COMPARISON OF ATTITUDES TOWARDS STATISTICS IN GRADUATE AND UNDERGRADUATE HEALTH SCIENCES' STUDENTS

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Many of the major decisions taken by health professionals have some statistical basis. Nowadays the interest in attitudes towards statistics has increased since there is some evidence that these can impede the effective learning of statistics and/or the correct development of useful statistical intuitions. In this work, we analyze the components of graduate (n=385) and undergraduate (n=507) health sciences students' attitudes towards statistics through their responses to the Survey of Attitudes Towards Statistics (SATS) scale. Our results show that health sciences' students have, in general, a positive attitude towards statistics and although graduate students value it more significantly, have better feelings and perception of self-competence, knowledge and intellectual skills, they rate it as difficult as undergraduate students.

INTRODUCTION

The ultimate goal of statistical education is to provide an appropriate use of statistical thinking (Schau et al., 1995). This is particularly pertinent in the context of the health sciences since these professionals need to carry out their own investigations and make decisions under uncertainty integrating the best practices of evidence based medicine.

Health professionals develop, at times, anxiety towards statistics due to their fear of mathematics. However, biostatistics courses can, nowadays, be conducted without a high level of calculus. Students' attitudes might influence their learning of statistical concepts as much as their cognitive abilities. The influence of attitudes towards statistics on the development of statistical reasoning and thinking has been studied in different ways (Carmona, 2004; Blanco, 2008). However, the attitudes towards statistics in health sciences' students are a new kind of research particularly pertinent due to an increasing number of students in this field.

The difficulties in the use of statistics by different groups of professionals, particularly by health professionals, are well documented mainly when carrying out research. Health professionals need to promote their statistical abilities in order to be able to recognize when additional knowledge and skills are required, to obtain this additional statistical understanding or, better yet, to claim the consultation of a statistician.

Improvement of positive attitudes towards statistics is a critical goal in statistics education. Positive attitudes contribute to a better use of statistical knowledge and to a better understanding of the variation inherent to data, enabling better decision-making under uncertainty when dealing with statistics.

In this work, we evaluate, compare and present the first study which analyses the attitudes towards statistics in Portuguese health sciences students enrolling in postgraduate or undergraduate programs.

METHOD

Sample

Participants were 892 health sciences' students and professionals enrolled in graduate or post-graduate programs in various (public and private) higher education institutions from northern Portugal (201 male, mean age +/- SD 24 +/- 5 years; 691 female; mean age +/- SD 25 +/- 9 years). A first group (n=507, 56.9%; mean age +/- SD 22.49 +/- 7.33 years) was enrolled in a graduation and a second group in post-graduation programs (n= 385, 43.1%; mean age +/- SD 27.95 +/- 8.45 years).

Instrument

The attitudes of students were assessed by using the Survey of Attitudes Towards Statistics - SATS (Schau et al, 1995). These authors define attitude towards statistics as a multidimensional construct with four sub-scales:

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- *Affect:* Positive or negative feelings concerning statistics (I like statistics, I feel insecure when I have to do statistics problems, I get frustrated going over statistics tests in class, I am under stress during statistics classes, I enjoy taking statistics courses, Statistics scares me)
- *Cognitive competence*: Perception of self-competence, knowledge and intellectual skills when applied to statistics (I have trouble understanding statistics because of how I think, I have no idea of what's going on with statistics, I make a lot of maths errors in statistics, I can learn statistics, I understand statistics equations, I find it difficult to understand statistical concepts)
- *Value:* Appreciation of statistics usefulness, relevance and value of statistics in personal and professional life (Statistics is worthless, Statistics should be a required part of my professional training, Statistical skills will make me more employable, Statistics is not useful to the typical professional, Statistical thinking is not applicable in my life outside my job, I use statistics in my everyday life, Statistics conclusions are rarely presented in everyday life, I will have no applications for statistics in my profession, Statistics is irrelevant in my life).
- *Difficulty:* Perceived difficulty of statistics as a subject: (Statistics formulas are easy to understand, Statistics is a complicated subject, Statistics is a subject quickly learned by most people, Learning statistics requires a great deal of discipline, Statistics involves massive computation, Statistics is highly technical, Most people have to learn a new way of thinking to do statistics).

Firstly, a translation of the original SATS from English to European Portuguese was conducted after which an English native-speaking teacher back-translated this European Portuguese version into English. The English form was compared in order to verify the similarity of the Portuguese (European) and the original version. A strong correspondence was observed between the two forms indicating that the Portuguese (European) version of the SATS can be considered consistent with the original one.

In our study, according to Estrada et al (2002), each statement was valued in a range from 1 to 5, where 1 indicates "strongly disagree" and 5 indicates "strongly agree". The Cronbach's alpha was 0.88 demonstrating a good level of internal consistency. For statistical evaluation we used factorial analysis, Pearson's correlation coefficients, and confidence intervals. In order to visually group similar individuals, and therefore define profiles, we used an N-dimensional radial coordinate visualization. In this procedure N lines originate radials from the center of the circle to its perimeter meeting the points called Dimensional Anchors. These visualized variables correspond to equidistantly distributed points along the circumference of the circle. The spring constant has the values of i-th coordinate of the data point and each point is then displayed at the position that produces a spring force sum of zero. The variable with larger scale than the others will lead the spring visualization.

RESULTS AND DISCUSSION

In table 1, we present means, standard deviations, minimum, maximum and Z scores for each component and for total score.

