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STUDENT'S ATTITUDES TOWARDS PROBABILITY AND STATISTICS AND ACADEMIC ACHIEVEMENT ON HIGHER EDUCATION

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Abstract: A simple analysis of the learners' academic status at different levels of education shows that these learners have poor performance in probability and statistics subject and they have negative attitude to this subject. Therefore, the aim of this study is to investigate the relationship between the attitude and academic achievement of 134 students of three classes of a compulsory subject of the fourth period aimed at probabilistic and statistical content, at a federal university, in the state of São Paulo, Brazil, at the end of 2017. We used the Auzmendi Scale (1992) that considers attitudes towards mathematics and statistics, at the same time, being composed of five basic factors (utility, anxiety, trust, pleasure and motivation). Some of the results indicate that there is an indication that students lack confidence in solving statistical and probabilistic problems, noting that there is no great anxiety about Probability and Statistics, however, they do not feel confident about solving problems probabilistic and statistical. And they present initial motivation and this fact generates better results in the first evaluation of the discipline that deals with basic concepts of Combinatorial Analysis and Probability.

Keywords: attitudes, teaching of probability and statistics, higher education**.**

1. Introduction

The teaching-learning of probability and statistics increasingly occupies an important place in Higher Education institutions due to the current need of professionals trained in dealing with large amount of information, processed in minimum time, and with mastery of techniques of data analysis that support decision-making based on inference of sample data.

We believe that people forget what they do not use, but attitudes stick. And, considering that statistics coursework is perhaps the major contributor to a statistically literate society, students' attitudes toward statistics deserve special attention.

Statistics education research over the last decade has emphasized the need for reform in the teaching of statistics with a growing body of research in this area. An increasing number of scientific publications devoted to this topic indicates that statistics education is developing as a new and emerging discipline (Garfield & Ben-Zvi, 2008).

However, research on the teaching and learning of statistics remains disconnected, fragmented, and difficult to access (Zieffler, Garfield, Alt, Dupuis, Holleque, & Chang, 2008).

Students' attitudes and beliefs can impede (or assist) learning statistics and may affect the extent to which students will develop useful statistical thinking skills and apply what they have learned outside the classroom.

And also, Gal, Ginsburg and Schau (1997, p. 38), students' attitudes and beliefs regarding statistics deserve attention for three reasons: 1. their role in influencing the teaching/learning process; 2. their role in influencing students' statistical behavior after they leave the classroom; and 3. their role in influencing whether or not students will choose to enroll in a statistics course later on, beyond their first encounter with statistics.

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2. Theoretical background

We find different definitions of attitudes such as:

1) The sum of emotions and feelings experienced during the learning period of the subject or subject being studied (Gal and Garfield, 1997, 40).

2) Evaluative predisposition (positive or negative) that determines personal intentions and influences behavior "(Gómez-Chacón, 2000, p.23).

3) The ways of acting, feeling or thinking that show the disposition or the opinion of a person (Phillip, 2007).

Attitudes are usually stable, and can be graded according to their intensity, that is, being positive or negative, and sometimes expressing feelings attached to elements that are not strictly part of the subject.

These attitudes emerge early, and although they tend to be favorable at first, they may evolve negatively (Estrada, 2010). Initially, they were considered as a one-dimensional construct, but multidimensional models have been used by authors such as Gil (1999) or Gómez-Chacón (2000).

Carmona (2004) and Estrada, Batanero and Lancaster (2011) indicate that the origin of attitudes towards a subject comes from:

• Knowledge of the subject acquired in daily life;

• From previous learning expediencies;

• The connection that subject subjects make with others.

Measuring and assessing attitudes are fundamental to scientific research and educational practice, so there are major efforts to improve methodological approaches to setting up new and more accurate measurement instruments.

A privileged instrument is the measurement scale of attitudes, which serves to determine differences of degree or intensity in relation to an attitudinal object and to analyze its components.

Without forgetting the complementarity of other techniques (Martins, Nascimento, & Estrada, 2012), scales are more objective procedures. In our work, we will use a Likert Scale, which provides graduated scores for a series of statements.

