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Astronomy Attitude Scale: Development, Validity and Reliability[1]

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Abstract

The purpose of this study is to develop a valid and reliable attitude scale to find out middle school students' attitudes towards astronomy, subjects related to astronomy, the relationship between astronomy and daily life and also their attitudes towards the studies conducted. In the development stage of the scale, after existing attitude scales and studies on astronomy education were reviewed, initial items were prepared and expert views were consulted. Astronomy Attitude Scale (AAS), which was 5 point Likert, was conducted on a total of 302 middle school students studying in the Black Sea Region of Turkey. The scale was finalized through exploratory factor analysis and the scale's Cronbach-Alpha consistency coefficient was found to be 0,912. As a result of the analyses conducted, it was found that the scale

[1]This study based on Ph.D. thesis of Cumhur TÜRK.

which consisted of a total of 27 items -17 positive and 10 negative- had five sub-factors and the factor load values of the items in these factors differed between 0.533 and 0.777. The study revealed that the factor structure of the scale included various sub dimensions related to astronomy education and the statistical analyses conducted showed that AAS was a valid and reliable test.

Keywords: astronomy education, astronomy attitude scale, developing scale, validity, reliability.

1. Introduction

Astronomy is a very important educational tool in leading societies to scientific facts. Türk and Kalkan (2015) stated that astronomy had a pioneering role in every step of the development of physical sciences within the historical process. For example, when Soviet Union launched the Sputnik spacecraft, the people in U.S.A., the other super power of the time, were disconnected from science. In the space race that started as a result of these developments, U.S.A. developed and implemented new programs to introduce basic concepts of science into society in order not to fall behind. The most obvious change in these programs was the wider coverage of astronomy education in programs when compared with the past. STAR Project in the U.S.A. is an example to this change. Similarly, with CLEA Project in France, science projects were reconstructed and astronomy education was brought into the forefront.

Studies have reported astronomy concepts as among the subjects which primary education students were most curious about and wanted to learn the most. 2534 students between the levels K-4 and K-6 were asked about the subjects they wanted to learn the most in science lessons and the majority of the answers were astronomy subjects. In another study, it was found that while students were most interested in subjects such as animals and plant life until K-3 level, their interests shifted to subjects about astronomy in K-5 and upper levels. In summary, children and adolescents are in general very curious about subjects such as the universe, Big-Bang and celestial happenings in the universe (Baxter, 1989).

In a similar study, 3478 middle school students in Turkey were given a questionnaire which included the question "*If you had a magic sphere that knew the answer to everything, which three questions that you are most curious about would you ask?*" (Kalkan & Türk, 2012). The questions asked by the students were analyzed and classified in different times within the context of content analysis by 4 researchers who are experts in their field and the fields students from different socioeconomic and cultural environments were most curious about were found. Table 1 gives the general results of the study.

Table 1. Percentages of the distribution of students' questions in terms of categories

Category	**%**
Education	35
Future	83,2
Beliefs	10,1
Death fear	17,3
Worries about his/her family and friends	9,2
Questioning of concerns related to Earth	9,5
Actual	8,4
Social sciences	1,7
Science	18,5

Majority of the questions asked by students include concern for "the future". However, when considered from educational dimension, 18,5% of the questions were about scientific concepts. Physical sciences consist of few disciplines. These questions asked by the students within physical sciences were analyzed according to these disciplines and the results were presented in Table 2.

Table 2. Percentages of the distribution of the questions in "*Science*" category in terms of sub-groups

Category	%
Astronomy	51,7
Physics	9,3
Chemistry	4,7
Biology	17,1
Mathematic	4,7

The distributions in physical sciences were as: astronomy with 51,7%, biology with 17,1%, physics with 9,3%, mathematics with 4,7% and chemistry with 4,7%. As can be understood from these results, astronomy is the field that students are most curious about and most interested in.

Although astronomy is the field that students are most curious about and most interested in, a great number of studies have shown that students show a great resistance to learning these concepts (Baxter, 1989; Klein, 1982; Kalkan & Kıroğlu, 2007; Kıroğlu, 2015; Trumper, 2000, 2001; Türk & Kalkan, 2015; Türk, Kalkan & Şener, 2015; Vosniadou & Brewer, 1992; Zeilik, Schau & Mattern, 1998). However, this resistance has been presented with achievement tests conducted on students in general and there are limited numbers of studies which show students' attitudes towards astronomy (Mallon & Bruce, 1982; Zeilik, Schau & Mattern, 1999). Similarly, there are limited numbers of valid and reliable scales to measure students' attitudes towards astronomy in literature.

