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Adaptation and validation into Portuguese (BR) of the SATS-28 scale to measure attitudes towards Statistics

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Abstract: Statistical information is daily presence in any citizen's life in most different contexts. However, due to bad experiences with Mathematics in basic education, many Health students present negative attitudes towards Statistics. Knowing students' attitudes towards Statistics allows us to understand their propensity to learn it and then it is possible to think about strategies that enable a change, in case the attitude is negative, contributing to the development and formation of students' critical view. Thus, this study aimed to validate the SATS-28 scale of attitudes towards Statistics in Brazilian Portuguese version for Health students. Data from 811 students from 15 undergraduate Heath courses of Brazilians Federal Universities were used. The results indicate that the scale is valid, and its results are consistent.

Keywords: Attitude. Statistical Literacy. Scale Validation.

Adaptación y validación para el português (BR) de la escala SATS-28 para medir las actitudes hacia la Estadística

Resumen: La información estadística está presente y se presenta diariamente en diferentes contextos. Sin embargo, debido a la mala experiencia con las Matemáticas en la educación básica, muchos estudiantes del área de Salud tienen actitudes negativas hacia la Estadística. Conocer la actitud de los estudiantes hacia la Estadística permite comprender su predisposición a aprenderla y, a partir de esto, es posible pensar en estrategias que permitan un cambio, si la actitud es negativa, contribuyendo al desarrollo y formación de una visión crítica en el estudiante. Por lo tanto, el objetivo de este trabajo fue validar la escala de actitudes hacia la Estadística SATS-28 en la versión portuguesa (brasileña) para estudiantes del área de Salud, datos de 811 estudiantes de 15 cursos de pregrado del área de Salud. Se utilizaron las Universidades Federales de Brasil. Los resultados indican que la escala es válida y sus resultados son consistentes.

Palabras clave: Actitud. Alfabetización Estadística. Validación De Escala.

Adaptação e validação para português (BR) da escala SATS-28 para medir atitudes em relação à Estatística

Resumo: O Informações estatísticas estão presentes e são apresentadas diariamente, em

diferentes contextos. Entretanto, devido à má experiência com Matemática no ensino básico, muitos estudantes da área da saúde apresentam atitudes negativas em relação à Estatística. Conhecer a atitude dos estudantes frente à Estatística permite compreender sua predisposição em aprendê-la e, a partir disso, é possível pensar em estratégias que possibilitem uma mudança, caso a atitude seja negativa, contribuindo para o desenvolvimento e formação de visão crítica no aluno. Sendo assim, o objetivo deste trabalho consistiu em validar a escala de atitudes acerca da Estatística SATS-28 na versão português (Brasil) para discentes da área da saúde. Foram utilizados dados de 811 estudantes de 15 cursos de graduação da área da saúde de universidades federais brasileiras. Os resultados indicam que a escala é válida e seus resultados consistentes.

Palavras-chave: Atitude. Letramento Estatístico. Validação de Escala.

1 Introduction

Statistics have been present in human daily life in different ways since ancient times when census-type surveys were used. At graduation, it became a mandatory subject for students in the humanities, exact sciences, and biological areas. In research, it serves as an essential tool for developing and analyzing studies. Daily, it is used in the political, economic, and financial scenarios, forming the basis for the decision-making process (Campos, 2007). However, not everyone truly understands the statistical information presented daily in these different contexts.

In the field of Statistical Education, there is a concept called Statistical Literacy, which refers to two main interrelated components: the ability to interpret and critically evaluate statistical information and the ability to discuss or communicate one's reactions to this information (Gal, 2004). The development of this skill is as essential for exercising citizenship as reading and writing (Snee, 1993; Mallows, 1998; Moore, 1998).

Given the relevance of the topic, there are literacy programs — such as those of Porciúncula Schreiber and Laurino (2019) — that seek to promote the human right to equality within the scope of statistical education by teaching descriptive statistics to young people in socioeconomic and environmental vulnerability.

There are two important aspects in the context of statistical education and literacy. The first is related to the teacher's preparation in relation to statistics; the second, with its role in the training of students. The literature presents articles addressing both themes.

