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DO YOU WANT TO KNOW A SECRET: GLOBAL ANALYSIS AND COMPONENTS OF PORTUGUESE TEACHERS' ATTITUDES TOWARDS STATISTICS

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Abstract: To know the attitudes of teachers toward Statistics are recognized as a need in statistics teaching. Therefore, it's possible to better understand the teachers' predisposition and commitment to the teaching and learning processes and their long-life training. This study involved 1098 teachers of the 1st (ages 6-10) and 2nd (11-12) cycles of Portuguese basic education focused on measuring attitudes towards Statistics and their components using a tested scale with good psychometric characteristics, EAEE. In the EAEE scale application, the levels of validity and reliability were maintained, presenting general results compatible with other similar studies, and revealing a high internal consistency. The results allowed the evaluation of the global attitude towards statistics on the teachers of the 1st and 2nd CEB-cycle of basic education. Furthermore, attitudes towards Statistics were assessed regarding their pedagogical and anthropological components. The attitude towards statistics on the part of 1st cycle teachers and 2nd cycle mathematics teachers in Portugal is generally positive globally, and the analysis of its components was done and was in line with other researches.

Keywords: Scale, attitudes toward statistics, components analysis, reliability.

INTRODUCTION

The study of attitudes towards statistics is important, both for its influence on the educational process and for the training teachers' results that may arise from it. Students have strong and, in general, well-defined feelings about statistics even before they start their training. These feelings, positive or negative, influence learning in the same sense as Gal et al. (1997).

Teachers' experiences as students and professionals must be considered, shaping their attitudes that will later influence their students' attitudes and learning process (e.g., Estrada, Batanero & Lancaster, 2011). Emphasizing that in the school environment, the attitudes formed by the experiences lived by students from a very young age can last throughout their academic training to adults, as defended by Eagly and Chaiken (1993), and these students can become teachers. Sweeting (2011) considers that teacher-building attitudes are cyclical and present a cycle that relates the attitudes of teachers with their behaviors and methods used in the classroom, and these to the attitudes (positive or negative) of their students with consequences for their performance and motivation. For students who become teachers, it can influence their attitudes and, from there, start a new cycle. In this way, there are benefits associated with positive attitudes that may result in greater motivation, both of students and teachers, for the teaching and learning processes of mathematics and statistics and thus contribute to better knowledge and better education, both individually and socially.

This study focuses on attitudes towards Statistics of teachers of the 1st and 2nd cycle of Portuguese basic education using the "Escala de Actitudes hacia la Estadística de Estrada" (acronym EAEE, 2002) measurement and characterization. EAEE was already tested in sociological and educational conditions, not

very different, and with good psychometric characteristics. We intend to verify if these conditions are also maintained in the present Portuguese case and, in addition, to analyze their attitudes' components.

FRAMEWORK

It is important to value the attitudes of students and teachers, including those in the early years, to contribute to knowledge and better statistics teaching. This valorization also implies knowing measuring instruments appropriate to the context and allowing the identification of factors that intervene in constructing their attitudes. Also, it means knowing that this construction and the change processes associated with it are generally long and difficult to control due to the multidimensionality of the construct.

The definition of attitudes varies greatly, depending on the researchers, and in the context of the study of attitudes towards mathematics and statistics, the rule is no exception. Thus, despite the definitions of attitude by several authors (e.g., Auzmendi, 1992; Galet al., 1997; Gómez Chacón, 2000), in the specific scope of this investigation, we base ourselves on Philipp (2007). He defines attitudes as forms of act, feeling, or thinking that show the disposition or opinion of the person to something, as is the case, for example, in mathematics and statistics.

In the same line of thought, Estrada (2009) considers that attitudes towards the subject of study, such as Statistics, are quite stable, of various intensities and are expressed positively or negatively, and can sometimes represent feelings that are linked to external factors to the subject. For example, the teacher or the book. These attitudes are created very early in students and, despite initially tending to be favorable, they have a negative evolution that, as a rule, persists over time, according to some studies mentioned by this researcher.

