

ATTITUDES OF TEACHERS TOWARDS STATISTICS: A PRELIMINARY STUDY WITH PORTUGUESE TEACHERS

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In this paper, we will discuss teachers' attitudes towards statistics, as we believe that these attitudes have a key role in the teaching and learning process. We will examine the attitude concept, review the literature regarding scales for the measurement of attitudes towards mathematics and statistics, and present and analyse some of the results of a questionnaire/scale applied to a sample of Portuguese teachers.

INTRODUCTION

This work is part of a preliminary study of the attitudes towards statistics of teachers from the second (ages 10 and 11) and third (ages 12 to 14) cycles of basic education in Portugal. It could be argued that without the full commitment of teachers to the teaching and learning process, it would be very difficult to implement any significant change in the ways in which statistics is taught. Nóvoa (1992, 30) stated that “the schools can not change without the participation of the teachers”. In addition, Gal and Ginsburg (1994, 1) wrote:

While statistics educators have focused on improving the cognitive side of instruction, i.e., the skills and knowledge that students are expected to develop, little regard has been given to non-cognitive issues such as students' feelings, attitudes, beliefs, interests, expectations, and motivations. (...) We believe that further attention to such factors is warranted, as they may contribute to students' difficulties in learning basic concepts in statistics and probability.

Therefore, it is necessary for this approach to include aspects such as attitudes, beliefs, interests, expectations and motivations which are associated with statistics, because teachers must go beyond the transmission of knowledge, and achieve positive attitudes, both in terms of the discipline and of its contents, and in relation to students, schools and education in general.

In this work, we will provide a brief summary of the current understanding of attitudes towards statistics and the Scale of Attitudes Towards Statistics (Escala de Actitudes hacia la Estadística de Estrada - EAEE) (Estrada, 2002). We will also begin to analyse the results of a survey of in-service Portuguese teachers in the second and

third cycles of basic education. The main purpose of this survey is to analyse Portuguese teachers' attitudes towards statistics.

ATTITUDES TOWARDS STATISTICS

Theoretical and empirical issues related to attitudes have received a great deal of attention over recent years, and different perspectives regarding what attitudes are have emerged. In conceptualising the affective domain in relation to mathematics education, McLeod (1992) distinguished between emotions, attitudes and beliefs and conceptualised attitudes as learned predispositions to respond positively or negatively to given objects, situations, concepts or people. As such, according to Aiken (1980, p. 2), the attitudes comprise three dimensions: cognitive (beliefs, knowledge), affective (emotional, motivational), and performance (behaviour, active tendencies) components. More recently, Phillip (2007) described attitudes as ways of acting, feeling or thinking, which (in this case) indicate the disposition or opinions of a person with regard to statistics.

Attitudes are intense feelings which are relatively stable, and which result from positive or negative experiences encountered whilst learning a subject (in this case statistics) over a period of time. Students may have these experiences of statistics at school, or as part of an informal extra-curricular learning process. In other cases, students transfer their negative feelings towards mathematics onto statistics (Gal & Ginsburg, 1994).

Within the field of statistics education, the level of interest in the beliefs, attitudes, and expectations that students bring to the classroom is increasing, as “such factors can impede learning of statistics, or hinder the extent to which students will develop useful statistical intuitions and apply what they have learned outside the classroom” (Gal & Ginsburg, 1994, p. 1). These authors have suggested that statistics teachers should not focus solely on the transmission of knowledge and skills, because if students encounter difficulties whilst learning about statistics, this experience might impede their desire to receive further instruction. They may also fail to appreciate the potential usefulness of statistics in their professional and personal lives. These theories are particularly relevant in terms of the training which teachers receive.

In the last two decades, a large number of tools with which to measure attitudes and anxiety levels relating to statistics have been developed (Gal & Ginsburg, 1994; Carmona, 2004). Three of the most widely used instruments with which to measure attitudes towards statistics are Wise's (1985) Attitudes Towards Statistics Scale (ATS), Roberts and Saxe's (1982) Statistics Attitude Survey (SAS) and Schau, Stevens, Dauphine and del Vecchio's (1995) Survey of Attitudes Towards Statistics (SATS). These scales have been validated using samples of students at college or university, but not among teachers or future teachers. For this purpose, Estrada (2002) proposed and developed a Scale of Attitudes Towards Statistics (EAEE), which was applied to prospective and in-service teachers. The EAEE is a combination

of three scales: the SAS (Roberts & Bilderback, 1980) and the ATS (Wise, 1985), which are the most commonly used in an international context, and the Spanish scale proposed by Auzmendi (1992).