Research participants should respond to each of them with a value (between 1 and 5) that qualifies their degree of agreement (1 = total disagreement up to 5 = total agreement). By adding the scores on all the questions in the scale, one gets the individual's attitude score. It is also possible to differentiate the scores by components or domains generated in the validation of the scale or to obtain the scoring distribution of a group of individuals.

For Estrada (2002) the evaluation of attitudes is a permanent theme in Education but is rarely approached in a systematic way as is also the case with attitudes towards Statistics.

Considering the attitudes towards probability and statistics, we present some scales of elaborated attitudes, as well as their components. Likewise, the characteristics of each scale were studied (for example, the type of subjects that are addressed or are attempting to measure the change or the stable attitude). These scales are:

1) Statistical Attitudes Inventory (SAS) (Roberts and Bilderback, 1980), aimed at university students (as future teachers). It is one-dimensional.

2) Statistical Attitudes Scale (ATS) (Wise, 1985) that measures attitude change in students. It has two distinct domains: attitudes toward the course they are pursuing and attitudes toward their future use.

3) Statistical Attitudes Scale (SATS) of Schau, Stevens, Dauphine and Del Vecchio, (1995) with four dimensions or components: affective competence, cognitive competence, value and difficulty and its later version (Schau, 2003).

4) Attitudes Scale in relation to Statistics (EAEE) (Estrada, 2002), specific to teachers, which considers

different didactic aspects of attitudes. It includes pedagogical components (affective, cognitive and behavioral) and anthropological (social, educational and instrumental).

In this work, we will use the Auzmendi Scale (1992) that considers attitudes towards mathematics and statistics, at the same time, being composed of five basic factors (utility, anxiety, trust, pleasure and motivation). The scale was taken from the original (in Spanish), translated and adapted to Portuguese considering the attitudes towards Probability and Statistics, the focus of the discipline that there is the interest to study.

All these scales are Likert with 5 or 7 degrees of response, being validated with university students or Basic Education and also presenting reliability. Moreover, none of them contemplate the attitude towards teaching the subject, which is one of our goals.

3. Materials and method

Objective and hypothesis

The aim of this study is to investigate the relationship between the attitude and academic achievement of students of a compulsory subject of the fourth period aimed at probabilistic and statistical content, at a federal university, in the state of São Paulo, Brazil, at the end of 2017.

The hypothesis we hold is that there will be a relationship between attitudes towards learning and academic performance and that students with more positive attitudes will obtain better grades.

Instrument

The questionnaire made by Auzmendi (1992) was used. It contains 25 items that can be answered with five options, as shown in Table 2.

It is supposed to measure 5 factors denominated: Utility (items 1, 6, 11, 20 and 21), Anxiety (2, 7, 12, 17 and 22), Trust (3, 8, 13, 18 and 23), Liking (4, 9, 14, 19 and 24) and Motivation (5, 10, 15, 20 and 25).

Participants

The questionnaire was administered to 134 students (men and women) out of a total of 274 students (48.91%) of three classes of a compulsory subject of the fourth period aimed at probabilistic and statistical content, at a federal university, in the state of São Paulo, Brazil, at the end of 2017.

It should be noted that the students were invited to participate, without having to participate in the research in question.

The ages ranged from 19 to 37 years. The mean age was 21.86 years and standard deviation was 2.98 years.

The subject aims to introduce the essential concepts of Probability theory and its implications in Statistics and is aimed at students in the area of Science and Technology, being that the curriculum intends to grant the opportunity to work and develop interdisciplinary themes, through a methodology that encourages the investigative stance, stimulates research and consequent scientific production, which provides the necessary means to trigger the process of continuous learning in the course of future academic and professional life.

Process

The questionnaire had the following instructions:

On the following pages there are a series of affirmations. These have been prepared in a way that allows you to indicate to what extent you agree or disagree with the ideas expressed therein. Suppose the statement is:

Example: I like Probability and Statistics

You must circle, according to your degree of agreement or disagreement with the corresponding statement, one of the following five numbers: (1) Totally Disagree; (2) Partially Disagree; (3) Neutral, neither agree nor disagree; (4) Partially Agree; (5) Totally agree.

