the acceptance range (0.50), and the values for each variable are higher than 0.5 as shown in table 5.

Table 5
Measure of sampling adequacy and partial correlations

Variable	X_1	X_2	X_3	X_4	X_5
X_1	0.603				
X_2		0.576			
X_3			0.558		
X_4				0.718	
X_5					0.759

Source: own elaboration

Table 6 shows the value of each variable allowing the identification of the students' perception of the study variables.

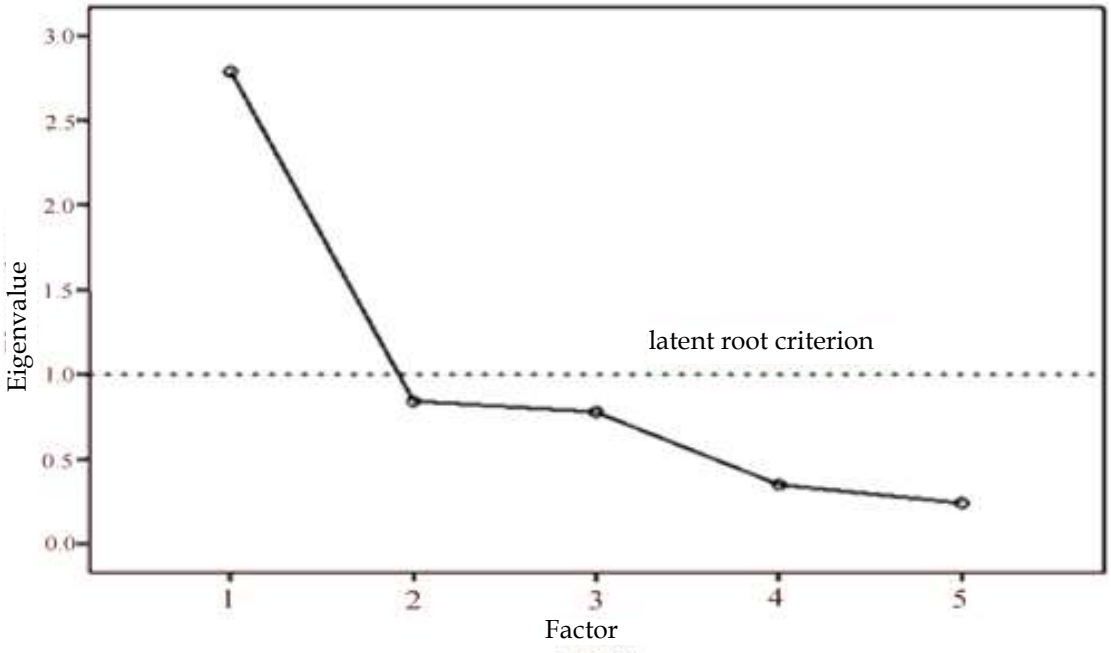
Table 6
Factorial loads, eigenvalue and variance

Variables	Factorial weights	Commonalities
X_5	.847	.717
X_4	.795	.632
X_2	.725	.525
X_3	.696	.484
X_1	.656	.430
Eigenvalue	2.789	
Total variance (%)	55.771	
Anxiety X_5, confidence X_4; usefulness X_2; likeness X_3; motivation X_1;		

Source: own elaboration

It is observed in table 6 that there is only one eigenvalue with a value greater than 1 for the latent root criterion, indicating that it is an appropriate factor to explain students' attitude toward mathematics.

Figure 2 shows the sedimentation graph and it is observed in contrast that there is only one appropriate factor to explain the studied scenario, which is composed by five variables according to their factorial weights and commonalities: anxiety X_5 (0.847 and 0.717); confidence X_4 (0.795 and 0.632); usefulness X_2 (0.725 and 0.525); likeness X_3 (0.696 and 0.484) and motivation X_1 (0.656 and 0.430). All this explain 55.77% of the variance; being the anxiety the variable of greater relative weight.



Source: own elaboration.

Figure 2
Sedimentation analysis

The results of this research confirm that the students of the Faculty of Economics at UASLP develop anxiety toward mathematics courses and perceive attitude as an element to consider within the teaching-learning practice. Based on the explained variance criterion, the factors that explain it make up 56% of the variance extracted, while the remaining 44% is explained by other factors not considered in this model.

5. Conclusions

The empirical findings of this study reinforces Auzmendi's (1992) theoretical model. In addition, the results are consistent with those from Cardoso *et al*. (2012) that exposed that the perception of mathematics is to be useful, but complicated, and therefore produces anxiety. The obtained results are also congruent with those provided by Alvarez and Ruiz (2010) where the difficulty is present in the student's learning process.

One limitation of this study lies in the sample size, as it is suggested to use a larger sample for identifying the most crucial and influential of the five constructs: usefulness, likeness, anxiety, motivation, and confidence. Likewise, this work can be extended to compare several schools offering undergraduate programs in economics, which include mathematics in their curriculum, to find out if significant differences exist among the levels of anxiety, confidence, usefulness, likeness, and motivation.

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