British Journal of Applied Science & Technology
18(4): 1-11, 2016; Article no.BJAST.29673
ISSN: 2231-0843, NLM ID: 101664541

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Clustering the Attitudes towards Statistics and Technology among Medical Post Graduate Students

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Authors' contributions

This work was carried out in collaboration between all authors. Authors AS and HT designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the literature searches. Authors RY and SK managed the analyses of the study and literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJAST/2016/29673
Editor(s):
(1) Lesley Diack, School of Pharmacy and Life Sciences, Robert Gordon University, UK.
Reviewers:
(1) Stephen Akandwanaho, University of KwaZulu-Natal, South Africa.
(2) Vicente Estrada, Universidad Complutense , Madrid, Spain.
Complete Peer review History: http://www.sciencedomain.org/review-history/17549

Original Research Article

Received 23rd September 2016
Accepted 18th November 2016
Published 18th January 2017

ABSTRACT

Introduction: Rapid development of statistics and its application in various sciences along with the growing advances in data manipulation and representation with modern computer technologies accentuate the need for replacing traditional methods in statistics education with modern ones. This study is primarily concerned with measuring the psychometric properties of the Persian version of Students Attitudes toward Statistics and Technology Scale (SASTSc) to obtain a tool for assessing attitudes in educational settings.
Methods: The reliability analysis was undertaken on 192 medical students, 21 Ph.D. students and 171 M.Sc. students who passed or were taking vital statistics course at Ahwaz Jundi Shapour

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University of medical sciences. SASTSc was adapted based on internationally accepted guidelines for translation and cultural adaptation. The psychometric properties of the Persian version of SASTSc were analyzed using confirmatory factor analysis and internal consistency. To find the attitudes of participated, homogeneous groups were also identified using cluster analysis based on the principal components derived from factor analysis.

Findings: Most medical students showed positive attitudes to learning statistics by technology. The average score of five dimensions of the questionnaire was above 3, indicating students' positive attitude toward using technology in teaching statistics. Confirmatory factor analysis validated the five-factor structure (statistics cognitive competence, technology cognitive competence, usefulness of technology in statistics, attitudes to the worth and usefulness of statistics and emotion concerning statistics). The comparative fit index was above the cutoff point of 0.80 (CFI=0.851) and the Non-Normed Fit Index was also acceptable (NNFI=0.74). The Root Mean-Square Error of Approximation (RMSEA) equaled 0.081, indicating that the model is a good fit. Cronbach's α was 0.892 for the whole scale, confirming the scale's reliability.

Conclusion: The current research provides some evidence for appropriate metric properties of the Persian version of SASTSc. Confirmatory factor analysis validates the five-factor structure of the scale. SASTSc can be used as a valid and reliable tool to determine the opinions of the students in relation to learning statistics with technology in Iranian educational settings.

Keywords: Confirmatory factor analysis; cluster analysis; attitude; statistics; technology.

1. INTRODUCTION

The meaning of the term "technology" has changed significantly since its emergence in education. This term has its roots primarily in computer science-related fields but today; it is used in more sophisticated devices like TV, educational videos or presentations. The term "educational technology" mostly connotes computer, software and related facilities [1,2].

Rapid development of statistics and its application in various sciences along with the growing advances in data manipulation and representation with modern computer technologies accentuate the need for replacing traditional methods in teaching statistics with modern ones. This, of course, does not mean that the traditional methods should be forgotten altogether but it encourages the combination of both traditional and modern approaches. A large body of scholarly literature discussed different ways of using computer in teaching statistics courses at universities and tried to investigate the impact of using technology in improving teaching quality. As Biehler suggested, modern computing has revolutionized the practice of statistics so that practical statisticians have achieved a great progress in statistical computing [1].

Following Biehler, Moore [3] has paid a lot of attention to a technology-based approach in teaching statistics. He believed that statistics education is affected by the reforms which have taken place in the teaching of mathematics, and technology, as a part of this process, strongly influences what we teach and how we teach. He also maintains that computer sciences will dominate statistics in future, and educational technology will find its way into our classroom.