Do not spend a lot of time with each statement but be sure to answer all statements. Work fast but with care. The answer to the questionnaire took place in the classroom where they receive class.

Statistical analysis

Factor analysis can identify variables representative of a much larger set of variables for use in subsequent multivariate analyzes or create a whole new set of variables to partially or completely replace the original set of variables for inclusion in subsequent techniques. In both cases, the purpose is to maintain the nature and character of the original variables, reducing their number to simplify the multiple analysis to be used later.

A factorial load represents the correlation between an original variable and its factor. When determining a level of significance to the interpretation of loads, a similar approach to determining the statistical significance of correlation coefficients can be used.

Table 1, which contains the sample sizes required for each factor load value, is considered significant. It is assumed that the values considered for constructing the table generate significance that are double the conventional correlation coefficients.

Table 1. *Guidelines for identification of significant factor loads based on sample size.*

Factor load	Required sample size for significance of 5%
0.30	350
0.35	250
0.40	200
0.45	150
0.50	120
0.55	100
0.60	85
0.65	70
0.70	60
0.75	50

Source: Hair, Tathan, Anderson and Black (2007).

Thus, 0.5 was adopted as the acceptable limit of the contribution of the variable in the creation of the factor in order to avoid the problem of the indetermination of the relation between variables and factors, considering that the sample refers to the number between 120 and 150 students.

In addition, still in its statistical component, this research employs the Kaiser-Meyer-Olkin test (KMO), defined as:

> (...) a statistic that indicates the proportion of the data variance that can be considered common to all variables, i.e., that can be attributed to a common factor, then: the closer to 1 (unit) the better the result, that is, the most appropriate is the sample to the application of the factorial analysis. The Bartlett sphericity test tests whether the correlation matrix is an identity matrix, which would indicate that there is no correlation between the data. Thus, we seek a level of significance assumed in 5% to reject the null hypothesis of identity correlation matrix (Oliveira Júnior and Morais, 2009, p. 585).

In all situations reported here, the samples were adequate for the application of factorial analysis (KMO> 0.5) and Bartlett with null hypothesis rejection.

We also perform the internal consistency analysis (Cronbach's alpha), which refers to calculating the correlation between each test item and the rest of the items or total (total score) of the items (Pasquali, 2001).

The IBM SPSS Statistics Base 22.0 was used in the preparation of the technical report.

4. Results and discussion

Table 2 presents the absolute and relative frequencies of the students' responses to each of the items of the Attitudes Scale towards to Probability and Statistics.

Table 2. *Distribution of the students' answers and the nature of the propositions, for each of the items of the Attitudes Scale towards to Probability and Statistics.*