Regarding teacher preparation, for example, Frei, Rosa, and Biazi (2023) and Serpa (2023) highlight that the time allocated to Statistics content during the training of primary and secondary education teachers should be a point of attention, as it appears to be insufficient. Regarding the role of the Statistics teacher and its impact on student learning, efforts to improve teaching and learning have been on the agenda of teachers (Pereira, Dufranc, & Villagra, 2019), since teaching focused only on formulas and calculations fails to develop the ability to think statistically (Snee, 1993; Moore, 1998; Mallows, 1998).

In addition to the role of the teacher, there is the stigma associated with subjects that utilize Mathematics. Onwuegbuzie and Wilson (2003) indicate that between 66 and 80% of postgraduate students experience some level of anxiety regarding Statistics subjects.

This scenario, however, can be transformed. A study (Chen et al., 2018), conducted with children between 7 and 10 years of age, showed that a positive attitude toward Mathematics is a predictor of good performance in this subject. Furthermore, this study suggests that a positive attitude can regulate the brain systems involved in mnemonic learning and memory formation processes, facilitating the acquisition of knowledge and the student's performance in the

subject.

Attitude can be defined as a person's predisposition to respond consciously, favorably, or unfavorably, to a specific object (Hourigan, Leavy & Carroll, 2016). Thus, if the attitude towards something is favorable, the individual will approach and defend it; If the attitude is unfavorable, they will move away and avoid it (Klausmeier & Goodwin, 1977). Cazorla, Silva, Vendramini and Brito (1999) define that the attitude towards Statistics corresponds to the affective response given by those who will use it, whether studying a discipline or analyzing research data.

Understanding students' attitudes is important since, as Ma and Xu (2004) describe an initial effort to improve student disposition can have a long-term impact on the cycle of attitude and achievement. In this sense, works such as that of Latterell and Wilson (2018), who evaluated the attitudes towards mathematics of students and teachers in primary and secondary education, and by Rodrigues, Cézar, and Rosa (2017), who evaluated attitudes related to mathematics and anxiety towards mathematics in students in initial teacher training have, fortunately, become increasingly common.

As it is not possible to measure attitude directly, instruments that can measure secondary variables related to this construct must be used (Oliveira Júnior, 2017). The literature presents different instruments that allow the assessment of attitudes toward statistics, including the Statistics Attitude Survey (SAS) by Roberts and Bilderback (1980), the Attitudes Toward Statistics (ATS) by Wise (1985), and the Survey of Attitudes Toward Statistics (SATS) by Schau, Stevens, Dauphinee, and Vecchio (1995), which are the most commonly used (Oliveira Júnior, 2017).

Understanding students' attitudes toward statistics allows them to improve their learning process, aiming to develop a critical view of the information presented to them, regardless of the context. As a research question, we have: Is it possible to validate and adapt an attitude measurement scale that was originally created in English to the Portuguese language? Therefore, this work aims to validate a scale of attitudes toward statistics among undergraduate health students at Brazilian universities, maintaining all the methodological rigor required in this process, as established in the literature (International Test Commission, 2017).

2 Materials and Methods: Instruments

The literature presents different instruments that aim to measure attitudes toward statistics. Among the three most used — SAS, ATS, and SATS (Oliveira Júnior, 2017) — we chose to use the last one, which we will detail below.

An article published by Schau et al. (1995) discusses the key characteristics that an instrument of attitudes toward statistics should exhibit for adequate use in research and education. For these authors, the scales must: cover the most important dimensions of attitudes toward statistics; be applicable in most departments that offer introductory statistics courses and serve as relevant measures throughout the course with only small changes in verb tense; be short, so that their application occurs in a short time; and include items that measure both positive and negative attitudes.

Furthermore, the authors suggest that the students' opinions should be considered for the development and validation of the content, after all, they are the ones who answer the instrument. Finally, they highlight that the structure of the proposed instrument is supported by research using confirmatory analysis techniques, such as confirmatory factor analysis.

Since, according to Schau et al. (1995), none of the instruments to assess attitudes

towards Statistics exhibited all the desired characteristics, these authors proposed the SATS scale, developed to include all these factors. To achieve this, the authors used a variation of the nominal group technique involving graduate and non-graduate students enrolled in an introductory Statistics course and the teachers who taught it.

This group generated 92 words and phrases that represented attitudes toward statistics. Additionally, 21 phrases were included, developed from a review of existing instruments and a set of comments written by other students in introductory statistics courses. From this, the group reached a consensus on an item structure that consisted of four dimensions: (a) Affective — positive and negative feelings related to statistics; (b) Cognitive competence – attitudes related to intellectual knowledge and skills applied to statistics; (c) Value — attitudes related to the usefulness, relevance, and value of statistics in personal and professional life; and (d) Difficulty – attitudes related to the difficulties of statistics as a discipline.