Garfield and Burrill draw attentions to three major points in using technology as follow:

1- Technology should be helpful.
2- Both hardware and software should be accessible.
3- Students should be experienced enough to take advantage of technology.

They also believe that the advances in computers and computing during the past quarter of a century have resulted in replacing it with other technological teaching aids. The advantages of computer and software including their dynamic nature, their speed, together with their increased storage capacity and processing power, enable students to experience and explore all aspects of the statistical process--from planning the sampling or experimental design, through data collection, database management, modeling, and analysis, to interpreting and communicating findings [4]. Garfield et al. [2] suggested that instructors employ technology not just as a way to compute numbers but as a way to explore ideas and concepts and improve student learning.

Ben states that technology is changing faster than at any time and is changing the way people teach and learn. He specifically emphasizes the use of web-based classes to improve the quality of statistics education [5]. Chance et al. [6], however, have gone further. They maintain that the idea of teaching statistics today without some form of technology is almost impossible.

However, the question raised here is how technology can shape teaching and learning statistics. Therefore, the instructors, people and students' attitudes towards learning statistics with technology need to be evaluated. This evaluation is of great importance in theory and practice. Evaluating the attitude to technology-supported learning in statistics can provide students, instructors and planners with helpful information. To do so, teaching statistical softwares can be a good way to evaluate various teaching courses, or students or instructors can provide decision-makers with their feedback on teaching or learning statistics with technology to allow them make informed decisions.

Evaluation of attitudes toward teaching statistics with technology and its relation with other variables is only possible if a proper assessment instrument is available, being validated with respect to reliability and validity. These studies pay a lot of attention to evidence that the predetermined structure of the instrument demonstrates an acceptable fit to the data and that all items are measured by the instrument. If such evidence is available, results can be unambiguously interpreted [7].

Anastasiadou was the first who drew a lot of attention to this issue. In this study, the internal consistency of the questionnaire was evaluated by Cronbach's α, which is considered to be the most important reliability index. The results showed a value of 90.8%, thereby validating the reliability of the research scale. Then a Principal components analysis with Varimax Rotation along with computation of certain values were carried out to determine the factors that remain in the scale [8].

Despite the importance the foregoing discussion seems to have, investigation of the related literature indicates that the instrument proposed by Anastasiadou has been the only one used to assess attitudes toward statistics education. Therefore, scholars need to conduct more studies in this regard, especially on determining the factors affecting this attitude. Due to the lack of the Persian version of this scale, this study primarily aims to fill the gap to enable teachers, students and scholars to evaluate students' attitudes toward using technology in statistics education. Then it seeks to explore the ideas and factors affecting the outcomes of statistics courses at universities.

2. METHODOLOGY

The sample consists of 192 Iranian students from the school of the Medicine of Jundi Shapour University in Ahwaz, Iran. The students were allotted 10 to 15 minutes to complete the questionnaire. All questionnaires were returned. Additional information about individuals' academic fields and demographic status was collected as well. The participants felt free to take part in this study, and all questionnaires were filled out anonymously. The students were told that this scale is used to measure their attitudes toward learning statistics with technology and its impact on their professional and personal lives. This scale includes 28 items referring to 5 attitude subscales as positive and negative attitudes concerning a student's knowledge and skills as applied to statistics, positive and negative attitudes concerning a student's knowledge and skills as applied to computer technology, positive and negative attitudes concerning a student's attitudes to learning statistics with technology, positive and negative attitudes to the worth and usefulness of statistics in students' personal and professional life, and finally, positive and negative emotions concerning statistics. Each item of the instrument used a 5-point Likert scale that ranged from 1- Strongly Disagree to 5- Strongly Agree [8]. As included in the guideline of the questionnaire, there was no reversed items. Each factor was measured on five variables.

