

PSYCHOMETRIC PROPERTIES OF THE ATTITUDE TOWARD STATISTICS SCALE ON A BANGLADESHI SAMPLE

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ABSTRACT

Existing literature suggested the attitude toward Statistics as a predictor of academic performance in Statistics. There was unavailability of measures for assessing attitude toward Statistics in Bangladesh. The present study was designed to adapt the Attitude toward Statistics Scale (ATSS: Wise, 1985). The adaptation procedure was done by following the guidelines of the International Test Commission (ITC). The translated ATSS was administered on a sample of 238 students from the University of Chittagong who were selected through non-probability sampling techniques. The internal consistency reliabilities, test-retest reliability, standard error of measurement, face validity, content validity, construct validity, and item response bias were estimated for assessing the psychometric properties of the Bangla ATSS. The item-total correlations, Chronbach's Alphas, split-half reliabilities, test-retest reliability, factor loadings, and DIF contrasts suggested that this measure would be a psychometrically sound measure to apply in Bangladesh context.

Keywords: Attitude, Statistics, Reliability, Validity

INTRODUCTION

Attitude is a tendency attributed to the individual that regularly constitutes his or her thoughts, feelings and behaviors. It is a mental, sensational and behavioral pre-tendency of the individual organized depending on him or her and any object around them, social issue, object, or experience against an incident, information, feeling and motivation (İnceoğlu, 2004). It is inferred but not directly observable. It is comprised of beliefs and behavioral predispositions toward a targeted object (Auzmendi 1991; Gal and Ginsburg, 1994). It is an important predictor of behavior with its cognitive, perceptive and behavioral dimensions. It includes the tendency to the attitude object, the objection to an attitude subject or being on that side (Çakır *et al.*, 2006).

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Students' attitudes influence their own beliefs that also affect their behavior, especially in motivation and achievement (Gal *et al.*, 1997; Dweck, 2002). In recent years, attitudes towards statistics have received increasing attention in education. The ultimate goal of statistics education is to provide appropriate use of statistical thinking and knowledge (Schau *et al.*, 1995). Statistics is necessary for many situations, including for conducting scientific research and advancing knowledge and technology. Attitude towards statistics is defined as a disposition to respond favorably or unfavorably to objects, situations or people related to statistics learning (Chiesi and Primi, 2009). Studies suggested a positive relationship between attitudes toward statistics and statistics achievement (Chiesi and Primi, 2010; Vanhoof, 2010; Wise, 1985). Students' attitudes towards Statistics play an important role in understanding statistical concepts and developing statistical thinking skills that influence the learning and course grades related to statistics. Students' negative attitude toward a course causes for their feelings of anxiety toward the course. It can negatively affect their performance and their overall psychological and physiological condition.

From the authors' observations, most undergraduate students in Bangladesh have a fear toward Statistics course. Their performances are not at the expected level. So, it is important to know their attitude toward the Statistics for improving their performance at the expected level. However, there was no such developed or adapted instrument that would help know about students' attitude toward statistics in Bangladesh. The present study was designed to adapt the Attitudes toward Statistics Scale (ATSS: Wise, 1985) in the Bangladesh context. This scale was developed in response to the difficulties of items of the Statistics Attitude Survey (SAS: Roberts and Bilderback, 1980). At least one-third items of the SAS were related to students' success in statistical problem solving or success in understanding statistical concepts. Items of the SAS measure students' achievement rather than their attitude. These items also inappropriate for students are at the beginning in a statistics course. So, to overcome these difficulties Wise (1985) developed the Attitude toward Statistics Scale. Items of the ATSS are focused on the changing attitudes of students in basic statistics. Shultz and Koshino (1998) reported this measure as a reliable and valid measure for assessing students' attitude toward statistics.

The present study's main objective was to adapt the Attitude toward Statistics scale (Wise, 1985) in Bangladeshi culture. Other objectives were – i) to estimate

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the item-total correlation of the measure; ii) to assess the internal consistency reliabilities; and iii) to determine the convergent validity of the Bangla ATSS.