The 113 words and phrases formulated generated 80 items in the initially proposed instrument, which uses a seven-point Likert scale, ranging from *strongly disagree* to *strongly agree*. From a pilot survey carried out with 132 students from introductory statistics courses, 32 items were retained. For validation, this instrument was applied to 1,403 students enrolled in 33 introductory statistics courses in the Departments of Education, Management, Mathematics and Statistics, Psychology, and Sociology at the University of New Mexico and in the Department of Educational Psychology at the University of South Dakota.

As a result of the analyses used to validate the instrument (correlations, Cronbach's alpha, and confirmatory factor analysis), the final version of the SATS consists of 28 items — six items for the Affective dimension, six for Cognitive competence, nine for Value, and seven items for Difficulty. According to the authors, the results obtained demonstrate the usefulness of this instrument in measuring students' attitudes toward Statistics.

The present study deals with the adaptation and validation of the SATS-28, given its application in several international studies, such as: Nasser (2004); Chiesi and Primi (2009); Coetzee and Van der Merwe (2010); Saraiva (2015). To access the original version of the instrument, it was necessary to contact the author, Candace Schau, via email. The author provided the original instrument, permission to use it for a limited period and without copyright, with clear recommendations regarding the need to maintain its structure.

In addition to the items in this instrument, we included additional questions related to sociodemographic information, such as age, gender, course attended, the stage of the course in which they are enrolled, contact with Statistics subjects, and self-perception regarding Mathematics and Statistics.

3 Materials and Methods: Population and Sample

A cross-sectional study was carried out, with the target population consisting of all undergraduate students in the health field at the Federal University of Rio Grande do Sul (UFRGS) and the Federal University of Bahia (UFBA). As an inclusion criterion, undergraduate students in the health field enrolled in at least one discipline in the 2020/1 semester at UFRGS, and in the 2021/2 semester at UFBA were considered. The list of subjects and classes in force during this period was obtained via the universities' electronic systems. Based on this list of subjects and classes, the data was tabulated using Excel software.

For sample composition: at UFRGS, classes were drawn from each stage of each course, and all enrolled students were invited to participate voluntarily in the study. At UFBA, the management of the Multidisciplinary Health Institute (IMS) was responsible for sending an

email inviting students to participate voluntarily in the study. Regarding the minimum sample size, the guidance from the International Test Commission (2017) guideline was considered, which suggests a sample size of at least 300 participants in studies that aim to investigate the factorial structure of an instrument. Thus, the strategy consisted of obtaining as many responses as possible within the information collection periods.

4 Materials and Methods: Procedures for translating the scale

Following the recommendations suggested by the International Test Commission (2017), there are some steps that must be taken to translate and adapt scales. We will address the first three, starting with the so-called Precondition, which pertains to activities that must be carried out before the translation and validation process begins. The second, called Test Development Guidelines, focuses on the instrument adaptation process. The third, Confirmation, includes guidelines with the evidence necessary to address the equivalence, reliability, and validity of an instrument across languages and cultures.

Based on this, all the steps taken to obtain the Brazilian version of the SATS-28 instrument will be described. The process began by obtaining permission from the owner of the scale's intellectual property rights (Ms. Candace Schau) to carry out the translation and adaptation. This request was made through a website on which the author presents various pieces of information related to the scale, ranging from how to calculate the score to presentations and work already carried out. The response with consent to use for a period of one year, and subsequently renewed for another year, was sent via email.

As a second step, the instrument was translated into Portuguese (Brazil) by a doctor in Applied Linguistics. Once this was done, it was necessary, according to the guideline, to check whether what was assessed was understood in the same way across all linguistic and cultural groups, since this is the basis for valid intercultural comparisons. To achieve this, in practice, it was recommended to have the support of experts in the construct to be measured, in order to check whether it made sense in the group's culture.

At this stage, we had the help of experts in the areas of Statistics: three professors from Statistics departments at two Brazilian universities who teach courses in the health area, with Statistics Education or scale validation as their areas of expertise; and Psychometrics: a research group on psychological assessments at a Brazilian university that focuses on the construction, adaptation, and standardization of instruments; as well as with a group of four undergraduates from three different health courses. Individual virtual meetings were held with each person or group in which the questions were presented, each one was discussed, and an understanding of the translation carried out was assessed. Suggestions were given to obtain a version that was faithful to the original instrument and clear enough for the target population of the research.