Anastasiadou aimed to consider Students Attitudes toward Statistics and Technology Scale as an instrument to measure students' attitudes that monitors affective factors relevant to learning statistics with technology. The researcher evaluated the validity and reliability of the questionnaire and asked a Greek sample to fill it out. This tool was composed of 28 items referring to five different conceptual variables, as follow: "1- statistics cognitive competence (questions 1-6), 2- technology cognitive competence (7-10), 3- attitudes to learning statistics with technology (11-16), 4- attitudes to the worth and usefulness of statistics (17-22) and 5- emotion concerning statistics (23-28)". The study reported the responses of 123 Greek students. The results of the paper presented the final scale, consisting of all 28 items of the initial SASTS scale, and the questionnaire proved to be valid and reliable. The model was fitted using chi-square goodness-of-fit test [8].

Two forward translations were made from English into Persian independently of each other by the first author, as a professional statistician, and by an English translator with no statistical background(Forward translation) [9]. Then two translations were compared with each other and with the original questionnaire. Differences were debated and the pre-final version of the Persian translation of SASTSc was resulted(Backward translation) [9]. Next, a statistics expert was asked to translate version 1 back into English to make sure that version 1 reflected the same item content as the original version. Differences and possible ambiguities were discussed. The Persian version of the questionnaire was tested on 16 subjects to evaluate its readability and clarity. The participants were asked to write down their suggestions on the content of the questionnaire when filling it out. Their comments did not point out any problems with the questionnaire and thus no changes were made. The Persian version of the scale is available on request from the first author. As was the case in the studies of Templar [10] and Van hoof [7], this study focuses on graduate students.

2.1 Statistical Analysis

Raw data were considered to identify any deviations from normality and outliers. Table 1 presents the descriptive statistics of this sample. The psychometric properties of the Persian version of SASTSc were evaluated through measuring factor structure and internal consistency. LISREL was used to analyze CFA of the five-factor scale. Box plot was also used to detect the univariate outliers. Box plot, as one of the most helpful exploratory graphs used to display variation in samples of statistical population, is depicted for the extracted factors. As can be seen in this plot, the highest mean is obtained for the fourth factor (attitudes to the worth and usefulness of statistics), whereas the third factor (usefulness of technology in statistics) received the maximum scores. Although the maximum scores were obtained for item 10 of the second factor (technology cognitive competence) and item 5 of the first factor (statistics cognitive competence), they were generally ranked below the other three factors with respect to the scores obtained. Items of each subscale were grouped together [11,12]. Significance and size of factor loadings, standardized residuals and modification indices were reviewed for the proposed model [11]. The correlations among latent factors were checked as well.

Although standardized residuals demonstrate which relationships are not well explained, they would not suggest ways that the model might be altered to arrive at a better fitting model [11]. Therefore, modification indices rather than standardized residuals were used to guide model modification. There are no clear guidance or cutoff points on how to choose modifications indices. The best way is to choose modification indices with the highest values. To avoid the risk of deciding and building models on chance, moreover, theoretical arguments were used to guide the modification of the model [11,13-15].