MATERIALS AND METHODS

Participants

The present study was conducted on a sample of 238 students from the University of Chittagong who were selected through purposive sampling technique. Students studying in the Department of Statistics and who were studied statistics as a course of their Bachelor degree included as the sample in the present study. Their age *mean* was 21.53 years and *standard deviation* was 1.12 years. Among respondents, 132 (55.5%) were male and 106 (44.5%) were female. Among them, 95 (39.9%) were from the Science faculty, 95 (39.9%) were from the Biological Sciences faculty, and 48 (20.2%) from the Social Sciences faculty, and 90 (37.8%) were 2nd-year students, 99 (41.6%) 3rd-year students, and 49 (20.6%) 4th-year students.

Measure

The Attitudes toward Statistics (ATSS: Wise, 1985) is 29 items instrument containing two subscales for measuring attitude toward statistics. These subscales were - (i) Attitudes toward Field (attitude towards the use of statistics as a field of study, e.g., statistics seems very mysterious to me) and (ii) Attitudes toward Course (attitude toward the course, e.g., statistics will be useful to me in my profession). The distribution of items in each subscale of the ATSS is given below:

- (i) *Attitudes toward field*: It includes 20 items and the item numbers are 1, 3, 5, 6, 9, 10, 11, 13, 14, 16, 17, 19, 20, 21, 22, 23, 24, 26, 28, 29; and
- (ii) *Attitudes toward course*: It includes 9 items and the item numbers are 2, 4, 7, 8, 12, 15, 18, 25, 27.

In this scale, respondents were required to express their opinion in 5-point Likert-type scale that ranged from 1 (Strongly Disagree) to 5 (Strongly Agree). The ATSS is a psychometrically sound instrument for assessing students' attitude toward statistics in the field and course level. The *coefficient alphas* were .92 and .90, and the test-retest reliabilities were .82 and .91 for the Attitudes toward Field subscale and the Attitudes toward Course subscale, respectively (Wise, 1985). The Attitude toward Course subscale had significant, and the Attitude toward Field had a non-significant correlation with students' course grades. These

correlations suggested that the subscales are measuring two different type of attitude.

Procedures

Translation and adaptation procedures of the ATSS were done by following the guidelines established by the International Test Commission (ITC) for the translation and adaptation of measurement instruments from one language to another and from one culture to another. Following steps were used for the adaptation of the ATSS –

Stage one: Ensuring construct equivalence and taking permission

Equivalency of the original version of the ATSS in the Bangladeshi culture by meaning was determined by reviewing journals and books written by Bangladeshi scholars. An expert from the Department of Psychology, University of Chittagong, had also judged equivalence of the constructs between the two cultures. It appeared convincing from the literature review along with the expert's opinion that the instrument's construct under the study was equivalent in the Bangladesh context. So, corresponding authors of the measures were emailed to take their permission to adapt the scale in our cultural context.

Stage two: Forward translation

The ATSS was translated into Bangla language by two students – one from the Psychology department and another from the English department of the University of Chittagong (Bangladesh). Then these translations were evaluated by a news translator who was expert in translation between English and Bangla and by a teacher of the Psychology department of the University of Chittagong. These experts put much effort into selecting the best words, expressions of items to translate and evaluate translations. Then these translations of the ATSS were converted into one.

Stage three: Back translation

The back-translation of the translated Bangla ATSS into the original language (English) was done by two persons who were Bangladeshi and expert in the English language. One of them was teacher of English department of Premier University, Chittagong, Bangladesh, and another was student of the A' level at Mastermind International School and College, Chittagong, Bangladesh. Their translations were converted into one. Then, items of the original English version

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and the back-translated version of the two scales were compared by two teachers of the Psychology Department of the Chittagong University to ensure that the translated English version maintained the same meanings and concepts as in the original version. The expert opined that the back-translated version was very much similar to the original version.

Stage four: Pretest

In this stage, the translated Bangla of ATSS was administered on a sample of 30 students selected purposively from the University of Chittagong. The questionnaire was administered in classroom settings. The collected data of the pretest were subjected to *item analysis* to estimate the *item-total correlations* and *internal consistencies*.