Table 1. Summary of results in total score and components score (n=892)

	Empirical Mean	Standard Deviation	Minimum	Maximum	Theoretical Mean	Z score
Affect	18.93	4.30	6	30	18	0.22
Cognitive	21.73	3.40	6	30	18	1.10
Value	32.07	5.79	9	45	27	0.88
Difficulty	19.68	3.57	7	35	21	**-0.37**
Total Score	92.62	12.88	28	140	84	0.67

We consider a theoretical mean of 3 for each item to represent the indifference point. Our results suggest a moderately positive attitude towards statistics. Furthermore, we found that the health sciences' students have a positive score concerning the perception of their own capacity to learn and valuation of statistics, a slightly positive feeling towards statistics and saw statistics as a difficult matter (score under the theoretical mean).

Correlation studies among components, and between components and total score, are shown in table 2.

Table 2. Pearson' correlation coefficients

	Affect	Cognitive	Difficulty	Value
Total Score	0.85	0.76	0.66	0.75
Affect	1.00	0.62	0.54	0.45
Cognitive		1.00	0.46	0.37
Difficulty			1.00	0.19
Value				1.00

$p<0.001$ for all coefficients

The order of correlation of the components (table 3) on the global attitude is as follows: Affect, Cognitive, Value and Difficult. In order to verify the factorial structure of attitudes we carried out a factorial analysis by which 6 factors explained 54.8% of the total variance in our sample. Moreover, the factors don't appear clearly separated in our health sciences students' sample.

Table 3. Factor analysis summary

Factor	Total	% Variance	Cumulative %
1	6.90	24.65	24.65
2	2.94	10.50	35.15
3	1.76	6.29	41.44
4	1.39	4.98	46.42
5	1.27	4.55	50.97
6	1.07	3.84	54.80

In figure 1, we compare the undergraduate and graduate groups of students in terms of the different components of attitudes and total score. Each of these values was divided by the number of items in order to get a homogeneous scale.

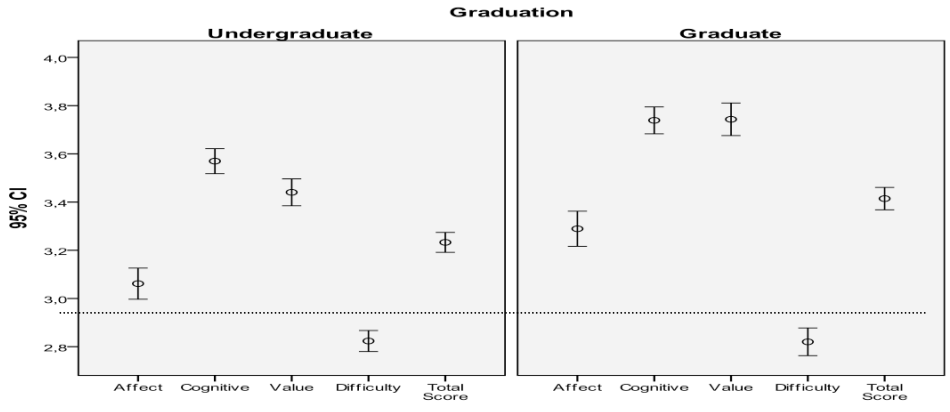

Figure 1. Confidence intervals (95 %) for mean score by component and total score

We found that our graduate students have a more positive attitude towards statistics concerning their feelings, their own perception of self capacities and on the topic valuation. Notwithstanding, at a 0.05 level, no statistical differences were found on the difficulty students perceived about statistics. Such facts suggest that even at a graduate's level statistics is not faced

fearlessly, thus jeopardizing the development of a critical reasoning and the capacities of autonomous learning as was perceived by the Dublin Descriptors.

The Radviz' graphic, for the components proposed by Schau et al. (1995), is shown in figure 2. In order to find similarities between graduate and under-graduate health sciences' students, and therefore to define profiles, we used the radial visualization techniques. We found that the undergraduate group presents several cases which are more distant from the center of radviz indicating greater influence of a particular component. Moreover, we observed that the cognitive and value components are more accountable for variation in the attitudes towards statistics among individuals.

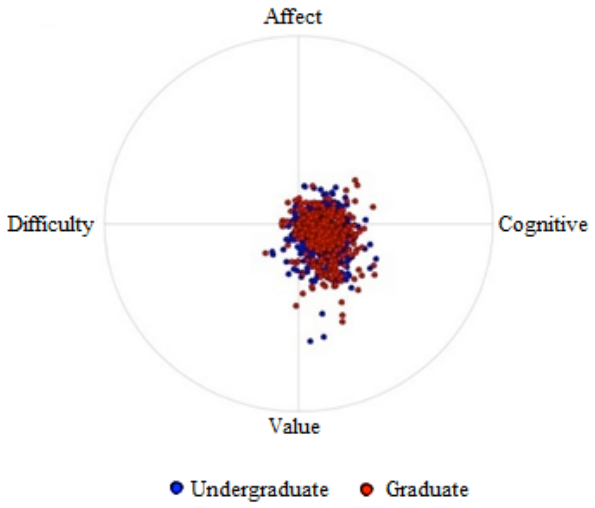

Figure 2. Radviz graphic for attitudes by components

CONCLUSIONS

In the field of health sciences, the variation among students' attitudes towards statistics is best explained by their perception of self competence, knowledge and intellectual skills, appreciation of its usefulness, relevance and value in personal and professional life rather than by the perceived difficulty or the positive or negative feelings concerning statistics.

Our results show that graduate health sciences' students have, in general, a better attitude towards statistics than under-graduate students with exception to the difficulty component by which no statistical significant differences were found between the two groups.

It is mandatory for teachers of applied statistics to promote more effective ways of teaching statistics, hence contributing to a *user-friendly* approach to statistics by both graduate and under-graduate health sciences' students–an approach primarily supported by a conceptual basis allowing students to "learn by doing" rather than on a mathematical basis.

Statistics often seems 'scary' and although learning may seem an intimidating task, with more effective ways to teach statistics, such as projects, everyone can love to learn statistics.

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