The ordinal nature of SASTS scale was also considered and basic assumptions (like multivariate normality) was investigated. Two Robust Maximum Likelihood (RML) estimation techniques were undertaken: RML for ordinal data with polychoric correlations [14] and RML with covariances [12]. RML is preferred to Weighted Least Squares estimation (WLS) because WLS requires a very large sample size and produces more proper results as model complexity increases [16]. RML is preferred to ML for both polychoric correlations and covariances to correct nonnormality of the data. When departure from multivariate normality is present and data are categorical, parameter estimates, chi-square statistics and standard errors tend to be biased [12]. In this case, Satorra-Bentler adjustment of the chi-square statistics is suggested to adjust estimations based on the degree of normality [11,13]. First, canonical correlations are analyzed. Canonical correlation estimates what Pearson correlation coefficient between two ordinal variables would be if both were continuous and normally distributed in the population [13]. Afterwards, the estimated continuous population variables are used in the confirmatory factor models instead of observed variables [17]. Next, the covariance matrix is analyzed, conditional on the assumption of continuous observed variables. A covariance matrix that is also known as variance-covariance matrix, is a matrix whose element is the covariance between the elements of random vectors of variables. This analysis together with Satorra-Bentler adjustment provide accurate parameter estimates for Likert scale with five responses under nonnormal conditions [7]. Because SASTSc is based on five-point Likert scale, this technique seems appropriate. Satorra-Bentler-scaled chi-square statistics [13,14] is obtained during the CAF analysis to evaluate the magnitude of discrepancy between the sample and fitted matrices. As noted earlier, SBS is used to correct normality in the data. However, it is worth mentioning that chi-square-based statistics are sensitive to sample size [11]. This may lead to the rejection of logical models since small degrees of lack of fit result from small P-values when sample size is large [7]. Thus, other goodness-of-fit indices were used to evaluate the model: Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI) and Non-Normed Fit Index (NNFI) [11,12,18]. RMSEA value less than 0.05suggests good model fit, whereas RMSEA in the range of 0.05 and 0.08 shows a reasonable fit. CFI and NNFI values fall between 0 and 1, where higher values are indicative of better model fit. The value 0.90 suggests more acceptable model fit [12,18-21].

Cronbach's α is also used to evaluate the internal consistency reliability of the questionnaire. This index is based on the number of all variables or items in the questionnaire and demonstrates the correlations among them. The reliability of an instrument means that its results are characterized by repeatability, and these results are not associated with measurement errors. Cronbach α is the most important index of internal consistency and is the mean of correlations of all the variables, yet does not depend on their arrangements [8].

After validating the scale structure, the students were grouped using cluster analysis method. This analysis was performed under certain conditions as follow: 1) each group is homogenous with respect to certain characteristics 2) each group should be different from other groups with respect to the same characteristics. In fact, observations in each group are similar to each other. Like factor analysis, clustering is used to group observations. However, it is notable to say that factor analysis aims to cluster variables into homogenous classes and measure a latent variable. Therefore, factor analysis is an appropriate way to determine latent variables and their related observed variables, whereas cluster analysis serves to group the variables [21].

3. FINDINGS

A sample of 192 students from the school of medicine at Ahwaz Jundi Shapour University of Medical Sciences, filled out the SASTSc questionnaire. The average age of students was 27.86 ± 4.44 (ranging from 23 to 33). Statistical indices presented in Table 1 were obtained from M.Sc. and Ph.D. students, most of whom were women (81%). The overall score of each item was calculated. Box plot 1 displays the median and interquartile range of the factors of the questionnaire. As can be seen, statistics cognitive competence received the highest score, whereas technology cognitive competence was given the lowest score. Usefulness of technology in statistics received a high score.

Table 1. Descriptive of background characteristics of participated students

		M.Sc N=171 (89%)	**Ph.D N=21 (11%)**
Age mean (SD)		27.3 (4.4)	31.0 (3.6)
Gender n (%)	Male	32 (19%)	5 (24%)
	Female	139 (81%)	16 (76%)
Faculty n (%)	Medicine	123 (72%)	9 (43%)
	Health	16 (9%)	3 (14%)
	Nursing & midwifery	20 (12%)	2 (10%)
	Para medicine	12 (7%)	7 (33%)

The second plot depicts the percentage of negative responses (disagree, strongly disagree) to each item. As depicted, question 10 is graded the highest (I can fix many hardware problems in computers). The student's ability in testing statistical hypotheses, i.e. item 5 ranked the second place. The lowest percentage of disagreement was calculated for item 21 (statistics helps me to understand politics) and item 15 (I like to use computers to make statistical graphs), indicating students' attitudes toward learning statistics with technology and using it in their personal lives.