The *Cronbach's Alphas* were .891 and .892 for Attitude toward Field subscale and Attitude toward Course subscale, respectively. *Item analysis* revealed that *corrected item-total correlations* ranged from -.050 (Item 16) to .782 (Item 27). Only item 16 had low *item-total correlation* with the total score and the rest of the items had sufficient item-total correlations. Translation of item 16 was reviewed, expert opinions were taken, and finalized for the final study.

Stage five: Final study

In this stage, the translated Bangla ATSS was administered on the final sample of the study. The Ethical Principles of Psychologists and Code of Conduct of the American Psychological Association (APA) was followed. Respondents were requested to read the written instructions carefully. They were also given verbal instructions about their task. They were also assured that the information collected would be confidential and used for research purposes only.

RESULTS AND DISCUSSION

Item Analysis

Collected data of the present study were subjected to the *item analysis* to estimate *corrected item-total correlations* for each item of the Bangla Attitude toward Statistics Scale (ATSS). From Table 1, *item-total correlations* of items of the Bangla ATSS ranged from -.027 (item 16) to .629 (item 12). An item-total correlation value less than .3 indicates that the item does not correlate very well with the scale overall (Field, 2017). Only item 16 had a negative and low item-total correlation. So, this item was excluded from the measure. Item-total

correlation is an index of item discrimination. Low item-total correlation of item 16 suggested that this item failed to discriminate between Bangladeshi people having favorable and unfavorable attitudes toward statistics.

TABLE 1 : CORRECTED ITEM-TOTAL CORRELATION AND CRONBACH'S ALPHA IF THE ITEM DELETED

Item	Corrected item-total correlation	Cronbach's Alpha if item deleted
Item 1	.514	.897
Item 2	.358	.900
Item 3	.429	.899
Item 4	.486	.897
Item 5	.555	.897
Item 6	.363	.900
Item 7	.494	.897
Item 8	.533	.897
Item 9	.573	.896
Item 10	.436	.898
Item 11	.449	.898
Item 12	.629	.894
Item 13	.619	.895
Item 14	.516	.897
Item 15	.494	.897
Item 16	-.027	.909
Item 17	.384	.899
Item 18	.474	.898
Item 19	.581	.896
Item 20	.572	.896
Item 21	.591	.896
Item 22	.497	.898
Item 23	.455	.898
Item 24	.462	.898
Item 25	.554	.896
Item 26	.477	.898
Item 27	.413	.899
Item 28	.379	.900
Item 29	.462	.898

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Validity of the Scale

The Bangla ATSS has face validity and content validity those were confirmed by experts. Moreover, construct validity was assessed through exploratory factor analysis.

Exploratory Factor Analysis (EFA)

Several statistics were examined to determine the suitability of the data for exploratory factor analysis. The *Kaiser-Meyer-Olkin (KMO)* measure of sampling adequacy (.903) and the *Bartlett's test of sphericity* ($\chi^2 = 2590.543.67$, $df = 378$, $p < .001$) suggested sufficiency of the data. Moreover, items' correlation matrix shows that all coefficient values were less than .90, suggesting no multicollinearity problem. The *KMO measure of sampling adequacy* score and the *Bartlett's test of sphericity* score suggested the suitability of the data for EFA. Kaiser (1974) suggested that the KMO score .70 is mediocre, .80 is meritorious, and .90 is superb for EFA. Field (2017) suggested a significant *Bartlett's test of sphericity* score have to significant as it indicates original correlation matrix and identity matrix differed sufficiently. In the present study, the Kaiser-Guttman criterion was followed to assess the number of factors. A component with ≥ 3 items with factor loading $\geq .40$ and an Eigenvalue ≥ 1 was considered as a factor. Table 2 shows that five components have fulfilled the criteria to be considered as a factor. Item 6 cross loads in component 2 and 6. In component 6, its factor loading is negative. So, this item is included in component 2. Among items, 1st factor contains item 11, 13, 14, 24, 29, 2nd factor contains item 1, 3, 5, 6, 9, 10, 19, 3rd factor contains 4, 15, 18, 25, 27, 4th factor contains 17, 20, 21, 22, 23, and 5th factor contains 2, 7, 8, 12. These five factors explained 53.328% variance. Although there are two subscales, attitude toward field is loaded into 3 factors (1st, 3rd, and 4th factor) and attitude toward field loaded into 2 factors (2nd and 5th factors). Such differences may be due to cultural differences. In the original study, Wise (1985) reported that attitude toward field and attitude toward course explained 49% of total variance.