As a result of this process, the instructions presented at the beginning of the scale and four items were revised and rewritten. Following this change, a new round of conversations with undergraduate students was held. This time, instead of talking individually with students about the questions and their understanding, a pilot study was conducted using the instrument, which had already been modified and was made available to students online, through a link that led to an electronic form created via SurveyMonkey, which was self-administered. This would be the same method used to apply the instrument to the sample.

The group of students who participated in the pilot study was a snowball sample. The composition of the group began with contacting a student from the UFRGS Pharmacy course. This student was invited to respond to the online questionnaire and provide feedback regarding her understanding of the questions and the presentation of the self-administered instrument.

After receiving her response, she was asked to nominate another colleague, and the process was repeated until eight students were reached.

Right at the beginning of the pilot, a suggestion was common to the first three participants: the way the instrument was presented online made it difficult to visualize the answer choices. A change was then made to the presentation of the items, and the pilot continued. For the other participants, no changes were necessary, as everyone understood that the items were written clearly and arranged in an easy way to be answered. We thus conclude the scale adaptation stage.

5 Materials and Methods: Data collection procedures

Data collection occurred using different strategies at the two universities. At UFRGS, probability sampling was used. However, given the low student participation rate, a census was conducted at UFBA; that is, all students who met the inclusion criteria were invited to participate in the study.

By stratified sampling, the composition of the sample was carried out by drawing groups from each stage, course, and stratum of the population. The draw was carried out by generating a list of random numbers obtained using the statistical software R. For each of the subjects, each stage, and each course, a number (ID) was assigned, and the sample is made up of the IDs drawn from the subjects corresponding to the list generated by the software.

Based on this selection, a standard email was sent to the responsible teachers, informing them that their class had been selected to participate in the research and asking whether they would agree to help disseminate an email inviting students. Teachers had fifteen days to respond. In the case of non-response or non-agreement by the stipulated date, draws were made again, and the procedure was repeated until all courses had a class from each stage with a positive response from the teacher contacted.

As soon as the professor returned the email agreeing to help, another standard message was sent to him to be passed on to the students in the class, inviting them to participate in the study online, using a link available in the body of the email. Student participation occurred voluntarily, after agreeing to the Free and Informed Consent Form (TCLE) presented at the beginning of the electronic form.

Contact with UFRGS professors was made between September 21 and November 27, 2020. In total, 174 subjects were drawn, corresponding to 463 classes and 4,505 occupied places. Teachers from 105 subjects (corresponding to 277 classes and 2,394 occupied places) returned the contact agreeing to help disseminate the e-mail with an invitation to students in the selected classes.

At UFBA, where contact was made via email directly by IMS, the total number of active undergraduate students in January 2021 was 1,287. In the email, students were invited to participate in the online study using the provided link. Participation was voluntary, and students had to agree to the ICF presented at the beginning of the electronic form.

This research project was approved by the Health Research and Ethics Committees of UFRGS and UFBA (Certificate of Presentation of Ethical Appreciation number 20515819.6.0000.5347).

6 Analytics

In the Confirmation stage, according to the International Test Commission's (2017)

guidelines, certain steps must be taken to validate an instrument. Among them, we highlight: (1) selecting a sample with characteristics relevant to the intended use and of sufficient size for empirical analyses; (2) providing relevant statistical evidence about construct, method, and item equivalence for the intended population; and (3) providing evidence that supports the norms, reliability, and validity of the adapted version of the scale in the intended population.

To ensure the recommended steps, the following were carried out: descriptive analysis considering sample characteristics; calculation of Cronbach's alpha (with a confidence interval [CI] of 95%) to evaluate internal consistency; structural equation modeling considering the same strategy used by Schau et al. (1995); and correlation analysis to evaluate concurrent criterion validity.

As for the descriptive analysis, the quantitative variables are presented through measures of central tendency (mean and/or median) and dispersion (standard deviation [SD] and/or interquartile range — IQR). Qualitative variables are presented in absolute and relative frequencies. The scoring of each dimension was carried out according to the scale author's description: for negatively worded items, the scoring was inverted (1 becomes 7, 2 becomes 6, and so on), so that the highest score always represented the most positive response; the responses to the items in each dimension were added, and this sum was divided by the number of items in the dimension.