n	Proposals	Nature (*)	Totally agree	Partially Agree e	Neutral, neither agree nor disagree	Partially Disagree	Totally Disagree
1	I regard Statistics and Probability as much-needed matters in my career.	P	69 (51. 5%)	46 (34.3%)	10 (7.5%)	7 (5.2%)	2 (1.5%)
2	Statistics and Probability issues leave me bad.	N	3 (2.2%)	10 (7.5%)	18 (13.4%)	34 (25.4%)	69 (51.5%)
3	Studying or working with Statistics and Probability does not scare me.	P	24 (17.9%)	47 (35.1%)	31 (23.1%)	27 (20.1%)	5 (3.7%)
4	Using elements of Statistics and Probability is fun for me.	P	6 (4.5%)	33 (24.6%)	43 (32.1%)	32 (23.9%)	20 (14.9%)
5	Statistics and Probability are too theoretical to be used in my professional practice.	N	5 (3.7%)	9 (6.7%)	25 (18.7%)	47 (35.1%)	48 (35.8%)
6	I want to have a deeper knowledge of Statistics and Probability.	P	32 (23.9%)	33 (24.6%)	36 (26.9%)	18 (13.4%)	15 (11.2%)
7	Statistics and Probability are topics that I'm afraid of the most.	N	1 (0.7%)	12 (9.0%)	14 (10.4%)	42 (31.3%)	65 (48.5%)
8	I have confidence in myself when I face statistical and probabilistic problems.	P	4 (3.0%)	39 (29.1%)	38 (28.4%)	41 (30.6%)	12 (9.0%)
9	I have fun talking to others about Statistics and Probability.	P	11 (8.2%)	24 (17.9%)	34 (25.4%)	39 (29.1%)	26 (19.4%)
10	Statistics and Probability may be useful to those involved in research but not to other professionals.	N	1 (0.7%)	2 (1.5%)	10 (7.5%)	39 (29.1%)	82 (61.2%)
11	Knowing how to use Statistics and Probability would increase my chances of working.	P	34 (25.4%)	51 (38.1%)	39 (29.1%)	6 (4.5%)	4 (3.0%)
12	When I come across a statistical or probabilistic problem, I cannot think clearly.	N	9 (6.7%)	30 (22.4%)	32 (23.9%)	56 (41.8%)	7 (5.2%)
13	I calm down when I am solving a statistical or probabilistic problem.	P	5 (3.7%)	29 (21.6%)	41 (30.6%)	48 (35.8%)	11 (8.2%)
14	The statistics and odds are nice and stimulating for me.	P	10 (7.5%)	34 (25.4%)	47 (35.1%)	32 (23.9%)	11 (8.2%)
15	I hope to use little statistical or probability in my professional life.	N	14 (10.4%)	29 (21.6%)	38 (28.4%)	37 (27.6%)	16 (11.9%)
16	For the professional development of my career, I believe there are other issues that are more important than Statistics and Probability.	N	43 (32.1%)	49 (36.6%)	29 (21.6%)	11 (8.2%)	2 (1.5%)

17	Working with Statistics and Probability makes me very nervous.	N	8 (6.0%)	17 (12.7%)	32 (23.9%)	37 (27.6%)	40 (29.9%)
18	I do not change my behavior when I have to work with statistics and probability problems.	P	31 (23.1%)	25 (18.7%)	42 (31.3%)	27 (20.1%)	9 (6.7%)
19	I would like to have a profession in which I would have to use Statistics and Probability.	P	8 (6.0%)	26 (19.4%)	44 (32.8%)	24 (17.9%)	32 (23.9%)
20	I have great satisfaction in solving statistical and probabilistic problems.	P	21 (15.7%)	36 (26.9%)	38 (28.4%)	29 (21.6%)	10 (7.5%)
21	For the professional development of my career, one of the most important subjects to be studied is Statistics and Probability.	P	6 (4.5%)	22 (16.4%)	37 (27.6)%	46 (34.3%)	23 (17.2%)
22	Carrying statistics makes me uncomfortable and nervous.	N	5 (3.7%)	17 (12.7%)	30 (22.4%)	45 (33.6%)	37 (27.6%)
23	If I worked, I think I would dominate the statistical and probabilistic contents.	P	66 (49.3%)	45 (33.6%)	12 (9.0%)	10 (7.5%)	1 (0.7%)
24	If I had the opportunity, I would enroll in other courses in Statistics and Probability.	P	27 (20.1%)	34 (25.4%)	32 (23.9%)	27 (20.1%)	14 (10.4%)
25	The subject that is taught in the Statistics and Probability class is very uninteresting.	N	3 (2.2%)	9 (6.7%)	14 (10.4%)	41 (30.6%)	67 (50.0%)

(*) P = positive nature proposition; (N) = negative nature proposition.

We used the exploratory factorial analysis (AFE) on the scale, with the intention of defining the factors that explain its covariance. It was configured to omit absolute factor loads lower than 0.50 according to Hair, Tathan, Anderson, and Black (2007) and was applied on the 25 items of the Scale, considering a sample of 134 students.

We obtained four factors and 20 items presented eigenvalues greater than one, accounting for 57,116% of the total variance, with the first factor accounting for 33.003% of it, indicating its dominance in the scale (Table 3 and Figure 1).