TABLE 2 : COMPONENT MATRIX OF EFA OF BANGLA ATTITUDE TOWARD STATISTICS SCALE

Items	Components					
	1	2	3	4	5	6
Item 13	.661					
Item 24	.655					
Item 29	.604					
Item 11	.537					
Item 14	.509					
Item 10		.614				
Item 1		.608				
Item 5		.586				
Item 9		.584				
Item 3		.519		.508		
Item 19		.516				
Item 18			.748			
Item 25			.711			
Item 15			.664			
Item 27			.620			
Item 4			.530		.473	
Item 22				.766		
Item 21				.634		
Item 23				.630		
Item 17				.532		
Item 20				.448		
Item 7					.753	
Item 2					.624	
Item 8	.466				.579	
Item 12					.526	
Item 28						.739
Item 6		.440				-.530
Eigen Value	8.446	2.661	1.363	1.262	1.200	1.015
Variance explained	30.166	9.504	4.869	4.505	4.284	3.624

Extraction method: Principle component analysis, Rotation: varimax

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Reliability of the Scale

Internal consistency reliabilities: Collected data of the present study were subjected to the *item analysis* to estimate the *internal consistency* reliabilities including *Cronbach's Alpha*, Split-half reliability through *Spearman-Brown coefficient*. Table 3 shows the Bangla ATSS has good internal consistency reliabilities to apply in the Bangladeshi culture (>.8; Kline, 2000). Furr (2011) opined that values between .70-.80 are sufficient to use. Wise (1985) reported that subscales, attitude toward field and attitude toward course, had good *Cronbach's alpha* (.92 and .82 respectively). Cashin and Elmore (2005) also reported good *Cronbach's alphas* of this scale.

TABLE 3 : INTERNAL CONSISTENCY RELIABILITIES OF THE BANGLA ATTITUDE TOWARD STATISTICS SCALE AND ITS TWO SUBSCALES (ATTITUDE TOWARD FIELD AND ATTITUDE TOWARD COURSE)

Subscales	<i>Cronbach's Alpha</i>	<i>Spearman-Brown Coefficient</i>
Attitude toward Statistics Scale	.91 [.892, .925]	.93
Attitude toward Field	.89 [.868, .909]	.90
Attitude toward Course	.83 [.795, .860]	.86

Values in parentheses are 95% confidence interval of *Cronbach's Alpha*

Test-retest reliability: For ascertaining test-retest reliability, data were collected from 20 students within the gap of 1 month. These data were subjected to the *Pearson Product Moment Correlation Coefficient*, to estimate the test-retest reliability. The test-retest reliability of the Bangla ATSS was ($r=.611, p<.01, 95\% CI [.217, .834]$), the Attitude toward Field was ($r=.641, p<.01, 95\% CI [.264, .848]$), and the attitude toward Course was ($r=.612, p<.01, 95\% CI [.219, .834]$). Shultz and Koshino (1998) reported test-retest reliabilities of this scale. The test-retest reliability coefficients were .59 and .72 for the Attitude toward Course subscale and the Attitude toward Field subscale, respectively for undergraduate students. For graduate students, these scores were .71 and .76, respectively.

Standard Error of Measurement (SEM): The *SEM* of the Attitude toward Field subscale is 3.48, and the Attitude toward Course was 2.80. The *SEMs* of both subscales were above the minimum score (accepted level<SD/2). The *SD* of both subscales were 10.50 and 6.80, respectively.

Differential Item Functioning:

To estimate the item response bias among students (students from Statistics department (Major) and students from other departments who study statistics as 100 or 200 marks course (Minor or related course)) the Bangla ATS scale, data were analyzed through DIFAS 5.0 (Penfield, 2013). The *Mantel-Haenszel* χ^2 value ≥ 3.84 is significant at .05 and ≥ 6.63 is significant at .01 (Penfield, 2013). If we consider *p*-value .01, then none of the items has DIF contrast. Table 4 shows that two items (item 5 and item 12) have response bias. The DIF contrast is not present in the rest of the items.