Most students showed positive attitudes to learning statistics with technology. The overall average score of SASTSc was higher than 3 (3, 67±0.48). The highest score was obtained for Attitudes to the worth and usefulness of statistics (4.11±0.65). According to the average score obtained for "Emotion concerning statistics", most students feel good about statistics. No sections showed the mean score close to zero, so no students were neutral on the items. Descriptive statistics for students' attitudes toward learning statistics with technology based on gender differences are presented in Table 2.

Table 3 shows the means obtained for the factors of SASTS scale for M.Sc. and Ph.D. students. Accordingly, students have similar attitudes toward worth and usefulness of statistics and attitudes to the worth and usefulness of statistics in either groups. However, these two attitudes are significantly different from other attitudes in the scale.

3.1 Structural Analysis of the Scale

The five-factor structure of SASTSc was validated with RML, and the results pointed to the goodness-of-fit of the model. Satorra-Bentler adjusted chi-square statistics (χ^2=707.407, df=314, p-value<0.001) accepted the model. The values for the goodness-of-fit indices of the proposed model were presented in Table 4.

Analysis of the internal consistency of the Persian version of SASTSc scale indicated that the value of the Cronbach's α for this instrument is 0.892 (89%), thereby getting over the cutoff value of 80%, which is an extra good value for the internal consistency of the conceptual structure of the scale.

The value of the Cronbach's α for these five factors were equal to 0.821, 0.781, 0.875, 0.833 and 0.874 for statistics cognitive competence, technology cognitive competence, usefulness of technology in statistics, attitudes to the worth and usefulness of statistics and emotion concerning statistics, respectively.

Table 5 includes information on scale mean and variance if item deleted, the correlation between a particular item and the sum of the rest of the items and square of the multiple correlation coefficient. The more the correlation between a particular item and the sum of the rest of the items, the higher the homogeneity between that item and the rest of the items. In addition, the square of the multiple correlation coefficient included in column 4 resulted from the multivariate regression between that item and the rest of the items. Thus, increasing square of multiple correlation coefficient implies an increase in the correlation between that item and other items in the scale. The last column, and perhaps the most important part of the table, is an indicator of homogeneity between items and shows the overall reliability of the scale if item deleted.

