Validity evidences of the attitudes towards statistics scale

SATS_{PORTUGUÊS}: a study with Brazilian students.

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Introduction

One of the reasons why statistical education has become more and more important concerns the technological development in the past decades that have resulted in even faster information exchanges. It is important to analyze the students' attitudes toward statistics because they could be affecting the students' performance. Chiesi and Primi (2009, p. 309) defined Attitude toward statistics as 'a disposition to respond favorably or unfavorably to objects, situations or people related to statistics learning'.

Understanding the affective component in the statistical learning process is imperative, once the formation and consolidation of the negative attitudes can compromise the students' learning, and consequently generate resistances to its uses in the scientific research in the professional performance or in personal decisions (Lalonde & Gardner, 1993; Robert & Bilderback, 1980; Wise, 1985; Waters, Martelli, Zakrajsek & Popovich, 1989; Schau, Stevens, Dauphinee & Vecchio, 1995; Vendramini, 2000; Cazorla, Silva, Vendramini & Brito, 2000; Vendramini, Silva, Cazorla & Brito, 2000).

The attitudes toward statistics studies are relevant considering that statistics is a scientific method and its tools make it possible to organize and to interpret a big batch of data. Moreover, it helps the decision making in uncertain conditions and it contributes to build critical citizens in a more and more technological and computer-assisted society. Therefore it is necessary to provide the academic community with valid and accurate measurement instruments to assess the students' attitudes toward statistics, and to make it possible for the instructors to develop positive attitudes towards the potential use of this tool.

For these reasons, this study aims to verify validity evidences of the Portuguese version of the Survey

of Attitudes toward Statistics Scale (SATS$_{PORTUGUESE}$) scores and their relations with scores from two other measurements of attitudes toward statistics, the Attitude toward Statistics Scale (ATS$_{PORTUGUESE}$), and the Statistics Attitude Survey (SAS$_{PORTUGUESE}$).

This study is a part of a more comprehensive project aiming to develop and validate a scale of attitudes toward statistics from the translation, adaptation and validation of five different scales of the attitudes toward statistics. This project was financed by the National Council for Scientific and Technological Development (CNPq) and counted on the voluntary participation of researchers from Brazilian universities located in different states.

Method

A convenience sample of 2074 undergraduate students from ten Brazilian Universities was selected from various statistics classes. They were 48.2% male and 51.8% female students, and their ages ranged 17 to 58 (*M*=22.3, *SD*=5.1). They were from different areas (Human Sciences: 34.4%; Exact Sciences: 46.3%; Health and Biological Sciences: 19.3%).

The attitudes toward statistics were measured using three instruments translated from English to Portuguese and adapted to Brazilian students by the authors of this article, they are: *Attitudes Toward Statistics* – ATS (Wise, 1985), *Statistics Attitudes Survey* – SAS (Roberts & Bilderback, 1980), *Survey of Attitudes Toward Statistics* – SATS (Schau, Stevens, Dauphinee & Del Vecchio, 1995).

The scores from the SATS scale assess four components of attitudes toward statistics: Affect (6 items), Cognitive Competence (6 items), Value (9 items) and Difficulty (7 items). It is a 28-item instrument with a 7-point, ranging from 1 (strongly disagree) to 7 (strongly agree), Likert-type response format, with higher ratings indicating more positive attitudes after recoding the 19 negative items. Examples of items/constructs on the Affect subscale are "I like statistics" and "I feel insecure when I have to do statistics problems"; on the Cognitive Competence subscale – "I make a lot of math errors in statistics" and "I can learn statistics"; on the Value subscale – "Statistics is worthless" and "I use statistics in my everyday life"; and on the Difficulty subscale – "Statistics is a complicated subject" and "Learning statistics requires a great deal of discipline".

The ATS is a 29-item, Likert-type scale with five response possibilities ranging from 1 'strongly disagree' to 5 'strongly agree'. The ATS questionnaire includes both positively and negatively formulated items. The questionnaire consists of two subscales – Field (20 items) and Course (9 items) – that respectively aim to measure attitudes toward the use of statistics in the students' fields of study and attitudes toward the particular statistics course in which they are enrolled. Examples of items on the Field subscale are "I feel that statistics will be useful to me in my profession" and "Studying statistics is a waste of time"; on the Course subscale are "The thought of being enrolled in a statistics course makes me nervous" and "I get upset at the thought of enrolling in another statistics course".