Table 3. *Eigenvalue, percentage of variance and cumulative variance of the factors found for the Attitudes Scale in relation to statistics.*

Factor	**Initial Own Values**		
	Eigenvalue	**% of variance**	**% cumulative**
1	8.251	33.003	33.003
2	3.415	13.662	46.665
3	1.438	5.754	52.418
4	1.174	4.697	57.116

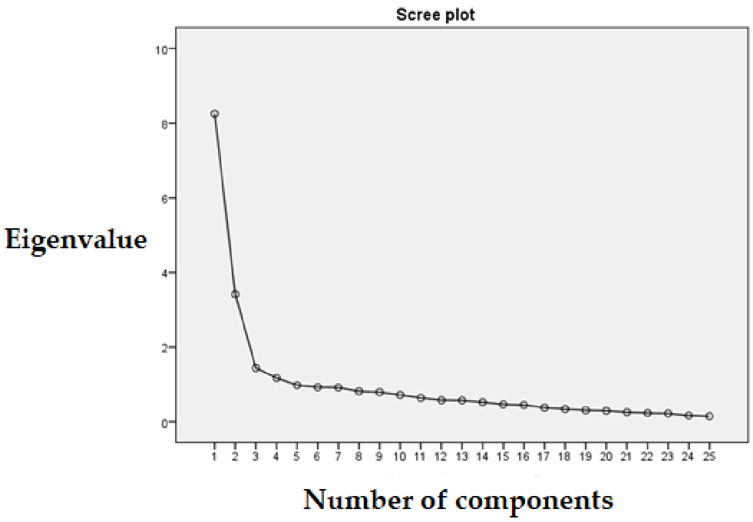

Figure 1. *Scree Plot of Factorial Analysis.*

When we applied the Kaiser-Meyer-Olkin (KMO) test we obtained the value of 0.877 of the 20 items of the scale, indicating that these significantly explain the attitudes of these students towards Probability and Statistics. This test indicates the adequacy of the factorial analysis, considering the proportion of the variance that can be attributed to a common factor. This value varies between 0 and 1 and the closer to 1 the result becomes better.

In addition, the KMO indicates the suitability of the sample size and values between 0.5 and 0.7 are considered "poor"; values between 0.7 and 0.8 are "good"; between 0.8 and 0.9 are "excellent"; and above 0.9 are "magnificent". Therefore, the appropriateness of the sample size is optimal to identify students' attitudes towards Probability and Statistics.

Bartlett's sphericity test tests the null hypothesis that the original correlation matrix is an identity matrix. A significant test (p less than 0.05) shows that the correlation matrix is not an identity matrix, and therefore, there are relations between the variables that are expected to be included in the analysis.

The values of the matrix of anti-image correlations showed low coefficients, indicating low level of partial correlations. The Bartlett test was highly significant [χ^2 (190) = 14114.499; p <0.001]; therefore, the factorial analysis is appropriate.

After conducting factorial analysis of main components and Varimax rotation with Kaiser normalization, we obtained four factors found for the Attitudes Scale towards Probability and Statistics that we call: Lack of Confidence, not Pleasure, Utility and Motivation. These four factors would be measured by the following items (Table 4).

Table 4. *Result of the factorial analysis on the items generating the scale.*

Scale Item	Description	Scale Domains			
		Lack of Confidence	not Pleasure	Utility	Motivation
2	Statistics and Probability issues leave me bad.	0.665	-	-	-
3	Studying or working with Statistics and Probability does not scare me.	0.530	-	-	-
7	Statistics and Probability are topics that I'm afraid of the most.	0.766	-	-	-
8	I have confidence in myself when I face statistical and probabilistic problems.	0.553	-	-	-