Based on these three scales, a list of 36 items was developed, consisting of both positive (affirmative) and negative items in order to avoid the problem of acquiescence (Morales, 1988), and including various pedagogical and anthropological components, as described by Estrada (2002) and Estrada et al. (2004). These items were submitted to a panel of expert judges, and, following their evaluation, a final scale consisting of 25 items (14 affirmative and 11 negative) was proposed. The distribution of items according to the various components is provided in Table 1.

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

Table 1: Components of attitudes as assessed in the EAEE

In this study, attitudes were measured using a 25-item Likert scale. The independent variables we considered were: gender, group (prospective vs. in-service teachers), the number of previous courses taken in statistics, specialty (the subject in which the prospective teachers were specialising or the subject which the teachers taught) and the number of years of teaching experience in mathematics (for in-service teachers).

METHOD, RESULTS AND DISCUSSION

In this study, we analysed the results of a survey of 71 teachers in the second and third cycles of basic education in Portugal. The survey was distributed in the teachers' annual meeting (ProfMat 2008, 2-4 September) and in some schools in Seia, S. Romão, Oliveira do Hospital and Lisbon. This allowed us to obtain a sample of the 212 teachers who were involved in these teaching cycles in Portugal at the time. The EAEE (Estrada, 2002) was translated and adapted to the Portuguese language by the authors, and two items were added. These two new items were related to the use of technology in statistics classes. In Table 1, these items were included in the section in which the behavioural components of teaching overlap with educational and anthropological components (items 26: "In statistics classes, I need to use the computer and the Internet in order to perform the tasks that I have set", and 27: "I do not need to use a calculator in order to perform the tasks that I set in statistics

classes”). All of the items comprised statements, to which the respondents marked their level of agreement or disagreement on a five-point Likert type scale (from 1: strongly disagree, through 3: neither agree nor disagree, to 5: strongly agree). Of the 27 items, 15 were positively worded (for instance, question 26) and 12 were negatively worded (for instance, question 27). For the 12 negatively worded items, the scale was reversed when the responses were analysed (from 1: strongly agree, through 3: neither agree nor disagree to 5: strongly disagree), meaning that the teachers’ attitudes towards statistics could be measured in terms of the total score for all of their answers. The minimum score was 27, and the maximum was 135, with a mid-point of 81. In the data analysis, statistical software and a spreadsheet were used.

Of the 71 respondents, 61 (86%) were women. With regard to the teachers’ years of experience, we found a mean of approximately 15 years, with a standard deviation (SD) of 7.8 years. The distribution is shown in Figure 1 (left), in which we can see the number of new teachers and those with far more experience.

The cycles in which the teachers were working are also shown in Figure 1 (right). Of the 71 respondents, only 51 indicated the subject in which they had graduated (we think that the 20 missing answers may have been a result of the presentation of the question). Of these respondents, around 78% were mathematics graduates (in teaching or other areas) and around 6% were economics graduates. These 51 respondents had graduated from a total of 13 different subject areas.

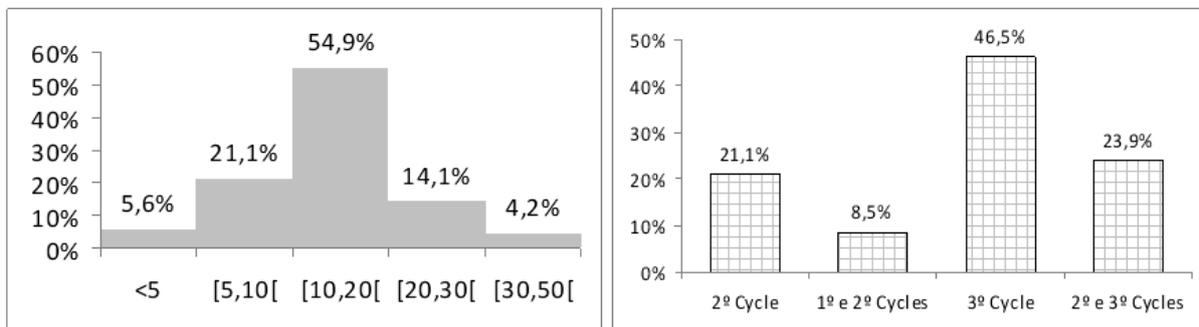


Figure 1: Years of experience of teaching (left) and teaching cycles (right)

Table 2 provides an analysis of each item. The mean value and SD were computed for a positive scale, meaning that all of the scores are comparable. The nearer to five they are, the stronger the indication of a positive attitude towards statistics. In contrast, if the scores are closer to one, this indicates a negative attitude towards statistics.