In several studies, it is usual to consider attitudes as a multidimensional construct structured by components, such as statistics. There are several possible approaches, e.g., Wise (1985), Auzmendi (1992), and Schau (2003). This work will use the approach of attitudes towards statistics from Estrada (2002) with their components: pedagogical and anthropological. Attitudes are also considered a multidimensional concept, and the differentiation of dimensions in attitudes towards statistics is important. Estrada (2002) considered three basic factors, called pedagogical (or didactic) components:

- Cognitive component: which refers to the ways of expressing thought, conceptions, and beliefs concerning the object of the attitude (statistics), ranging from simple perceptual processes to more complex cognitive processes, including ideas, beliefs, images, and perceptions about the attitude object and have characteristics such as a fixed and stable character, different from mere opinion, singularity, referring to a single person, object or situation, and not always expressed consciously;
- Affective or emotional component: which is related to the ways of expressing the feeling to the object of attitude (the statistic), encompassing all the emotions and feelings that the statistic provokes, being positive or negative subjective reactions, of proximity or distance, of satisfaction or dissatisfaction, which reinforce the subject's relationship with the attitude object and which can contribute to consolidating the motivational power of attitudes;
- Behavioral or trend component: appears associated with actions to statistics (the object of attitudes), covering the behavior actions or

intentions that represent the tendency to decide in terms of action to the statistics in a concrete and determined way.

However, given the particular focus on teachers - in addition to the pedagogical components - Estrada's (2002) scale took into account the anthropological components:

- Social component: is related to the perception and appreciation of the statistics role in any citizen sociocultural context, and which appears as an alternative to the view of statistics as a type of knowledge isolated from culture or cultural values;
- Educational component: which is related to aspects related to the educational environment and encompasses the interest in statistics and their learning, the vision of its usefulness for the student, the opinion on the importance of its inclusion in the curriculum, and also the perceived difficulty to it;
- Instrumental component: refers to the attribution of the usefulness of statistics to other subjects as a form of reasoning and cultural components.

Following the various definitions of attitudes and the multidimensional structures attributed, several surveys have also emerged designed to measure attitudes towards statistics. However, they are mainly focused on the study of student attitudes. Several of the instruments for measuring attitudes towards statistics with greater use, acceptance, and projection in their research at an international level are referenced in reviews carried out by several authors (e.g., Silva et al., 1999; Estrada, 2009; Nolan et al., 2012). However, in this investigation, the Escala de Attitudes hacia la Estadística de Estrada – EAEE – of 2002 was applied, a scale created from scratch in Spanish and aimed explicitly at future teachers. According to Estrada (2002), this scale was constructed by combining the SAS, ATS, and EAEA scales. The building process resulted in a 25-item Likert scale, with 14 being affirmative and 11 negatives, with five options, ranging from 1-"totally disagree" to 5-"totally agree"). This scale was first applied to a sample of 74 prospective elementary education teachers undergoing training at the University of Lleida and 66 working teachers in the Catalan province of Lleida. In this application, this scale presented a Cronbach's alpha of 0.77 for reliability. Estrada (2002) also mentions that teachers' attitudes towards statistics can have effect by personal variables: such as gender, age, or personality, school variables, such as the academic performance they had as students, and previous studies in statistics (professional experience or specialty). Other variables, such as statistical training or professional knowledge, may influence professional aspects. Thus, studies on these attitudes are necessary to understand teachers' attitudes towards statistics. These studies will allow a better intervention and, in this way, enable to reinforce the teaching and learning processes of statistics,

This work's objective is to evaluate and characterize attitudes towards statistics of teachers of the 1st CEB (CEB, the Portuguese acronym, and their students' ages 6-10) and Mathematics teachers of the 2nd CEB (students aged 11-12) and the analysis of its components. The EAEE (Estrada, 2002) 's selected measurement instrument assesses teachers' global attitudes towards statistics. In a differentiated way, to evaluate the fundamental components of attitudes - pedagogical and anthropological. At the same time, the psychometric characteristics of the scale were studied.

METHODOLOGY

The technique used to obtain the necessary

information for the development of this work was the survey using an opinion questionnaire to measure teachers' attitudes towards statistics – EAEE scale (Estrada, 2002). The EAEE was developed for teachers in training or practice and was used in this work. The similarity between this investigation's specific social and school context and that of Estrada's (2002) research was also considered.