TABLE 4 : DIFFERENTIAL ITEM FUNCTIONING (DIF) INFORMATION AMONG STUDENTS OF THE BANGLA ATTITUDE TOWARD STATISTICS SCALE

Items	Mantel χ^2	LOR Z	COX Z	Items	Mantel χ^2	LOR Z	COX Z
1	.015	.125	.122	14	3.068	1.777	1.752
2	3.515	-1.906	-1.877	15	.034	-.191	-.184
3	1.289	1.178	1.134	17	3.454	1.863	1.86
4	2.156	-1.456	-1.47	18	0	.014	.013
5	5.361*	2.38	2.314	19	.967	.929	.983
6	.546	-.715	-.738	20	.463	.672	.679
7	2.293	-1.574	-1.512	21	.001	-.023	-.023
8	.023	.158	.15	22	1.06	1.012	1.03
9	1.784	1.29	1.335	23	.834	-.889	-.913
10	.226	.467	.476	24	.022	.147	.149
11	1.227	1.081	1.108	25	.084	.27	.292
12	4.097*	-2.043	-2.024	27	2.818	-1.724	1.679
13	3.42	1.815	1.851	29	1.877	1.329	1.373

Reference group: Respondents from Statistics department, Focal group: Respondents from others department; **p*<.05; LOR Z = *Standardized Liu-Agresti Cumulative Common Log-Odds Ratio*, COX Z = *Standardized Cox's Noncentrality Parameter estimator*

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The above discussed information about the Bangla Attitude toward Statistics Scale's psychometric properties suggested that this measure could be applicable in the Bangladesh context. However, this study had some limitations. This study was conducted on students from the Chittagong University who were selected through the non-probability sampling technique. Norms and cut off scores for this measure were not established in this study. For better generalization of the findings using this measure, norms would be needed. Therefore, a study would be undertaken using a representative sample for establishing norms. This scale would be used to assess the undergraduate students' attitudes toward statistics. This scale would also be helpful for introducing the intervening program for changing attitude from unfavorable to favorable. This study would also be useful to the curriculum designers and teachers to determine how students' attitudes toward statistics could be improved.

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Appendix

The Attitude toward Statistics Scale (Bangla version)

নিচে বাম পাশে পরিসংখ্যানের প্রতি মনোভাব সম্পর্কিত কিছু উক্তি আছে। এর ডানপাশে পাঁচ মাত্রার মানকের মাধ্যমে আপনার অনুভূতি বা মনোভাব প্রকাশের জন্য ৫টি পছন্দক্রম (A, B, C, D, E) রয়েছে। প্রতিটি উক্তি মনোযোগ সহকারে পড়বেন এবং যে পছন্দক্রমটি আপনার অনুভূতি বা মতামতকে সবচেয়ে ভালোভাবে বর্ণনা করে সেটিতে টিক চিহ্ন (✓) দিন। এখানে সঠিক বা ভুল উত্তর বলে কিছু নেই। কোনো উক্তি বাদ দেয়া যাবে না এবং না বুঝলে আমাকে জিজ্ঞাসা করবেন।

(A = একেবারেই একমত নই, B = একমত নই, C = অনিশ্চিত/মাঝামাঝি, D = একমত, E = সম্পূর্ণ একমত)