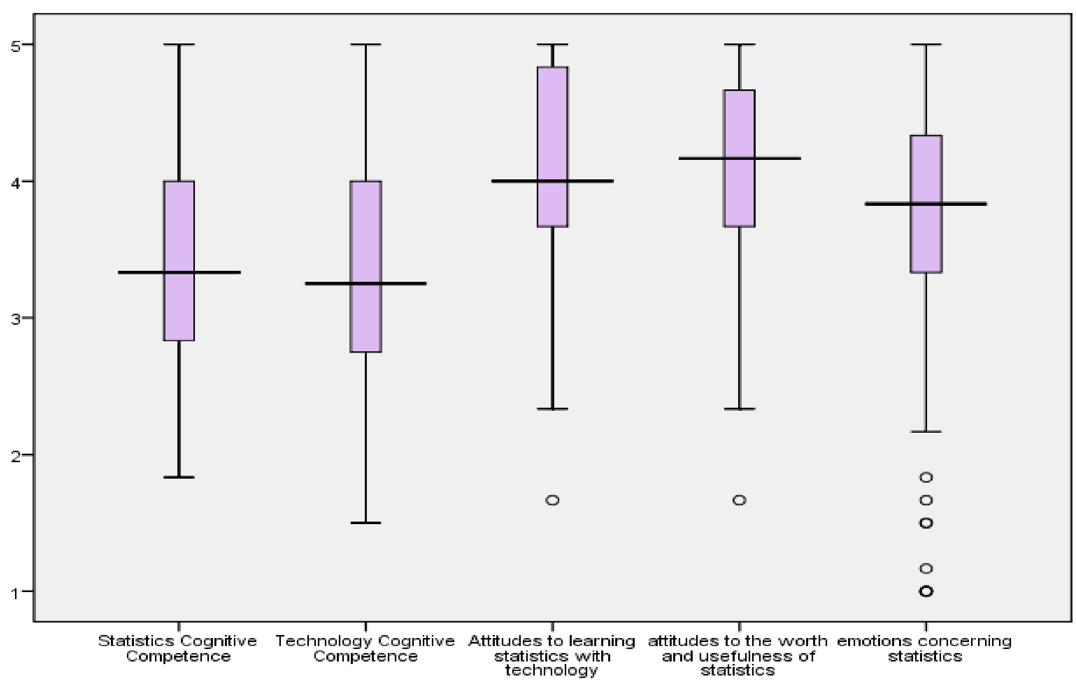

Fig. 1. Box plot for comparing median and distribtion of 5 dimention scors

Table 2. Comparing mean scores all dimensions of attitude between male and female students

	Total (n=192) (Mean±SD)	Male (n=37) (Mean±SD)	Female (n=155) (Mean±SD)
Statistics cognitive competence	3.30±0.72	3.45±0.78	3.27±0.70
Technology cognitive competence	3.17±0.86	3.41±0.89	3.11±0.86
Attitudes to learning statistics with technology	4.03±0.69	3.96±0.82	4.05±0.65
Attitudes to the worth and usefulness of statistics	4.11±0.65	4.09±0.72	4.12±0.64
Emotion concerning statistics	3.73±0.78	3.76±0.80	3.72±0.78
Total	3.56±0.47	3.73±0.54	3.65±0.46

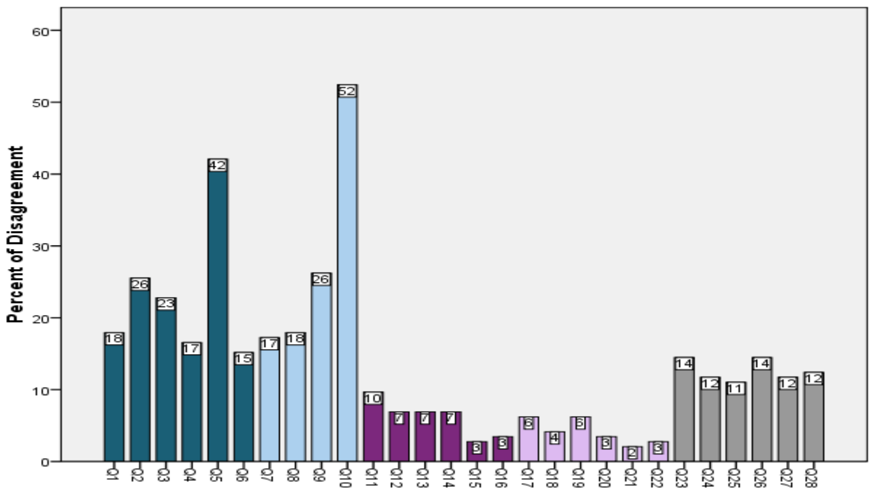

Fig. 2. Bar chart for omparing percent oppose of the questionnaire items

Table 3. Goodness of fit measures of confirmatory factor analysis for 5 dimensions of SASTSc

Model	χ^2	df	RMSEA	NNFI	CFI	BIC	AIC
5-factor	707.40	314	0.080	0.0740	0.851	1043.9	835.4

After validating the scale, the students were divided into three groups using cluster analysis method. As presented in Table 5, the first cluster, containing the majority of the students (65%), gave the highest score to the attitude toward learning statistics with technology. They also got the highest score for technology cognitive competence. The second cluster with 23% of the students received a low score for technology cognitive competence, and the third group with 12% showed the lowest interest in statistics, yet were interested in learning statistics with technology.