The Portuguese translation of this scale was submitted to a five experts panel opinion to ensure that the final translation was as faithful as possible to the spirit of the original scale, taking into account the specificities of the Portuguese social and educational context, as well as those of the Portuguese language. In addition to the translated EAEE scale (Martins, 2015), the questionnaire has a part for the personal (personal variables) and professional and academic characterization of teachers (school variables).

To establish the sample for the study, and for convenience, from among the 23 Boards of Pedagogical Zone (Portuguese acronym, QZP) existing at the time in Portugal, the QZPs of Coimbra, Guarda, and Vila Real. On the other hand, this choice aimed to cover regions of the interior and the coast, and urban and rural areas, with different dimensions. Initially, telephone or personal contact was made with directors of the 81 groupings of these QZPs. After obtaining the prior agreement of 64 directorates of the groupings of the three selected QZPs, data collection began. The sampling process was similar to random sampling by "clusters" (Cohen et al., 2011). In this sample of this study, only the choice of "curls" was not random,

The resulting sample is extensive, with 1098 questionnaires. This sample "comprises a sufficient variety of cases and approximately reproduces the population distributions, through the relative percentages of the essential criteria" (Martins, 2015, p.242). This reproduction of the distributions of essential population criteria was well achieved in this sample, according to the data provided by DGEEC (2012). Thus, the sample is expected to be representative according to the other variables (Ghiglione & Matalon, 2001). It should be noted that the ratio between the total number of teachers from the 2nd CEB in the area of Mathematics and Natural Sciences recruitment and the total number of teachers from the 1st public CEB in Portugal in the 2010/2011 academic year was 0.27. The same ratio of the participants in this study was 0.29, corresponding to a similar proportion to the total country values (Martins, 2015). Finally, 37 questionnaires (3.3% of the total number of questionnaires) were eliminated, those that did not have a score assigned to one or more items of the scale, and 1098 questionnaires were validated for analysis.

PROFILE OF RESPONDENTS

Of the respondents in this study, 79.6% are teachers, with average ages between 37.2 and 54.2 years, ranging from 23 to 68 years, and the teachers present an average age slightly higher than the teachers (38, 7, and 55.7 years old). In addition, 77.6% are teachers at the 1st CEB, with 82.4% women in this cycle and the average age of 46.3 ± 7.8 years, and the percentage of women in the 2nd CEB is lower (69.9 %) and also the mean age (42.8 years ± 9.5 years). The aging of the teaching staff, which was more pronounced in the 1st CEB, is still reflected in the length of service. The initial training is very diversified in both cycles, and most teachers, around 70%, carry out their initial training in the specific area of the Portugues cycle in which they teach. Only about 30% of the teachers in the sample carried out some academic training in addition to initial training, with those from the 1st CEB showing slightly higher proportions for the various types of post-university training. Overall,

in terms of qualifications, 83.5% indicate a Bachelor's degree and 9.7% a Doctorate/Master's degree, with the Bachelor's degree having only some expression in the teachers of the 1st CEB. Concerning statistical training in the 2nd CEB teachers, 87.4% obtained it in higher education. In comparison, only 30.5% of the 1st CEB teachers indicated that they did not have any training or had learned independently, 33% and 9%, respectively, in the 1st CEB and 2nd CEB. Finally, in terms of teaching Statistics, it should be noted that 37.2% of the teachers of the 1st CEB indicated that they had not taught Statistics yet,

RESULTS AND DISCUSSION

The analysis of the teachers' total scores was obtained both from global attitudes and their components. The connection between EAEE scale items and their components is presented in Table 1. Finally, the scale's reliability analysis will be based on the results.

GLOBAL AND COMPONENT ANALYSIS

The results of the global and components analysis are summarized in Table 2. It can be seen that averages are above the midpoint always, with positive variations between 8%, in the case of the Instrumental component and 26% for the Social component. In the global case (EAEE all items), the average of 87.97 (17% higher than the middle point, 75) has a difference of about 13 points, corresponding to 70% of the maximum possible. In summary, attitudes can be considered to be generally positive, both globally and by components. Regarding the dispersion, the values of the coefficient of variation (cv) are between 0.13 and 0.17, respectively, for the global case and the Instrumental component, with relatively small dispersions.

