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A psychometric scale for determining university students' attitudes towards the statistics courses they take: Statistical Attitude Scale (SAS)

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Abstract

The aim of this study is to develop a Likert type scale to measure the attitudes of university students towards the statistics course they take. Firstly, first and third grade students from Ondokuz Mayis University Arts and Science Faculty Psychology Department are asked to write sentences which include their attitude towards statistic course in sub-dimensions like love, joy, fear, interest, importance, trust, used in daily life and career; then an item pool of 70 items obtained from sentences by created a large literature study. The item pool is examined by academic members of Ondokuz Mayis University Faculty of Education Department of Education Sciences and is reduced to 48 items, then it is examined by academic members of Ondokuz Mayis University Science and Arts Faculty, Department of Turkish Language and Literature and suited to grammar and spelling rules. The pilot Likert type scale of 48 items is implemented on 191 university students taking the statistics course. Item analysis tools are used on the obtained data and 18 items are decided to be removed from the scale. The recreated Likert type scale of 30 items is implemented on 246 university students taking the statistics course and factor analysis is used on the obtained data. 13 items are removed from the scale and it is seen that 17 items are grouped in 3 factors. Later, the final Likert type scale of 17 items is implemented on 477 university students taking the statistics course. The last obtained data has a 0,916 Cronbach alpha reliability coefficient and its internal consistency is perfect. The KMO value, testing the suitability of the final scale for factor analysis, found to be 0,946 and the Bartlett test results found to be χ^2=3305,282 (p=0,00<0,01) which indicates that the suitability of the scale for factor analysis is perfect.

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Keywords: Likert attitude scale; Statistical Attitude Scale; Item remainder correlation; Item selectivity index; Cronbach alpha coefficient; Factor analysis.

1. Introduction

The word *attitude* is firstly used by Herbert Spencer in 1862. Spencer used the word *attitude* to express the mental state of an individual. In the year 1888, Lange treated attitude as a concept in his laboratory studies. Later, attitude concept has become an important topic for research and discussion among psychologists and sociologists [1-5].

According to Anderson (1988), attitude is an excitement of mid-level intensity which prepares someone, or gets someone to have a tendency, to react with a proper or an improper response when met with a special object [2, 3, 6].

According to Allport (1935), attitude is a state of mental or neurotic preparation formed in life, which makes a dynamic or directive effect on an individual's response against the relevant state or object [2, 4, 6].

As seen in these descriptions, attitude reveals itself in emotion, thought and actions. Therefore attitude is a psychological structure which differs from individual to individual, that is not directly observable, and can be associated with beliefs, actions and feelings towards an object, a state or people [3, 7-16, 17].

2. Measuring attitudes

Attitude is a psychological variable which can be seen as an important and critical predictor of behavior with cognitive, affective and behavioral components that are not directly observable [3, 16]. Especially in education research, measuring of attitudes is related to behaviors. To change an individual's behavior in the desired course or to estimate future behaviors, the measure of attitudes is needed. In the measuring of attitudes, it is aimed to obtain reliable scores that can represent an individual's feelings and the density of implications [7, 15, 18, 19].

Attitude scales separate the qualitative features of most variables, into various groups and express them with numerical values. Expressing variables related to attitude by rating enables the comparison of these rates. Rating scales are commonly used in the measuring of attitudes. These scales have three principle assumptions: continuity, linearity and one-dimensionality [3, 15].

3. Likert's total rating scale

This is the scale type developed by Rensis Likert in 1932 and it is the most practical scaling method. This scale includes a series of items related to the subject's attitude towards an object. There are two types of item structures in these scales which are positive and negative approval sentences [8, 16, 17].

Two, three, four, six and seven-point response categories are used in Likert type scales. However, the five-point Likert type scale which is formed as "strongly disagree, disagree, neither agree nor disagree, agree, strongly agree", is the most practical one [8, 15].

Item analysis methods like two independent groups t-test, item selectivity index, simple linear regression analysis, item remainder index, factor analysis and non-parametrical statistical methods are used for item selection in Likert type scales [7, 16, 17].

Spearman rank differences correlation is used to see the rate of relation between the methods used for item analysis. A correlation value close to 1 indicates a good relation between the methods used for item analysis [7, 15].

The internal consistency of Likert type scale depends on the assumption that all the items in the scale would be measuring the same feature. Several methods have been developed to calculate the internal consistency coefficient. Of these methods, the Cronbach alpha internal consistency coefficient is used most. A scale with an internal consistency coefficient greater than 0,60 is considered to be reliable [9, 13, 14].

4. Application

Created pilot scale of 48 items is implemented on 191 university students from various departments of Ondokuz Mayis University taking the statistics course. Responses of subjects to positive items have been rated as "strongly agree = 5, agree = 4, neither agree nor disagree = 3, disagree = 2, strongly disagree = 1", where as their responses to negative items are rated just the opposite [3, 7, 16]. Subjects that are not responded to at least one of the items and those that are given monotone responses are counted as invalid and removed from the analysis and the remaining scale scores of 162 subjects are taken into application.