12	When I come across a statistical or probabilistic problem, I cannot think clearly.	0.689	-	-	-
13	I calm down when I am solving a statistical or probabilistic problem.	0.608	-	-	-
17	Working with Statistics and Probability makes me very nervous.	0.833	-	-	-
22	Carrying statistics makes me uncomfortable and nervous.	0.800	-	-	-
4	Using elements of Statistics and Probability is fun for me.	-	0.751	-	-
9	I have fun talking to others about Statistics and Probability.	-	0.794	-	-
14	The statistics and odds are nice and stimulating for me.	-	0.646	-	-
19	I would like to have a profession in which I would have to use Statistics and Probability.	-	0.574	-	-
20	I have great satisfaction in solving statistical and probabilistic problems.	-	0.700	-	-
1	I regard Statistics and Probability as much-needed matters in my career.	-	-	0.749	-
11	Knowing how to use Statistics and Probability would increase my chances of working.	-	-	0.738	-
15	I hope to use little statistical or probability in my professional life.	-	-	0.619	-
21	For the professional development of my career, one of the most important subjects to be studied is Statistics and Probability.	-	-	0.700	-
24	If I had the opportunity, I would enroll in other courses in Statistics and Probability.	-	-	0.558	-
6	I want to have a deeper knowledge of Statistics and Probability.	-	-	-	0.644
25	The subject that is taught in the Statistics and Probability class is very uninteresting.	-	-	-	0.757

The following is a detailed explanation of the identification of the four factors:

1. **Lack of Confidence when solving statistical and probabilistic problems**: related to the aspects of not having great anxiety in relation to Probability and Statistics, however, there is a perspective with the perception of lack of confidence in the capacity to execute before the problems of Probability and Statistics. Items: 2, 3, 7, 8, 12, 13, 17 and 22.

As can be seen, items such as: (1) 79.8% of students disagree that Statistics and Probability are topics that I fear the most; (2) 76.9% of students disagree that Statistics and Probability issues leave you bad; (3) 61.2% of students disagree that performing statistics makes them uncomfortable and nervous; and (4) 57.5% of students disagree that working with Statistics and Probability makes them very nervous; are the most representative items of the aspects of anxiety factors that students indicate as attitudes toward Probability and Statistics.

However, items such as: (1) Only 47.0% of students disagree that when they are faced with a statistical or probabilistic problem, they cannot think clearly; (2) Only 25.3% of students agree that they will be calm when solving statistical or probabilistic problems; and (3) Only 32.1% of students agree that they feel confident when solving statistical and probabilistic problems; indicate that students do not feel confident when solving statistical and probabilistic problems.

2. **It is not a pleasure to think about elements of Probability and Statistics**: it has negative connotations about satisfaction in dealing with Probability and Statistics issues. Items: 4, 9, 14, 19 and 20.

The items of this factor that most reflect this aspect are as follows: Only 26.1% of students agree that they have fun talking to others about Statistics and Probability, (2) Only 29.1% of students agree that use elements of Statistics and Probability are fun; and (3) Only 42.6% of students agree that they have great satisfaction in solving statistical and probabilistic problems.

3. **Use of Probability and Statistics in the labor market**: measures the productivity or benefits that Probability and Statistics can offer. Items: 1, 11, 15, 21 and 24.

The items of this factor that most reflect this aspect are the following: (1) 85.8% of students agree that Statistics and Probability are much needed subjects in their careers and (2) 63.5% of students agree that knowing how using Statistics and Probability would increase your chances in the job market.

4. **Motivation in working with Probability and Statistics in the classroom to the extent of its usefulness in the labor market**: it includes aspects of motivation for knowledge, but also related to aspect of utility. Items: 6 and 25.

The items that reflect this aspect are the following: 80.6% of the students disagree that the subject that is taught in the Statistics and Probability class is uninteresting and 75.4% of the students agree or are indifferent to the desire to have a knowledge of Statistics and Probability.

It is very important to be careful with the application of any instrument of data collection. In this scale, for example, we observe that it reliably reproduces the reality of the respondents. The use of Cronbach's alpha came to "express, by means of a factor, the degree of reliability of the answers resulting from a questionnaire" (Almeida, Santos, & Costa, 2010, p.2).

According to Nunnally (1978), at least 0.70 would be an acceptable reliability value. In this study, the reliability of the responses was 0.912, which confirms the high internal consistency of the instrument reduced by the factorial analysis.

As Pasquali points out (2003), when the number of items is small, which is the case of the fourth factor, this data should be relativized, since in this case the item under analysis substantially affects the total score in its favor.

The data contained in Table 5 show Cronbach's Alpha reliability values for those of the initial scale of 25 items, the reduced scale with 20 items and the four factors from the Factor Analysis.