Reinforcing what was mentioned to extreme values, it can be observed (Figure 2)

that the minima were always higher than the minima possible. In terms of maximum values, it can be seen that the maximum possible was reached in the Affective, Cognitive, and Social components. The greatest relative distance was reached in the Behavioral component with -6%, which is also not very large and is, incidentally, very close to -5% of the global case.

Still, regarding the total score, it has a median of 88 points in the global case, which is above the value of an attitude of indifference, 75 points. The interquartile range is 17 points (between 79 and 96 points), for a minimum score of 46 and a maximum of 119. In summary, most teachers present total scores on the scale above the indifference value. The idea remains that teachers' attitudes towards statistics are generally positive.

The global results presented are in line with the values obtained by Estrada (2002), in which the mean was 88.8, and the mode was 91. However, in the study by Estrada (2002), in-service teachers present an average score total (91.32) higher than that of teachers still in training (85.38), with the average of the present study between these two averages. In the comparative study by Aparício et al. (2010), Spanish teachers' average was 83.9±7.2, Peruvian teachers' was 72.9±11.1, and Portuguese teachers' average in this study lies between these two, with a value of 79.6±12.3.

The pedagogical components: The Affective component had an average of 18% above the corresponding value to an indifference attitude (30 points), 35 as median, and an interquartile range of 8.25 points (between 31 and 39.25 points). In the Affective component, it is considered that teachers have ways of expressing feelings mostly positive towards statistics, encompassing all the positive emotions and feelings that statistics provoke.

In the Cognitive component, the mean

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Pedagogical Components	Anthropological components		
	Social	Educational	Instrumental
Affective	1, 17, 25	3, 9, 18	5, 16, 19, 23
Cognitive	6, 7, 10	11, 13, 21	2, 24
Behavioral	15, 22	8, 14, 20	4, 12

Figure 1 - Correspondence between the items and the components of the attitudes evaluated in the used version of the EAEE scale

Components		Punctuation Total	Minimum possible	Minimum	Maximum	Maximum possible	Average	Midpoint	SD	CV
Global		25	46	119	125	87.97	75	11.87	0.13	
Pedagogical	Affective	10	16	50	50	35.47	30	5.56	0.16
	Cognitive	8	16	40	40	29.27	24	4.08	0.14
	Behavioral	7	13	33	35	23.23	21	3.65	0.16
Anthropological	Social	8	15	40	40	30.33	24	4.27	0.14
	Educational	9	15	44	45	31.82	27	5.14	0.16
	Instrumental	8	10	39	40	25.82	24	4.39	0.17

Figure 2 - Statistical summary of the total score in global terms and by components of attitudes

	Punctuation Total	Component affective	Component cognitive	Component behavioral
Total Score	1.000	0.938	0.890	0.829
Affective Component	-	1.000	0.769	0.667
Cognitive Component	-	-	1.000	0.607
Behavioral Component	-	-	-	1.000

Figure 3 -Pearson's Correlations for the Pedagogical Components

	Punctuation Total	Component Social	Component educational	Component Instrumental
Total Score	1.000	0.820	0.901	0.851
Social Component	-	1.000	0.609	0.531
Educational Component	-	-	1.000	0.671
Instrumental Component	-	-	-	1.000

Figure 4 - Pearson correlations coefficients for the anthropological components

value is 22% above the value corresponding to an attitude of indifference-24 points, with an interquartile range of 5 points (between 27 and 32 points). Teachers present ways of expressing globally positive thoughts, conceptions, and beliefs concerning statistics.

Regarding the Behavioral component, the average is 11% above the value of an attitude of indifference (21 points) and the interquartile range of 5 points (between 21 and 26 points). Most teachers present total score values in this component higher than those for indifference, with moderately high values but less than in the other pedagogical components. In this Behavioral component, teachers have actions or behavioral intentions that represent the relatively positive tendency to act concerning statistics in a concrete way.