For the analysis of the factorial structure, carried out via a second-order factorial model, the same procedure performed in the original instrument was considered. This consisted of creating plots for each of the instrument's dimensions, with the aim of improving its reliability (Dauphinee, Schau & Stevens, 1997). Two portions were considered for the Affective dimension (A1 and A2), two for Cognitive competence (C1 and C2), three for Value (V1, V2, and V3), and two for Difficulty (D1 and D2). Each installment consists of three questions, except for D1, which consists of four.

In the second-order factorial model, it was assumed that the factors Affective, Cognitive Competence, Value and Difficulty (termed first-order factors) serve as indicators of attitude (second-order factor). The estimation was conducted using the maximum likelihood method, and standardized parameter estimates are presented. To assess the model's adequacy, the Chi-square statistic (x^2) and the Goodness-of-Fit (GFI), Root Mean Square Error of Approximation (RMSEA), and Tucker-Lewis Index (TLI) indices were considered.

For concurrent criterion validation, Spearman correlation was used. All analyses were performed using the R software, version 4.1.0. The descriptive sample level considered was 5%.

7 Results

In total, 1,052 students accessed the electronic survey form. Of these, 1,050 consented to participate in the study, and 830 answered all questions. Eighteen questionnaires were excluded because they were from students from other areas, and one questionnaire was excluded because it did not have course information. The final sample, composed only of forms with complete answers and from students in the health area, consisted of 811 subjects, representing all 15 undergraduate courses in the health area.

Among the respondents, the median age is 22 years old (IIQ: 20–25 years old), with 73.9% of them identifying as female and 65.8% being initial-stage students (up to half the number of course stages). When asked how they evaluate their results in Mathematics subjects during high school, the average grade among students was 5.08. In the question that assesses

how good they consider themselves to be in Mathematics, the average drops to 4.50.

Regarding how much they believe they will use statistics in their future professional field, the average obtained was 4.98. When asked how confident they consider themselves when using statistics, the average was 3.65. The average for how complex they think statistics is was 5.33. As for the SATS-28 scale scores, the higher their value, the more positive the attitudes related to the dimensions are. For the difficulty dimension, high score values imply less difficulty for individuals. In Table 1, descriptive measures of mean and standard deviation and Cronbach's alpha coefficient values are presented for each of the dimensions of the SATS-28 Portuguese version.

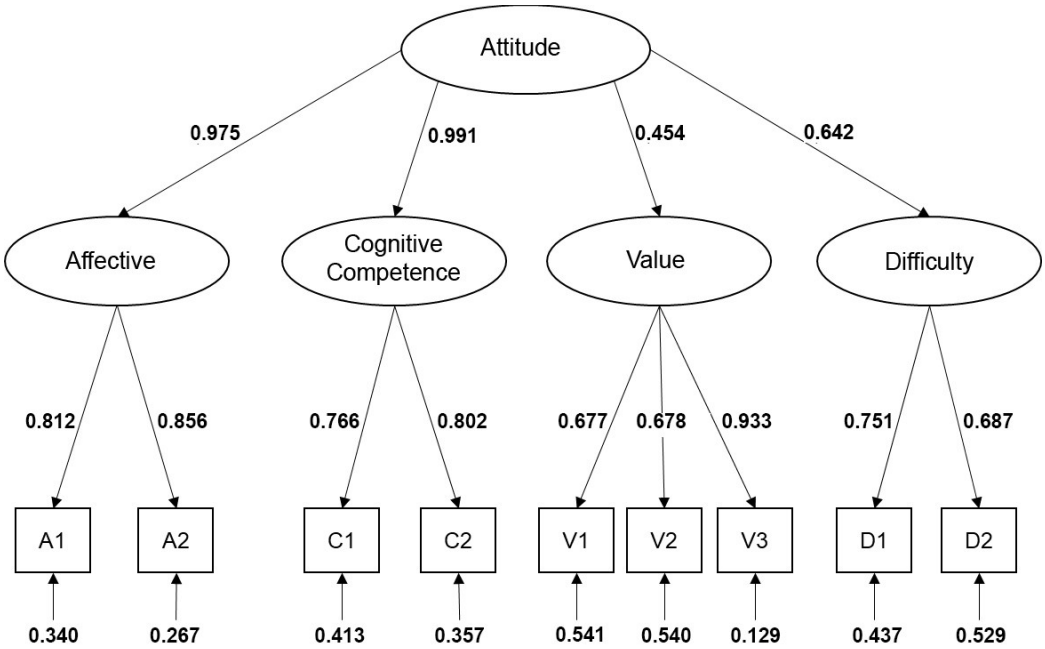
Table 1: Means and standard deviations (SD), internal consistency measure (Cronbach's Alpha) and their respective 95% confidence intervals (95%CI) for SATS-28 dimensions, Portuguese version.