	Item	Mean	SD
1	Some statistical information transmitted in television programmes bothers me	2.7	1.2
2	Statistics helps me to understand today's world	4.2	0.9
3	Through statistics, one can manipulate reality	1.6	0.7
4	Statistics is fundamental to the basic training of future citizens	4.3	0.6
5	I solve day-to-day problems using statistics	3.6	0.7
6	We should not teach statistics in schools	4.9	0.3
7	I have fun in classes in which I teach statistics	3.8	0.7
8	I find that statistical problems are easy	3.8	0.9
9	I do not understand the statistical information that appears in the media	4.1	1.0
10	I like statistics, because it helps me to fully understand the complexity of certain issues	3.7	0.9
11	I feel intimidated by statistical data	4.4	0.8
12	I find the world of statistics interesting	4.0	0.7
13	I like serious work which involves statistical analysis	3.9	0.8
14	I do not use statistics outside of school	3.4	1.0
15	When I attended statistics classes, I did not fully understand what was said	3.7	1.1
16	I am passionate about statistics because it helps me to view problems objectively	3.3	0.8
17	Statistics is easy	3.5	1.0
18	I find it easier to understand the results of elections when they are shown using graphics	3.7	1.0
19	Statistics are only good for people in scientific areas	4.7	0.5
20	I like to solve problems using statistics	3.8	0.7
21	Statistics is worthless	4.8	0.7
22	If I could eliminate part of the syllabus, it would be statistics	4.6	0.9
23	I usually explain statistics problems to my colleagues if they do not understand	2.7	0.9

24	Statistics helps people to make better decisions	3.8	0.7
25	When I read, I avoid statistical information	4.4	0.6
26	In statistics classes, I need to use the computer and the Internet in order to perform the tasks that I have set	3.2	1.1
27	I do not need to use a calculator in order to perform the tasks that I set in statistics classes	3.7	1.1

Table 2: Mean and SD for each item

The items with the highest mean scores (> 4.5) were 6, 19, 21 and 22. In addition to indicating positive attitudes towards statistics, these results reinforce our idea that these mathematics teachers seem to be aware of the importance of statistics as a part of the mathematics curriculum, as well as its importance for citizens in the modern world.

The items with the lower mean scores (< 3) were 1, 3 and 23. The result for item 23 seems to indicate a lack of collaboration between colleagues. With regard to items 3 and 1, we suspect that the respondents “wrongly” understood the meaning of the statements.

It is important to note that the two items which were related to the use of technology in statistics classes (26 and 27) had mean scores of 3.24 and 3.68 and SD values of 1.08 and 1.09 respectively. These results may indicate that there is still room for improvement, as teachers do not make use of technology in their classrooms.

Figure 2 indicates the frequencies of the total scores. From the graph, we can see that most of the respondents had a mean total score which was higher than 81 (the level of indifference). The modal score is 104, and the mean is 102.58, with a SD of 8.38 and a slight negative skewness (-0.53).

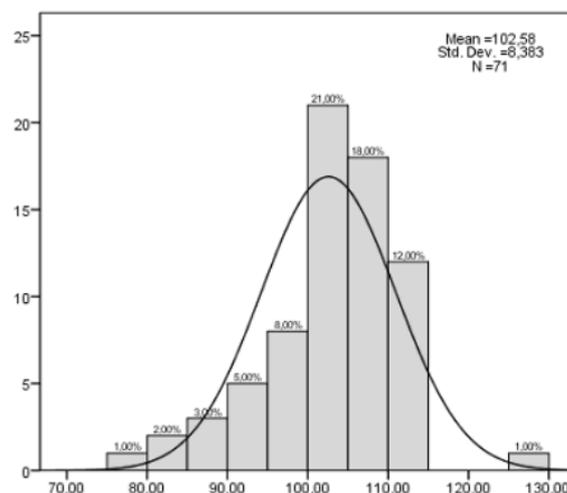


Figure 2: The frequencies of the total scores

Teaching component	Anthropological component			Total
	Social	Educational	Instrumental	
Affective	3.83	3.67	3.70	3.67
Cognitive	4.55	3.99	2.73	3.99
Behavioural	3.94	3.77	3.48	3.77
Total	4.13	3.80	3.40	3.80