For the Anthropological components, the Social component presents an average of 26% above the value of an attitude of indifference (24 points), the highest percentage among all components. In addition, the interquartile range is 6 points (between 27 and 33 points). In the Social component, and in general, the teachers showed to perceive and value the role of statistics in the sociocultural context of every citizen, presenting an alternative view of statistics as a counterpoint to a type of knowledge isolated from culture or cultural values.

For the Educational component, the total score average was 18% above the value of an attitude of indifference (27 points), with an interquartile range of 8 points (between 28 and 36 points). The idea for the Educational component is that teachers have a globally positive attitude towards their interest in statistics and learning. Their global attitude is positive in viewing its usefulness for students, agreement with curriculum inclusion, and statistics is perceived as difficult.

For the Instrumental component, the total score averages 8% above the value of an attitude of indifference (24 points), the lowest percentage found in the various components. It has an interquartile range of 6 points (between 23 and 29 points). In summary, most teachers present moderately high total score values in this component, but less than in the other anthropological components. That is, the idea remains that in the scope of the Instrumental component, they present positive values for attributing the utility of Statistics to other subjects as a form of reasoning and as a cultural component, although in a less pronounced way than in the other anthropological components.

In comparative terms with Estrada's (2002) results, with the 25 items of the EAEE scale and with teachers in practice and training, there seem to be no numerical differences. In this study, the average scores are slightly higher than those of Spanish teachers in the Affective, Cognitive, Social, and Educational components, being lower in the Behavioral and Instrumental components. However, considering only the 22 items used in work by Aparício et al. (2010), including only in-service teachers, it appears that these results are, for all components, between the average score of Peruvian teachers (lowest) and the values of Spanish teachers (highest).

SCALE RELIABILITY ANALYSIS

At this point, the scale reliability analysis for the present sample will be carried out. In this case, the scale will only be reliable if it guarantees that the relationship between the teachers' attitude towards statistics and the responses to the scale items is strong.

One of the ways to analyze reliability is to use Cronbach's alpha, which is the most referenced in the literature on attitudes towards Statistics, varies between 0 and 1 and which, on the other hand, Hassad (2007, pp. 62-63) mentions that "the recommended minimum Cronbach's alpha for exploratory studies is

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0.6 (…)." For the EAEE scale with 25 items used in this investigation and for the sample of 1098 teachers from the 1st and 2nd cycles of EB in Portugal, the coefficient of internal consistency, Cronbach's alpha, obtained was 0.869. Therefore, it can be considered that there is a good internal consistency of the scale in this study. This value is also above the value obtained by Estrada (2002), 0.774, with teachers in training and practice. The value obtained by Aparício et al. (2010), with working teachers from Spain and Peru, was 0.84 (Spanish collective 0.75 and Peruvian collective 0.84). However, in the previous study, only 22 of the 25 items of the EAEE scale were used. In the Portuguese teachers' sample (1098 teachers), a Cronbach's alpha of 0.87 is slightly higher than the value for the scale with 25 items and the values obtained in the studies with 22 items.

RELATIONSHIP BETWEEN ATTITUDES AND THEIR COMPONENTS

The total scale score and the attitudes scale components score, the linear correlations between them, are analyzed, and the components score each other. It appears that the affective component is the one that, for the total score, presents a strong positive linear association with the highest correlation coefficient (R), 0.94 (Figure 3), which reinforces the importance attributed to the domain affective in terms of attitudes. However, the partial correlation coefficients for the Cognitive component (0.89) and the Behavioral component (0.83) scores are also high. This fact indicates that these components also influence the total score. As for the correlation of each other components' scores, there are correlation coefficient values between 0.77 (Affective and Cognitive components) and 0.61 (Cognitive and Behavioral components). All the correlations

were statistically significant (Martins, 2015), so it can be assumed that these components of attitudes influence each other while being different aspects of attitudes.

In the scores of the anthropological components (Figure 4) and the partial correlation coefficients, it appears that the educational component, concerning the total score, presents a strong positive linear association (0.90). This fact reflects educational aspects' importance and influence on attitudes towards statistics. Those aspects are statistics interest and learning, its usefulness for the student, opinion about the importance of its inclusion in the curriculum, and even the perceived difficulty in statistics (Martins, 2015).