4. DISCUSSION

Medicine attaches great importance to statistics since it enables doctors and medical staff to practice evidence-based medicine. It is impossible to develop the skills required to review the evidence published in medical articles and decisions made by medical staff without at least a basic knowledge of statistics [22]. Introductory courses in statistics are the first experience that medical students gain in this regard. In Iran, an introductory course in statistics is obligatory for students of medicine. The syllabus mainly includes some important subjects as major probability distribution, parameter estimation, hypothesis testing, correlation and regression.

In the past decade, American Statistical Association has published the Guidelines for Assessment and Instruction in Statistics Education (GAISE) report [23]. Other suggestions have been proposed by statistics education community, and several studies have collected data on this issue [23]. Today, students of statistics are much concerned about new goals in statistics education. Examples of these include need to understand the purpose and logic of statistical estimators, understanding the statistical estimation procedure, growing trend of instructors' skills, understanding probability and chance, promoting statistical understanding and interpreting skills, developing the ability of contributing to solving statistical problems, etc. Technology paves the way to achieve these goals. As such, students have easy access to modern technology through modern and sophisticated facilities. These devices, particularly computers, help students to collect and analyze data faster and quite better than before.

Table 4. Variation of mean, variance, correlation, and Cronbac's α if item delete

Item number	Question	Mean	Variance	r	α
1	I am confident with statistics	100.5208	167.926	.351	.891
2	I can understand statistical reasoning easily	100.5573	164.855	.497	.887
3	I can understand statistical inference easily	100.6510	167.391	.414	.889
4	I can learn statistics easily	100.1615	167.257	.467	.888
5	I can solve difficult statistical test-hypothesis	101.0469	166.746	.438	.889
6	I take high marks in statistics	100.2552	165.929	.486	.888
7	I am very good at computers	100.2500	168.796	.331	.891
8	I don't have problems at using software	100.3698	169.470	.305	.892
9	I can easily run SPSS	100.6510	161.694	.519	.887
10	I can fix many hardware problems in computers	101.3906	169.485	.270	.893
11	Technology makes the learning of statistics easier	99.7865	166.630	.457	.888
12	Technology makes the learning of statistics more interesting	99.7969	166.906	.493	.888
13	Technology helps me to understand statistics	99.8229	165.675	.538	.887
14	I prefer to use technology to evaluate statistical problems	99.8281	166.394	.504	.887
15	I like to use computers to make statistical graphs	99.6094	171.276	.345	.891
16	SPSS software helps to discover many different statistical applications	99.9531	166.317	.533	.887
17	Statistics is valuable	99.7135	165.284	.528	.887
18	Statistics makes me overqualified	99.5990	168.032	.518	.888
19	Statistics is a part of our daily life	99.8333	168.339	.416	.889
20	Statistics helps me to understand economy	99.6198	169.954	.411	.889
21	Statistics helps me to understand politics	99.8438	169.284	.413	.889
22	Statistics helps me to understand reports on the newspaper	99.5990	171.079	.385	.890
23	Learning statistics is enjoyable	100.1771	164.879	.520	.887
24	I like learning statistics	99.8073	168.020	.416	.889
25	Statistics is interesting	100.1719	163.777	.577	.886
26	Statistics is not a frustrating disciple	100.2708	163.424	.566	.886
27	I get a lot of satisfaction solving statistical problems	100.1094	165.459	.539	.887
28	I am not afraid of statistics	100.1042	164.314	.496	.888

Table 5. Results of ANOVA for comparing score means in each cluster

	Cluster1		Cluster2		Cluster3		P-value
	Mean	SD	Mean	SD	Mean	SD	
Statistics cognitive competence	3.41	.70	3.02	.63	3.25	.85	0.006
Technology cognitive competence	3.37	.82	2.66	.75	3.07	.84	< 0.001
Attitudes to learning statistics with technology	4.33	.52	3.42	.56	3.62	.73	< 0.001
Attitudes to the worth and usefulness of statistics	3.42	.54	3.55	.44	3.19	.66	0.036
Emotion concerning statistics	3.86	.60	3.98	.67	2.14	.78	< 0.001
Number of students in each cluster	125		45		22		192

Maxwell believes that attitude toward computer is a broad and general concept and stated that it is necessary to consider the content of this attitude as well as measuring it [24].