The SAS consisting of 33 items and uses a 5-point Likert scale ranging from Strongly Agree through Neutral to Strongly Disagree, and is proposed as a one-dimensional scale, so that "it was not assumed that the SAS was factorially complex or that there were useful possibilities for identifying subscales for diagnostic purposes" (Roberts & Reese, 1987).

Participants were contacted at university classrooms and invited to participate in the study. After completing the informed consent form, they completed the attitudes' scales in groups in approximately 30 minutes.

The Rasch analysis was used in order to test the construct validity of a hypothesized model of attitudes toward statistics and the capacity of the instrument SATS$_{PORTUGUESE}$ to measure the hypothesized components. This analysis of residuals was designed to help identify the least number of contrasts to explain as much variance as possible. Rasch-residuals are interpreted based on principal components analysis (PCAR), where the components show contrasts between opposing factors rather than loadings on one factor.

All statistical analysis were computed with the software Winsteps Rasch Measurement (Linacre, 2009).

Results and Discussion

The responses of 2074 undergraduate students enrolled in statistics courses at a university were analyzed. The principal component analysis was utilized to investigate SATS$_{PORTUGUESE}$' internal structure. It is important to observe that the Rasch-residual-based Principal Components Analysis is an indicative, but not definitive, about secondary dimensions (Linacre, 2009).The results reveal that 40.8% of the variance in the data was explaining by the Rasch model . The eigenvalue of the first contrast is 3.6 - this indicates that it has the strength of about 4 items, bigger than the strength of 2 items (the smallest amount that could be considered a "dimension", in accordance with Linacre, 2009). It is important to inform that onlu the first contrast presented explained variance higher than 5%.

The location items of the SATS$_{PORTUGUESE}$ scale ranged from -.66 to .81 (*M* = .00; *SD*= .37). The internal consistency reliability estimates were $\alpha_{Cronbach=}$.89 for total scores, and the item-total correlation for subscales ranged from .24 to .74. The attitude level of people tha response the instruments ranged from -1.78 to 2.11 (*M* = .21; *SD* = .42) indicating that the level attitudes students is high than the location level of the items.

The other kind of score validity information is called concurrent validity. Scores have concurrent validity if they interrelate as expected with other measures of similar constructs. In this study, as a Carmona (2004) and Schau (2003), the scores of the scale SAT$_{SPORTUGUESE}$ were correlated with ATS$_{PORTUGUESE}$ (r = .776) and SAS$_{PORTUGUESE}$ (r = .730) indicating that they measure the same construct (Table 1).

According Schau (2003) there is evidence of concurrent validity for the SATS component scores of Affect, Cognitive Competence, and Value. SATS Affect scores correlated strongly with scores from Wise's ATS Course scale (which also measures students' affective feelings about statistics). Scores from the SATS Value component correlated strongly with scores from the ATS Field scale (which also measures students' attitudes about the value of statistics).

Table 1. Intercorrelations of the scales, subscales and math grades

Scales	SATS-Affect	SATS-Cognitive Competence	SATS-Value	SATS-Difficulty	SATS-Total	ATS-Course	ATS-File
SATS-A							
SATS-CC	.701 [*] a						
SATS-V	.427 [*] a	.351 [*] a					
SATS-D	.518 [*] a	.521 [*] a	.172 [*] a				
SATS-total	.858 [*] a	.815 [*] a	.697 [*] a	.682 [*] a			
ATS-C	.804 [*] b	.676 [*] b	.546 [*] b	.530 [*] b	.793 [*] b		
ATS-F	.501 [*] b	.364 [*] b	.752 [*] b	.276 [*] b	.628 [*] b	.605 [*] b	
ATS-total	.698 [*] b	.550 [*] b	.740 [*] b	.425[*] b	.776 [*] b	.857 [*] b	.929 [*] b
SAS-total	.679 [*] c	.565 [*] c	.498 [*] c	.478 [*] c	.730 [*] c	-	-

[*]Pearson product-moment correlation coefficients significant at p < .001

a n =2,052; b n =368; c n = 765

Conclusion

Understanding the affective component in the statistical learning process is imperative, it is necessary to provide the academic community with valid and accurate measurement instruments to assess these attitudes, and to make it possible for the instructors to develop positive attitudes towards the potential use of this tool. This study concluded that Portuguese version of the SATS scale is a simple measure that assesses

these attitudes and it is a valid and accurate measure to use in Brazilian students.

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