The correlation coefficients for the scores of the Instrumental component (0.85) and the scores of the Social component (0.82) are also high, revealing the influence they have on the total score. These correlation values are slightly lower than those presented in the scores for the pedagogical components. Regarding the correlation of the components with each other, there are values for the correlation coefficients between 0.67 (Educational and Instrumental components) and 0.53 (Social and Instrumental components). In the scores of the anthropological components, all correlations were statistically significant (Martins, 2015), with the same meaning as before.

CONCLUSIONS

In the application carried out now, the EAEE scale maintained the levels of validity and reliability, presenting general results compatible with other similar studies and revealing a high internal consistency. The objective was fulfilled based on the results. They were the teachers of the 1st and 2nd CEB global attitude towards statistics evaluation. Furthermore, it was possible to assess their

attitudes towards Statistics in terms of their fundamental pedagogical components and anthropological components. The attitude towards statistics on the part of 1st CEB teachers and 2nd CEB mathematics teachers in Portugal is generally positive, both at the global and component levels.

The average components' and global scores are relatively high, above the EAEE scale's intermediate value between the minimum and maximum possible values and with low dispersions. These scores are higher than those obtained by Peruvian teachers and lower than those obtained by Spanish teachers. However, they were more positive than those revealed in several studies with students. In the attitudes components the positive ones are highlighted in the pedagogical components. In it, the cognitive component in which teachers generally express positive thoughts, conceptions, and beliefs concerning statistics. In the anthropological components, the social component is highlighted. In the social component, teachers' presented a view of statistics that are not isolated from the surrounding culture, perceiving and valuing the role of statistics for everyone. In less favorable terms, in the pedagogical components, the behavioral component. In it, teachers show moderate indications of action or intention to act by viewing statistics in a concrete and determined way that stands out. The anthropological components and the instrumental component is highlighted. For it, teachers do not attribute positive values to the personal utility of Statistics in other areas or as a form of reasoning or cultural element. Finally, the components scores show strong correlations with the total score. More evident in the pedagogical components than in the anthropological ones and moderate correlations between them. This relation indicates that they influence each other but still differentiate aspects of attitudes towards statistics. On the other hand,

Some of the implications of the presented results lead us to formulate general indications for the plans of initial teacher training and continuous training of teachers of the cycles covered by the study. Thus, in addition to greater training in Statistics for teachers, it is suggested that this should cover, in particular, the processes of sampling and creation of questionnaires, the methodology of polls, and inferential statistics, as this would increase critical capacity and interpretation in the face of statistical information. It also indicated a greater use in teaching practices of technical sheets of statistical studies and, especially, of information transmitted by the media (including TV news) to increase positive attitudes towards statistics in the areas, simultaneously affective and social. In addition, bringing everyday subjects into teaching practice will enhance students' and teachers' interest and involvement. It will increase awareness of statistics' importance, usefulness, and applicability. It is also concluded that it would be essential to find ways to counteract the negative view of Statistics at the behavioral and instrumental level that it is not or is not very daily usable. So, in those levels of Statistics training teachers, discovery and exploration of enthusiastic and exciting ways to explain statistics in classes, implicating the affective and educational levels, as has already been proposed by Martinset al. (2012, p. 37). Day-to-day case studies and projects should be used to emphasize the usability of statistics and its phases – the statistical view of the problem-solving approach – and cooperative work should be strengthened". Another proposal, in the behavioral and educational components area, is to stimulate and enhance the habits of collaborative work among Statistics teachers since it provides enrichment and professional knowledge, including explaining statistics

problems to your colleagues.

This investigation had limitations. Convenience sampling, although well described in descriptive terms. The option to study with teachers from the 1st CEB and Mathematics teachers from the 2nd CEB left out the mathematics teachers from the 3rd CEB. Based on the data from this study, it will also be possible to explore other relationships and interrelationships, highlighting a possible analysis of attitudes towards Statistics by the district.

In summary, the results contributed to integrating and strengthening a more integral and holistic view of attitudes and their importance in the teaching of Statistics, especially in the cycles covered by the study. On the other hand, this study continues research – in Spain and Peru – so it is interesting to maintain this international path. Together, it may be possible to expand the cross-cultural studies of attitudes towards Statistics for teachers in each country's early years of education.

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