Table 5. *Cronbach's Coefficient reliability of domains and items in the training sample.*

Items	α de Cronbach	Number of items
Full scale	0.907	25
Reduced scale	0.912	20
Lack of Confidence when solving statistical and probabilistic problems	0.892	8
It is not pleasant to think about elements of Probability and Statistics	0.858	5
Usefulness of Probability and Statistics in the labor market	0.793	5
Motivation in working with Probability and Statistics in the classroom to the extent of its usefulness in the labor market	0.489	2

In this study, the reliability coefficients confirm the internal consistency of the instrument.

The coefficients of validity are also coefficients of correlation (Pearson) between independent variables (students' performance in the Vestibular contest and the first three periods of the course) and a dependent variable (Student attitudes) called criterion, constituting the criterion variable, according to Cronbach (1970), the critical element of the validation process, since the criterion must be, first of all, relevant, that is, it must also be valid.

Table 6 presents the Pearson correlation coefficients among the four domains obtained in the factorial analysis.

Table 6. *Coefficient of Correlation between Different Domains.*

	Lack of Confidence when solving statistical and probabilistic problems	**It is not pleasant to think about elements of Probability and Statistics**	**Usefulness of Probabilit y and Statistics in the labor market**	**Motivation in working with Probability and Statistics in the classroom to the extent of its usefulness in the labor market**
Lack of Confidence when solving statistical and probabilistic problems	1.000	0.596**	0.324**	0.336**
It is not pleasant to think about elements of Probability and Statistics	0.463**	1.000	0.628**	0.473**
Usefulness of Probability and Statistics in the labor market	0.324**	0.628**	1.000	0.504**
Motivation in working with Probability and Statistics in the classroom to the extent of its usefulness in the labor market	0.336**	0.473**	0.504**	1.000

** Significant correlation at the 0.01 level (bilateral test).

The analysis of the data contained in Table 5 shows a statistically significant correlation between all domains ($p < 0.01$) indicating that the positive correlations identified suggest that all domains of the scale go in the same direction, which reinforces the idea that the whole defines a scale.

Next, we will use statistics that describe the relationship between the assessments applied to the students during the course and the total points obtained in the attitudes scale and also the total points of each of the domains or factors generated in the scale that evaluate the attitudes of the students. undergraduate students in Mathematics in relation to Probability and Statistics.

Therefore, we will use the Pearson correlation coefficient or objective indices of the degree to which the variables of an instrument are associated to the variables in another instrument.

The Pearson correlation coefficient can vary in terms of value from -1 to +1, that is, the higher the absolute value of the coefficient, the stronger the relationship between the variables.

In addition, the sign of each coefficient indicates the direction of the relationship. If both variables tend to increase or decrease together, the coefficient is positive, but if one variable tends to increase as the others decrease, then the coefficient is negative.

Table 7 presents the Pearson correlation coefficients that determine the relationship between students' attitudes to Probability and Statistics and performance during the course of Basic Probability and Statistics content.

Table 7. *Correlation Coefficient of the reduced scale and the different domains and some factors that determine the students' achievement in Higher Education.*

Attitudes	**Number of Fouls**	**Assessment 1**	**Assessment 2**	**Activity Lists**	**Final Note**
Reduced scale that determines attitudes towards Probability and Statistics	-0.126	0.125	-0.072	-0.257**	0.002

Lack of Confidence when solving statistical and probabilistic problems	-0.203	0.130	0.059	-0.085	0.096
It is not pleasant to think about elements of Probability and Statistics	-0.054	0.144	-0.093	-0.238**	-0.007
Usefulness of Probability and Statistics in the labor market	0.038	0.001	-0.179	-0.328**	-0.145
Motivation in working with Probability and Statistics in the classroom to the extent of its usefulness in the labor market	-0.087	0.241*	-0.043	-0.220*	0.075

** Significant correlation at the 0.01 level (bilateral test).
* Significant correlation at the 0.05 level (bilateral test).