১.	আমি মনে করি পরিসংখ্যান আমার পেশাগত কাজে উপযোগী হবে।	A	B	C	D	E
২.	একটি পরিসংখ্যান কোর্সে অন্তর্ভুক্ত হবার চিন্তা আমাকে বিচলিত(নার্ভাস) করে।	A	B	C	D	E
৩.	একজন ভালো গবেষকের অবশ্যই পরিসংখ্যান বিষয়ক প্রশিক্ষণ থাকা প্রয়োজন।	A	B	C	D	E
৪.	পরিসংখ্যান আমার কাছে খুবই দুর্বোধ্য মনে হয়।	A	B	C	D	E
৫.	পরিসংখ্যান কোর্সে ঘূর্ণনের ফলে অনেকে উপকৃত হবে।	A	B	C	D	E
৬.	শিক্ষাক্ষেত্রের সঙ্গে পরিসংখ্যান কিভাবে সম্পর্কিত তা বুঝতে আমার অসুবিধা হয়।	A	B	C	D	E
৭.	পরিসংখ্যান কোর্সে ভর্তি হওয়া আমার কাছে খুবই অস্বস্তিকর অভিজ্ঞতা বলে মনে হয়।	A	B	C	D	E
৮.	উচ্চতর ডিগ্রির বা কোর্সের মধ্যে আমার পরিসংখ্যানের প্রশিক্ষণ অব্যাহত রাখতে চাই।	A	B	C	D	E
৯.	বিভিন্ন বিষয়, পদ্ধতি, কর্মসূচি ইত্যাদির যথার্থতা তুলনা করতে পরিসংখ্যান আমার কাছে উপযোগী হবে।	A	B	C	D	E
১০.	পরিসংখ্যান কার্যত উপকারী নয়, কারণ ইতোমধ্যে আমরা যা জানি এটি তাই বলে।	A	B	C	D	E
১১.	পরিসংখ্যান বিষয়ক প্রশিক্ষণ আমার শিক্ষাক্ষেত্রের সঙ্গে সম্পর্কিত।	A	B	C	D	E
১২.	আমি যদি পরিসংখ্যান কোর্সটি পরিহার করতে পারতাম।	A	B	C	D	E
১৩.	পরিসংখ্যান আমার পেশাদারী প্রশিক্ষণের একটি গুরুত্বপূর্ণ অংশ।	A	B	C	D	E
১৪.	পরিসংখ্যান কোর্সটি ও গণিত বিষয়ক বলে এটি আমার ভবিষ্যতে কাজে লাগবে।	A	B	C	D	E

১৫.	পরিসংখ্যান বিষয়ক অপর একটি কোর্সে ধারণার চিন্তায় আমি হতাশ হয়ে পড়ি।	A	B	C	D	E
১৭.	পরিসংখ্যান বৈজ্ঞানিক গবেষণার একটি অবিচ্ছেদ্য বিষয়।	A	B	C	D	E
১৮.	যখন আমাকে গাণিতিক সূত্র নিয়ে কাজ করতে হয়, আমি ঘাবড়ে যায়।	A	B	C	D	E
১৯.	কর্মক্ষেত্রে পরিসংখ্যান ব্যবহারে আমি আসলেই উৎসাহিত হই।	A	B	C	D	E
২০.	পরিসংখ্যান পড়া হচ্ছে সময়ের অপচয়।	A	B	C	D	E
২১.	পরিসংখ্যানের ওপর প্রশিক্ষণ আমার শিক্ষাক্ষেত্রে পরিচালিত গবেষণাকে ভালোভাবে বুঝতে সহায়তা করবে।	A	B	C	D	E
২২.	পরিসংখ্যানের উপর প্রশিক্ষণ থাকলে যেকোনো তার গবেষণালব্ধ ফলাফল ভালোভাবে কাজে লাগাতে পারবে।	A	B	C	D	E
২৩.	পরিসংখ্যানের উপর প্রশিক্ষণ সকল বিষয়ে পেশাগত দক্ষতা/অভিজ্ঞতাকে পরিণত করে।	A	B	C	D	E
২৪.	পরিসংখ্যান বিষয়ক চিন্তাভাবনা আমাদের দৈনন্দিন জীবনে গুরুত্বপূর্ণ ভূমিকা পালন করে।	A	B	C	D	E
২৫.	গাণিতিক সংখ্যা নিয়ে কাজ করতে আমি স্বেচ্ছান্যবোধ করি না।	A	B	C	D	E
২৭.	পরিসংখ্যান যথাযথভাবে ব্যবহার করা আমার কাছে খুবই জটিল মনে হয়।	A	B	C	D	E
২৯.	পরিসংখ্যান বিষয়ক চিন্তাভাবনা পড়ালেখার পাশাপাশি দক্ষ নাগরিক হবার জন্যও প্রয়োজন হবে।	A	B	C	D	E

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