Table 3: Mean scores according to the components of attitudes

Table 3 presents the respondents' mean scores according to the components of attitudes. According to a briefly analysis of these scores, none of the components – teaching or anthropological – presented high mean scores (> 4.5) or low mean scores (< 3). Nevertheless, a high mean score arises when the cognitive component of teaching is combined with the social anthropological component, and a low mean score can be obtained by crossing the cognitive component of teaching with the instrumental anthropological component.

We also studied the reliability of this survey; we obtained a Cronbach's alpha of 0.749 as a coefficient of internal consistency, and, taking into account the small number of respondents for this preliminary study, we believe this to be a reasonable value. Furthermore, in order to test the effect of each item on the internal consistency of the scale, we ran 27 more tests, using only 26 items at a time. For these 27 tests, the values for Cronbach's alpha varied from 0.725 to 0.768.

We analysed the influence of gender on attitudes towards statistics, and we did not find any statistically significant differences ($F(1, 69) = 1.582$, p-value: 0.213). However, we found that the mean total score for women, which was 103.8 (SD 1.09), was higher than the mean total score for men, which was 99.5 (SD 2.31). This result is in accordance with the results of Estrada et al. (2004).

With regard to the effect of their years of experience on teachers' attitudes towards statistics, despite a generally positive attitude, no statistically significant differences were found ($F(4, 66) = 0.367$, p-value: 0.831). Nevertheless, we found that the mean total score was higher and the SD was lower if the respondents had been teaching mathematics for fewer years, and vice versa. This result may be related to specific training in statistical and pedagogical approaches and teaching methods which the teachers received during their initial training.

Regarding the influence of the cycles of education on the teachers' attitudes towards statistics, we noticed that the mean total score was relatively high, but with no statistically significant differences ($F(3, 67) = 0.963$, p -value: 0.415). Slightly higher scores were observed in the case of teachers who taught in the second and third cycles and the first and second cycles (the smaller group of respondents), who also had the highest SD values. Nevertheless, the question of whether or not a more positive attitude towards statistics may be associated with the cycles of basic education needs further research.

Regarding the different areas of training and their relationship with attitudes towards statistics, no statistically significant differences were found ($F(1, 49) = 0.021$, p -value: 0.885). However, we noted that the respondents with basic training in mathematics had slightly lower mean scores (102.55 and SD 1.36), while those with training in other areas had a mean score of 103, but a greater SD (3.28). This result is interesting and somewhat unexpected; suggesting once again that further analysis in this area is required.

PRELIMINARY CONCLUSIONS

The sample size and the characteristics of this survey mean that our results cannot be generalised. We must clarify that the purpose of this study was not to make any generalisations, but to test the validity of the items and the performance of the scale used in the similar study carried out by Estrada et al. (2004).

Distributing this survey through the ProfMat 2008 organising committee did not prove to be a good option, since there the teachers had several others requests (workshops, conferences, team groups, and so on) which may explain the low response rate and possibly even some of the "wrong" answers.

For this preliminary study, Cronbach's alpha (the coefficient of internal consistency) was 0.749. In our view, this value is reasonable, given that the sample size was very small. For the purposes of the survey, this initial study suggests that teachers' attitudes towards statistics are generally positive, with a mean total score of 102.58 (and SD 8.38), which is well above the mid-point (81), which would indicate their indifference. These results are in line with the results of Estrada et al. (2004). We did not find statistically significant differences in the respondents' attitudes towards statistics in terms of some of the variables studied, but we should emphasise the following points: women had a slightly higher mean total score than men; the mean total scores were slightly lower in the groups of teachers with fewer years of teaching experience; the mean total scores were lower for the teachers who taught in only one of the cycles of basic education, and teachers with training in mathematics also had a higher mean total score than teachers with other forms of training. The mean scores of the two additional items were only slightly above three (indicating indifference), which leads us to infer that (in terms of these respondents at least) the use of technology in statistics classes needs further study.