We highlight in Table 6 the statistically significant relationships when using the Pearson correlation coefficient, which are:

(1) The ratio of the final grade of the lists made during the course and the scale that determines the attitudes towards Probability and Statistics is -0.257 ($p < 0.01$), that is, it is a negative relation indicating that according to the note of the lists increases the score in the attitudes scale decreases, converging to a negative attitude regarding Probability and Statistics. This may indicate that students do not consider these lists to be beneficial to their learning.

(2) The relation of the final grade of the lists made during the course of the course and the factor "It is not pleasant to think about elements of Probability and Statistics" is -0.238 ($p < 0.01$), that is, it is a negative relation indicating that according to the note of the lists increases the score in this factor decreases, converging to a negative attitude regarding Probability and Statistics. This may indicate that students do not take pleasure in completing the lists.

(3) The ratio of the final grade of the lists carried out during the course of the course and the factor "Probability and Statistics Usefulness in the labor market" is -0.328 ($p < 0.01$), that is, it is a negative relation indicating which according to the note of the lists increases the score on this factor decreases, converging to a negative attitude regarding Probability and Statistics. This may indicate that students do not find it helpful to list.

(4) The ratio of the final grade of the lists made during the course of the course and the factor "Motivation in working with Probability and Statistics in the classroom according to its usefulness in the labor market" is -0.220 ($p < 0 , 05$), that is, it is a negative relation indicating that according to the note of the lists increases the score in this factor decreases, converging to a negative attitude regarding Probability and Statistics. This may indicate that students do not feel motivated to complete the lists.

(5) The ratio of the grade of the first evaluation of the subject and the factor "Motivation to work with Probability and Statistics in the classroom according to its usefulness in the labor market" is 0.241 ($p < 0.05$) that is, it is a positive relation indicating that according to the note of the first evaluation increases the score in this factor also increases, converging to a positive attitude regarding Probability and Statistics. This may indicate that students' initial motivation converges for better results.

5. Conclusions

In the process of evaluating the validity and reliability of the scale used, we consider an Exploratory Factor Analysis for the identification of conceptual domains and the elimination of questions that are unrelated to each other. It is observed, from the generated domains of the attitudes scale of students that study discipline related to elements of Probability and Statistics in Higher Education in relation to Probability and Statistics, the following:

1. Regarding Factor 1, there is an indication that students lack confidence in solving statistical and probabilistic problems, noting that there is no great anxiety about Probability and Statistics, however, they do not feel confident about solving problems probabilistic and statistical.

2. Regarding Factor 2, there is an indication that it is not pleasant for students to think about elements

of Probability and Statistics, that is, they present negative attitudes about satisfaction in dealing with subjects related to these contents.

3. Regarding Factor 3, there is an indication that students consider the usefulness of Probability and Statistics in the labor market, from the benefits that Probability and Statistics can offer.

4. Regarding Factor 4, there is an indication that students lack motivation to work with Probability and Statistics in the classroom as far as their usefulness in the labor market is concerned, but also related to the aspect of utility.

The study of attitudes not only makes sense in that it contributes to characterize better or more broadly the educational phenomenon, but also because its study contributes as an instrument that characterizes the effectiveness of the educational process itself regarding teaching of Probability and Statistics in Higher Education. In this way, the attitudes of the students who study a subject with probabilistic and statistical contents indicate the following aspects:

1. Students do not consider that the activity lists of the course contents that are carried out during the course bring benefits to their learning.

2. Students do not take pleasure in resolving the activity lists of the course contents that are carried out during the course.

3. Students do not consider it useful to solve the activity lists of the course contents that are carried out during the course.

4. Students do not feel motivated to solve the activity lists of the course contents that are carried out during the course.

5. The students present initial motivation and this fact generates better results in the first evaluation of the discipline that deals with basic concepts of Combinatorial Analysis and Probability.

The data show the importance of developing good attitudes towards university learning and call for educational actions by teachers to help students achieve this.

It is true that it is not just a matter of attitudes, it would be necessary to delve into the characteristics that accompany groups of students to complete their profile, at the level of strategies they use, learning approaches, self-concept, etc.

This, however, goes beyond the limits of this work and is a task to be addressed in further research.

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