Dimension	Mean (DP)	Cronbach's alpha (95% CI)
Affective	3.95 (1.33)	0.81 (0.79; 0.83)
Cognitive Competence	4.84 (1.14)	0.76 (0.74; 0.79)
Value	5.71 (0.88)	0.77 (0.74; 0.80)
Difficulty	3.18 (0.87)	0.63 (0.58; 0.67)

Source: Survey data

The path diagram is presented in Figure 1 and considers the SATS-28 structure model, composed of four factors as indicators of the latent factor attitude. Regarding model adequacy measures, the following values were obtained: : $\chi^2 = 148.1$; $gl = 23$; $\frac{\chi^2}{gl} = 6.44$; $GFI = 0.96$; $RMSEA = 0.08$ $(IC90\%: 0.070 - 0.095)$; $TLI = 0.94$.

Figure 1: SATS-28 path diagram, Portuguese version.



Source: Survey data.

Finally, to carry out concurrent criterion validation, Table 2 presents the values of the Spearman correlation coefficient, with their respective p-values, for each dimension and additional question answered by the participants and described at the beginning of this section.

Table 2: Validity of concurrent criteria (continued)

Dimension	Mathematics during High School.	Do you consider yourself good at Mathematics?	How confident do you consider yourself when using Statistics?	How complex do you consider Statistics?
Afffective	0.326 (p < 0.005)	0.499 (p < 0.005)	0.605 (p < 0.005)	-0.321 (p < 0.005)
Cognitive Competence	0.400 (p < 0.005)	0.568 (p < 0.005)	0.545 (p < 0.005)	-0.261 (p < 0.005)
Value	0.086 (p = 0.015)	0.195 (p < 0.005)	0.293 (p < 0.005)	0.001 (p = 0.969)
Difficulty	0.151 (p < 0.005)	0.211 (p < 0.005)	0.297 (p < 0.005)	-0.458 (p < 0.005)

Source: Survey data

Table 2: Validity of concurrent criteria (continued)

Dimension	Importance of Statistics in your daily life.	Importance of Statistics in your area of training.	Importance of Statistics in your undergraduate course.
Affective	0.215 (p < 0.005)	0.169 (p < 0.005)	0.145 (p < 0.005)
Cognitive Competence	0.131 (p < 0.005)	0.178 (p < 0.005)	0.154 (p < 0.005)
Value	0.432 (p < 0.005)	0.456 (p < 0.005)	0.470 (p < 0.005)
Difficulty	0.007 (p = 0.838)	-0.066 (p = 0.06)	-0.031 (p = 0.384)

Source: Survey data

8 Discussion

There is a higher average score for Value (5.71), close to the neutrality zone for Cognitive Competence (4.84), and negative attitudes for the Affective (3.95) and Difficulty (3.18) dimensions. This behavior indicates that undergraduate students in the health area consider Statistics to be difficult and have a negative affective attitude; however, they understand its importance.

The internal consistency estimates obtained were greater than 0.7, a value considered acceptable (Hair, Black, Babin, Anderson, & Tatham, 2009), with the exception of the Difficulty dimension. The same behavior was reported in the original scale (Schau et al., 1995).

Regarding the analysis of the second-order factorial model, a good model is expected to present small values of the Chi-square statistic, which results in a high p-value. However, failure to reject the null hypothesis only indicates that the model is consistent with the data matrix, but not that the model is correct (Hair et al., 2009; Giordani, 2015). Furthermore, it is not recommended to rely solely on one measure of model fit. Therefore, although the results obtained were not as expected, additional measures were used to assess the suitability of the model.

For the GFI and TLI indices, values close to 1 are considered ideal, and values between 0.9 and 0.95 are acceptable. For RMSEA, values close to 0 are considered ideal, with 0.10 being acceptable (Hair et al., 2009; Giordani, 2015). In this way, the joint analysis of the obtained results allows us to trust that the obtained model is adequate.