The Persian version of SASTSc was prepared to assess the medical students' attitudes toward learning English with technology, and its psychometric properties were evaluated as well. Students did not have any problems with understanding and completing the questionnaire. The mean and standard deviation of the items can be compared with those of future studies. The overall mean scores of the factors was positive, suggesting students' positive attitudes toward the use of technology in statistics education.

The findings of this study confirm the validity and reliability of the items included in the Persian version of SASTSc in a sample of students majoring in medical sciences. CFA analysis validated the five-factor structure (statistics cognitive competence, technology cognitive competence, usefulness of technology in statistics, attitudes to the worth and usefulness of statistics and emotion concerning statistics) of the scale. According to the values obtained for RMSEA, NNFI, CFI indices and their related cutoff values, the five-factor model was accepted. Adjusted chi-square model also confirmed the good fit of the model. The proposed factors were significantly correlated so that a strong correlation was found between attitudes to the worth and usefulness of statistics and emotion concerning statistics. The correlation between attitudes to the worth and usefulness of statistics and usefulness of technology in statistics was the only insignificant correlation observed during the analysis process.

As with the original version, the Persian version of SASTSc with the value of 0.892 for Cronbach's α displays a high internal consistency among items [8]. The index α also confirmed the internal consistency reliability of each section. The lowest value is calculated for technology cognitive competence. Anastasiadou reported that the lowest value of α (73.5) was observed for usefulness of technology in statistics. Other values of α for other factors were as follow: 90.1 for statistics cognitive competence, 82 for technology cognitive competence, 85.6 for attitudes to the worth and usefulness of statistics and 87.9 for emotion concerning statistics.

After validating the scale, the students were divided into three groups using cluster analysis method. The highest mean score concerning the first, second and third factors was obtained in the first cluster, and the highest mean score for the fourth and fifth factors was obtained in the second cluster. Moreover, the first cluster showed the most positive attitude toward the use of technology in statistics.

The main limitation of the present study is the lack of homogeneity among the participants with respect to the variables like gender (male and female), academic fields and academic degrees (M.Sc. and Ph.D.). Accordingly, the results pointed to a significant difference between academic degrees according to the responses obtained. Moreover, all of the variables were measured at a single point in time. Future longitudinal studies, including students from other medical sciences and academic fields, are needed to further validate and generalize the present findings. In addition, the score given to a student may have influenced his/her attitude toward statistics, and the fact that the researchers did not use a standardized test may also affect the results.

5. CONCLUSION

The present study provided evidence for the metric properties of the Persian version of SASTSc. Confirmatory factor analysis validated the five-factor structure of the scale. Good indices for both validity and reliability were obtained. The results reconfirmed the psychometric characteristics of the questionnaire observed by Anastasiadou. The significant correlations were found between the proposed factors. Those students who showed positive attitudes had a better performance on the test. The overall finding is that SASTSc might be a reliable and a valid instrument for identifying students' attitudes towards statistics education. According to the cluster analysis, three distinct groups were identified with respect to their attitudes although they all have positive attitudes toward learning statistics with technology. Most of the students (88%) (sum of the first and second clusters) were interested in statistics, and only 11% (n=22) (the third cluster) expressed indifference about statistics.

As a part of a need to cope with challenges in educational world and meet the needs of future studies for gaining more helpful and meticulous results, we believe the study presented in this article is a launching point for meaningful research related to statistics education.

ACKNOWLEDGEMENT

This article was a part of the Educational Process that performed in Ahwaz Jundishapur University of Medical Sciences. We hereby express our gratitude to the Office of the Vice-Chancellor for Education due to their Sincere cooperation to fulfill this project.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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