These results must be read with great caution and with full knowledge of the (very) small size of the studied sample. Nevertheless, this preliminary study has provided us with some directions for further research and action; for instance, in terms of rewriting some of the items and the need to validate this Portuguese translation of the EAEE (Estrada, 2002).

Having followed on from the study by Estrada et al. (2004), we have not addressed all of the issues which were raised during the survey, but we intend to do so in further analysis. In order to continue this study of attitudes towards statistics, we feel the need to collect more answers using this survey in order to validate the scale when studying teachers in the second and third cycles of Portuguese basic education, and in order to improve the graphical presentation of the first section: the questions regarding sample characteristics of teachers. We also intend to conduct further statistical analysis, including multivariate analysis.

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REFERENCES

- Aiken, L.R. (1980). Attitudes measurement research. In D.A. Payne (Ed.), *Recent developments in affective measurement* (pp. 1-24). San Francisco: Jossey-Bass.
- Auzmendi, E. (1992). *Las actitudes hacia la matemática estadística en las enseñanzas medias y universitarias* [The attitudes towards mathematics in teaching in high school and university]. Bilbao: Mensagero.
- Carmona, J. (2004). Una revisión de las evidencias de fiabilidad y validez de los cuestionarios de actitudes y ansiedad hacia la estadística [A revision of the reliability and validity of attitudes and anxiety towards statistics surveys]. *Statistics Education Research Journal*, 3(1), 5-28. Retrieved from [http://www.stat.auckland.ac.nz/~iase/serj/SERJ3\(1\)_marquez.pdf](http://www.stat.auckland.ac.nz/~iase/serj/SERJ3(1)_marquez.pdf)
- Estrada, A. (2002). *Análisis de las actitudes y conocimientos estadísticos elementales en la formación del profesorado* [Analysis of attitudes and elementary statistical knowledge in training teachers]. Ph.D. Universidad Autónoma de Barcelona. Retrieved from <http://www.tesisenxarxa.net/TDX-0502103-191818/>
- Estrada, A., Batanero, C., & Fortuny, J.M. (2004). Un estudio comparado de las actitudes hacia la estadística en profesores en formación y en ejercicio [A study comparing the attitudes towards statistics of training and in-service teachers]. *Enseñanza de las Ciencias*, 22(2), 263-274.
- Gal, I., & Ginsburg, L. (1994). The role of beliefs and attitudes in learning statistics: towards an assessment framework. *Journal of Statistics Education*, 2(2). Retrieved from <http://www.amstat.org/publications/jse/v2n2/gal.html>

- McLeod, D.B. (1992). Research on affect in mathematics education: A re-conceptualization. In D.A. Grows (Eds.), *Handbook of research on mathematics teaching and learning* (pp. 575-596). New York, NY: Macmillan & NCTM.
- Morales, P. (1988). *Medición de actitudes en psicología y educación* [Measurement of attitudes in psychology and education]. San Sebastián: Universidad de Comillas.
- Nóvoa, A. (1992). Formação de professores e profissão docente [Training teachers and teaching]. In Nóvoa, A. (Ed.) *Os professores e sua formação* [Teachers and their training] (pp. 15-33). Lisbon: Publicações D. Quixote.
- Phillip, R.A. (2007). Mathematics teachers' beliefs and affects. In F. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 257-315). Charlotte, NC: Information Age Publishing & NCTM.
- Roberts, D.M., & Bilderback, E.W. (1980). Reliability and validity of a statistics attitude survey. *Educational and Psychological Measurement*, 40, 235-238.
- Roberts, D. M., & Saxe, J. E. (1982). Validity of a statistics attitude survey: A follow-up study. *Educational and Psychological Measurement*, 42, 907-912.
- Schau, C., Stevens, J., Dauphine, T., & Del Vecchio, A. (1995). The development and validation of the survey of attitudes towards statistics. *Educational and Psychological Measurement*, 55(5), 868-875.
- Wise, S.L. (1985). The development and validation of a scale measuring attitudes toward statistics. *Educational and Psychological Measurement*, 45, 401-405.