The draft scale of 30 items, obtained by using item analysis methods on the pilot scale of 48 items and reducing it to 30 items, is implemented on 246 university students from various departments of Ondokuz Mayis University taking the statistics course. Subjects that are not responded to at least one of the items and those that are given monotone responses are counted as invalid and to be removed from the analysis and the remaining scale scores of 228 subjects are taken into application.

The final scale of 17 items, obtained by using factor analysis on the draft scale of 30 items and reducing it to 17 items, is implemented on 477 university students from various departments of Ondokuz Mayis University taking the statistics course. Subjects that are not responded to at least one of the items and those that are given monotone responses are counted as invalid and to be removed from the analysis and the remaining scale scores of 453 subjects are taken into application.

Descriptive statistics belonging to the scores of pilot, draft and final scales are shown in the table below:

Table 1. Descriptive statistics values of scale scores

Descriptive statistics	pilot scale	draft scale	final scale
Mean	146,8025	95,9956	51,0927
Median	148	97	52
Standard deviation	24,88129	20,62151	13,49976
Minimum scale score	90	41	17
Maximum scale score	205	145	83
Skewness	-0,206	-0,258	-0,239
Kurtosis	-0,281	-0,410	-0,391

Kolmogrov-Smirnov normality test p values belonging to the scores of pilot, draft and final scales are greater than 0,01 which means total scale scores follow normal distribution [10, 13].

Table 2. p values belonging to the normality tests for total scale scores

scales	p values
Pilot scale	0,200
Draft scale	0,200
Final scale	0,041

T-test, selectivity index, item remainder correlation and regression analysis are used on the scale scores calculated from the responses of 162 subjects to the pilot scale of 48 items. Item analysis results are shown in Table 3.

18 items are decided to be removed from the pilot scale of 48 items according to the results of the item analysis. The items that are decided to be removed from the scale according to the item analysis methods are shown in Table 4.

Rank scores for t statistics, selectivity indexes, item remainder correlations and regression coefficients are calculated firstly to compare item analysis methods [17, 18]. Spearman rank differences correlation coefficients calculated by using rank scores are as shown:

According to the correlation values seen in the table 5, it can be said that there is a strong relation between the item analyses methods used. The fact that these correlation coefficients are positive and high indicates that the item analysis methods used for selecting items to statistical attitude scale are compatible [7, 14, 15].

Factor analysis is used on item scores obtained from the responses of 228 subjects to the draft scale of 30 items. As a result of the analysis, a Kaiser-Meyer-Olkin compatibility test value of KMO = 0,914 and a Bartlett homoscedasticity test Chi-Square value of χ^2 = 3220,172 (p = 0,00) have been obtained. This data structure is found to be of perfect suitability for factor analysis because of the value KMO = 0,914 > 0,60. The hypothesis "correlation matrix equals to identity matrix" is denied because χ^2 = 3220,172 and p = 0,00< 0,01 which mean Bartlett test Chi-Square value is significant [10, 11, 14].

13 items in the correlation matrix of the draft scale are found to have correlation values smaller than 0,25; M3, M4, M11, M15, M17, M18, M22, M24, M25, M26, M27 and these are removed from the scale. Factor analysis is used again on the remaining 17 items. KMO value is found to be 0,922 and Bartlett test Chi-Square value is found to be χ^2 = 1820,316 (p = 0,00 <0,01) which indicate the data structure is suitable for factor analysis. Correlation values of these 17 items are found to be greater than 0, 25 in the correlation matrix [16, 17, 18].

Factor analysis is used on the item scores obtained from the responses of 453 subjects to the final scale of 17 items. As a result of the analysis, a Kaiser-Meyer-Olkin compatibility test value of KMO = 0,914 and a Bartlett homoscedasticity test Chi-Square value of χ^2= 3220,172 (p = 0,00) is obtained. This data structure is found to be of perfect suitability for factor analysis because of the value KMO = 0,914 > 0,60. The hypothesis "correlation matrix equals to identity matrix" is denied because χ^2 = 3220,172 and p = 0,00 < 0,01 which means Bartlett test Chi-Square value is significant [8, 9, 10]. Correlation values in the correlation matrix are found to be greater than 0,25 [12, 15, 16].