Inspection of the maximum likelihood estimates of the parameters (Figure 1) shows that each of the first-order plots is strongly associated with its hypothesized factor. Furthermore, the correlations between the first-order factors (Affect, Cognitive Competence, Value, and Difficulty) and the second-order factor (attitude) were significant ($p < 0.05$). It is worth noting the correlation between the first-order factors Value and Difficulty, which presented the lowest values ($r = 0.454$ and 0.642, respectively).

The Affective and Cognitive Competence dimensions showed weak or moderate, but significant, correlations with all the questions assessed. Different behavior was observed for the Value and Difficulty dimensions.

A moderate and significant correlation was found between the question "Do you consider yourself good at Mathematics?" and the Affective and Cognitive Competence dimensions. The question related to confidence in the use of Statistics was the one that presented the highest correlation values, being positively associated ($p < 0.005$) with the Affective ($r = 0.605$) and Cognitive Competence ($r = 0.545$) dimensions.

The questions related to the importance of Statistics showed moderate ($r \sim 0.5$) and significant ($p < 0.05$) correlations with the Value dimension. Finally, the question related to the complexity of Statistics showed a negative, moderate ($r = -0.458$) and significant ($p < 0.05$) correlation with the Difficulty dimension.

The results of this study are consistent with the definition of Hourigan, Leavy, and Carroll (2016) and the findings of Chen et al. (2018). The more positive the student's attitude toward Mathematics, the greater their positive attitude toward Statistics, their intellectual knowledge, and ability when using it. Furthermore, they corroborate the results obtained by Silva, Oliveira, and Miguel (2015) in a study that validated the SATS-28 scale in Portuguese (European Portuguese).

Therefore, the joint evaluation of the results obtained indicates that the SATS-28 scale Portuguese version (Brazil) is considered valid; that is, the dimensions measure what they propose to measure.

9 Conclusion

Despite being present in different contexts, the importance and use of statistics have perhaps never been so explicit as amidst the pandemic experienced in Brazil and around the world since 2020. During this scenario with such controversial information, the ease of manipulating or distorting data is clear. Therefore, knowing how to critically interpret information presented by the media, articles, or any other source of information becomes increasingly fundamental.

On the other hand, it is known that health professionals sometimes have a high degree of anxiety regarding statistics due to their negative experiences with mathematics (Pimenta, Faria, Pereira, Costa, & Vieira, 2010). Furthermore, it is also known that a student's attitude is directly related to their performance (Pimenta et al., 2010; Chen et al., 2018). Therefore, understanding students' attitudes toward statistics plays an important role in teaching this subject, as positive attitudes contribute to better use and understanding of the statistical information presented daily.

Therefore, this study aimed to validate the Brazilian version of the SATS-28, considering its original four-dimensional structure. The results obtained suggest that the instrument can be considered valid and reliable for measuring the attitude of undergraduate health students toward Statistics.

Regarding attitude, these students consider Statistics to be a difficult subject (the Difficulty dimension presented a lower average). However, they understand its importance since they showed positive attitudes related to the Value dimension.

It is worth highlighting here the important role of the teacher who, through teaching practices less focused on calculations and more on applications and interpretations of statistics in the context of the student's education, can help them develop more positive attitudes.

The results presented are limited by the fact that only students from two Brazilian universities participated in the research, limiting their generalizability.

Another limiting factor of the study is the low rate of student participation in the research. Initially, data collection was to be carried out in person until there were representatives from all levels of each course. However, with the onset of the coronavirus pandemic in the country and the change of classes to a remote format, the initial plan needed to be changed and data collection needed to be done online, through the teacher or LMS, responsible for forwarding the invitation email to their students.

Online surveys present a low response rate as a barrier. This, coupled with the fact that many studies in this format are being conducted simultaneously during the collection period of this study, and the fact that, according to the teachers' reports, students do not always access their emails, hindered obtaining a larger sample with representatives from all stages of each course.

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Despite this, the Brazilian version of SATS-28 met the necessary requirements to be considered valid and reliable and can be used by teachers, researchers, and research who wish to investigate the attitude of undergraduate students in the health area toward Statistics. It is worth noting that, according to guidance from Schau et al. (1995), the general score should not be used, as it was not validated by the author.

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