Table 3. Results of item analysis methods

items	t statistics	t test p values	selectivity index	item remainder correlation	regression coefficient	regression p values
M1	9,164	0,000	0,4568	0,6120	14,285	0,000
M2	11,510	0,000	0,5247	0,6710	15,739	0,000
M3	5,220	0,000	0,3827	**0,3670**	7,533	0,000
M4	5,880	0,000	0,3457	0,4590	11,680	0,000
M5	4,330	0,000	0,3148	0,4160	9,200	0,000
M6	**1,180**	**0,240**	**0,0802**	**-0,0100**	**0,789**	**0,650**
M7	**1,020**	**0,313**	**0,0741**	**0,1080**	**3,228**	**0,048**
M8	4,030	0,000	**0,2284**	**0,2860**	8,132	0,000
M9	8,300	0,000	0,5185	0,6210	13,112	0,000
M10	12,380	0,000	0,6728	0,7110	13,726	0,000
M11	8,970	0,000	0,5309	0,6830	14,588	0,000
M12	4,480	0,000	**0,2593**	**0,2710**	7,461	0,000
M13	**1,100**	**0,273**	**0,0741**	**0,1310**	**4,138**	**0,029**
M14	8,030	0,000	0,4074	0,5970	15,491	0,000
M15	6,630	0,000	0,3395	0,4230	10,975	0,000
M16	10,360	0,000	0,5247	0,6820	15,836	0,000
M17	8,160	0,000	0,4506	0,5350	11,787	0,000
M18	4,140	0,000	**0,2284**	**0,3370**	10,187	0,000
M19	9,000	0,000	0,5370	0,6320	13,345	0,000
M20	8,060	0,000	0,4074	0,5430	13,342	0,000
M21	3,570	0,001	**0,2284**	**0,3180**	8,423	0,000
M22	5,120	0,000	0,2963	0,4230	11,396	0,000
M23	7,220	0,000	0,4198	0,5620	13,019	0,000
M24	5,070	0,000	0,3272	**0,3700**	8,972	0,000
M25	8,460	0,000	0,5000	0,5900	12,572	0,000
M26	4,150	0,000	**0,2593**	**0,3310**	9,009	0,000
M27	3,670	0,000	**0,2593**	**0,3170**	7,426	0,000
M28	9,580	0,000	0,5062	0,6270	14,571	0,000
M29	5,640	0,000	0,3025	0,4150	11,020	0,000
M30	3,240	0,002	**0,1852**	**0,1920**	5,745	0,003
M31	2,200	0,000	**0,1235**	**0,1710**	5,460	0,000
M32	4,980	0,000	0,2963	**0,3600**	9,159	0,000
M33	**2,150**	**0,035**	**0,1605**	**0,1730**	4,434	0,005
M34	6,290	0,000	0,3580	0,4520	11,493	0,000
M35	6,460	0,000	0,3704	0,4360	10,199	0,000
M36	10,780	0,000	0,5247	0,6070	13,546	0,000
M37	5,120	0,000	0,2654	0,4590	13,590	0,000
M38	7,060	0,000	0,3519	0,5180	13,283	0,000
M39	7,780	0,000	0,3827	0,5840	15,585	0,000
M40	6,450	0,000	0,2963	0,4590	13,446	0,000
M41	6,250	0,000	0,3395	0,4250	10,309	0,000
M42	4,760	0,000	0,3086	**0,3120**	7,544	0,000
M43	5,890	0,000	0,3272	0,4270	11,121	0,000
M44	4,100	0,000	**0,2222**	**0,3390**	9,479	0,000
M45	5,880	0,000	0,3951	0,5170	11,263	0,000
M46	4,910	0,000	0,2593	0,4220	11,812	0,000
M47	10,780	0,000	0,6173	0,6600	13,242	0,000
M48	5,090	0,000	**0,2531**	**0,3470**	10,432	0,000

Table 4. Items that were removed from the pilot scale according to the results of item analysis

item analysis methods	items removed from the scale
independent group t-test	M6, M7, M13, M33
item selectivity index	M6, M7, M8, M12, M13, M18, M21, M26, M27, M30, M31, M33, M44, M48
item remainder correlation	M3, M6, M7, M8, M12, M13, M18, M21, M24, M26, M27, M30, M31, M32, M33, M42, M44, M48
simple linear regression	M6, M7, M13

Table 5. Spearman rank differences correlation coefficients belonging to item analysis methods

	t-test	selectivity index	item remainder correlation	simple linear regression
t-test	1,000	0,958 (0,000*)	0,964 (0,000*)	0,889 (0,000*)
selectivity index	0,958 (0,000*)	1,000	0,941 (0,000*)	0,800 (0,000*)
item remainder correlation	0,964 (0,000*)	0,941 (0,000*)	1,000	0,940 (0,000*)
simple linear regression	0,889 (0,000*)	0,800 (0,000*)	0,940 (0,000*)	1,000

(*)Significance of Spearman rank differences correlation coefficients

As a result of the factor analysis, three eigenvalues seen to be greater than 1 in the scree-plot graph belonging to the eigenvalues of draft and final scales and items are grouped in 3 factors for each scale [10, 11, 14]. Variance ratios due to each of these factors are as follows.

Table 6. Due variance ratios of factors in the draft and final scales

draft scale (30 items – 246 subjects)			
factors	eigenvalue	due variance (%)	total variance (%)
factor 1	7,426	24,911	24,911
factor 2	1,431	21,769	46,680
factor 3	1,163	12,261	58,941
Total	10,02	58,941	
final scale (17 items – 477 subjects)			
factors	eigenvalue	due variance (%)	total variance (%)
factor 1	7,337	23,563	23,563
factor 2	1,338	18,455	42,018
factor 3	1,035	15,101	57,118
Total	9,71	57,118	

Results from the factor analysis show that the distributions of the remaining 17 items in the draft scale and the 17 items of the final scale are given in Table 7.

Table 7. Distribution of items from the draft and final scales into 3 factors

draft scale (30 items – 246 subjects)	
factors	items
factor 1	M5, M6, M7, M12, M16, M28, M30
factor 2	M1, M2, M8, M9, M10, M20, M21
factor 3	M19, M23, M29
final scale (17 items – 477 subjects)	
factors	subjects
factor 1: concern-hate	M3(M5*),M4(M6*),M5(M7*),M9(M12*),M10(M16*),M15(M28*),M17(M30*)
factor 2: love-interest	M1(M1*), M2(M2*), M6(M8*), M7(M9*), M8(M10*)
factor 3: benefit-importance	M11(M19*), M12(M20*), M13(M21*), M14(M23*), M16(M29*)

As a result of the factor analysis, the first factor named as "CONCERN-HATE" since all of the items in factor one include the concern and hate towards the statistics course. Items in factor two are found to include the love and interest towards the statistics course, therefore the second factor is named as "LOVE-INTEREST". Finally, items in factor three include the benefit and importance of statistics, so the third factor is named as "BENEFIT-IMPORTANCE".

Cronbach alpha internal consistency coefficients of the pilot scale of 48 items, the draft scale of 30 items and the final scale of 17 items are found to be very high. Therefore, the reliability level of each scale is perfect [12, 13, 18].

5. Results, discussion and conclusion

Results for the psychometric features of the final scale created to measure the attitude of university students towards the statistics course are given below:

Table 8. Cronbach alpha internal consistency coefficients of scales

scales	reliability coefficients
pilot scale	0,925
draft scale	0,938
final scale	0,916

To ensure the "one-dimensionality" property which is the most important assumption of Likert type attitude scale, methods of item analysis like t-test, selectivity index, item remainder correlation and simple linear regression are used on the pilot scale of 48 items. According to these, 18 items are removed from the scale and a draft scale of 30 items is created. Later, factor analysis is used on the draft scale of 30 items and 13 items were decided to be removed from the scale. Thus, 13 items are removed from the draft scale and the final scale of 17 items is created. Finally, factor analysis is used on the final scale of 17 items and it is seen that the items is grouped in 3 factors.

To confirm the necessary features of a final scale for measuring attitudes towards statistics course, factor analysis is used to confirm structure validity. Three factors are found appropriate for the factor structure of the items in the final scale. Factors are named as "CONCERN-HATE", "LOVE-INTEREST" and "BENEFIT-IMPORTANCE" according to the attitude formats of the items they include.

Within the reliability studies of the final scale created to measure attitudes towards statistics course, Cronbach alpha coefficient, which is a criterion of internal consistency for determining the reliability level of a Likert type scale, is used. This coefficient is a criterion for the internal consistency (homogeneity) of the items in the final scale. The final scale has a very high internal consistency coefficient and it has a perfect reliability level.

Considering that attitude is a difficult and complicated concept, validity and reliability test results show us that the final scale SAS (STATISTICAL ATTITUDE SCALE), which is created to measure the attitudes of university students towards the statistics course they take, is a convenient and usable tool to measure the attitude of university students towards the statistics course they take validly and reliably.

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Appendix-1: Statistical Attitude Scale (SAS)

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1. I enjoy doing statistical analysis on a data.					
2. I like statistics more than other courses.					
3. I get bored while listening to the statistics course.					
4. I wish there wasn't a statistics course in my department.					
5. I wouldn't even say the word statistics if it was possible.					
6. I would like the course hours to be more for statistics.					
7. I can see the advantages of learning statistics in my monthly expenses.					
8. I would also like to be interested in statistics in my career.					
9. I don't want to encounter with statistics in my life again.					
10. I get distracted while studying statistics and I start procrastinating.					
11. I have learned how to interpret graphs through statistics.					
12. I help my friends with studying statistics.					
13. I am interested in interpreting statistical tables.					
14. I believe knowing statistics well will contribute to my career.					
15. I don't understand why statistics is taught in so many departments.					
16. Statistics should be in every level of a research.					
17. I wouldn't attend the statistics class if it wasn't obligatory.					