Attitude has a structure consisting of three components: cognitive dimension, affective dimension and behavioral dimension (Reid, 2006). Attitude consists of feelings, thoughts and behaviors related to an object. However, these dimensions are not independent of each other. They affect and are affected of each other and most of the time, there is a consistency between them (Aydın, 2000; Özgüven, 2004). An attitude generally makes an individual inclined to behave in a specific way to the object of attitude. An individual with positive attitudes to an object will be inclined to act positive, to get closer to that object and to support and help that object. An individual with negative attitudes to an object will be inclined to be indifferent to that object or to get away from that object, to criticize and even to hurt that object (Aydın, 2000).

A great number of attitude scales have been developed and conducted in studies of disciplines such as physics, chemistry, biology and mathematics (Akyüz, 2004; Trumper, 2004; Taşlıdere, 2007; Uzun & Sağlam, 2006). However, the same thing is not true for astronomy teaching. When studies have been considered, it is obvious that there is a need for an astronomy attitude scale which can be used by teachers and researchers in astronomy education. It is believed that such a scale can result in getting more valid and reliable information with studies about astronomy learning and teaching and attitude. Road maps drawn by the results of such researches will certainly make great contributions to significant learning.

The purpose of this study is to develop an up-to-date scale with effective usage features that can be used in finding out the attitudes of students towards astronomy. The fact that there are limited numbers of scales and studies in literature on measuring the attitudes of students towards astronomy in literature shows that there is an important gap in the present situation and also the significance of this study. In addition, this study is expected to shed light on teachers and researchers in this field.

2. Method and Material

In this study, in order to determine the attitudes of students towards astronomy which consisted of their feelings, thoughts and behaviors; AAS development, validity and reliability studies were conducted. For this reason, the study was conducted through review method. According to Cohen, Manion and Morrison (2007), review studies are the ideal research methods that can be used in studies which require broad participation, such as attitude studies. The stages of developing attitude scale were included extensively under the heading AAS development process.

2.1. Sample

The size of sample is still a question of debate in scale development studies. Related literature states that the size of sample should not be less than 100 people and it should be at least five times greater than the number of items in order to be exposed to factor analysis (Bryman & Cramer, 1999). On the other hand, even in studies with sufficient numbers of samples, unrealistic results can be obtained if the scale is not suitable for the characteristics of the sample (Fer & Cırık, 2006). Within this context, the sample of this study consists of 302 7^{th} graders studying in Turkey's Black Sea region during the academic year 2013-2014. 158 of the students are female while 144 are male. The ages of students are between 13 and 14. The reason why 7^{th} graders were included in the sample was the fact that the subjects and concepts of astronomy are most extensively taught in 7^{th} grade in Turkish science education programs. Thus, AAS was given to students at the end of the 7^{th} grade, after the students studied the astronomy unit.

2.2. AAS Development Process

The procedures during the process of developing AAS are given in items below and in schemes afterwards.

- While developing AAS, the results of some studies on astronomy in literature were thoroughly examined. These results were taken into consideration while preparing the scale.

- The following criteria were taken into consideration while preparing AAS:

– All the items were expressed as positive and negative, care was taken not to include factual expressions.

– Items were expressed in a plain and understandable language. Care was taken not to include more than one judgement/thought/perception in an item.

– Attitude items were organized as half positive and half negative. By taking the impartiality rule into consideration in attitude items, care was taken to make equal numbers of positive and negative items.

– For the positive items in the scale, the expressions "totally agree" and "agree" were used while the expressions "totally disagree" and "disagree" were used for the negative items. The "indecisive" expression was used for items that does not contain positive or negative idea.

- The question "*What are your thoughts on the astronomy subjects in science and technology lesson?*" was asked to a total of 57 7th and 8th graders in a middle school and the students' answers were taken in written form. The students' answers were analyzed, 14 items were formed and these were added in the scale.

- As a result of the studies, a draft AAS of 5 Likert type (totally agree, agree, indecisive, disagree and totally disagree) with 45 items was developed.

- The scale consists of 2 different sections. Demographic information about the students is in the first section while attitude expressions are in the second section.

- To ensure the content validity of the test, AAS was analyzed in terms of science, content and format by the experts stated in Table 3. The draft was analyzed by 3 academics and 2 teachers who had at least 10 years of experience. All the experts were informed about the main purpose of the test and they were given the test and the criteria on which they were asked to base their assessments. Necessary corrections were made in light of the assessments of the experts. Table 3 presents the demographic characteristics of the experts whose views were taken about the AAS.

Table 3. The demographic characteristics of the experts whose views were taken about the AAS

Gender	Title	Profession
Male	Prof. Dr.	Science and Astronomy Education
Male	Assoc. Prof.	Educational Sciences
Female	Research Assistant	Science Education
Male	Teacher	Science Education
Female	Teacher	Science Education

- After the experts' views were taken, the draft AAS was conducted on 10 middle schools students and the time they used to answer the test and whether there were any items they had difficulty in understanding were tested. It was observed that the students could answer the test in about 15-20 minutes. In addition, no negative feedback came from the students in terms of whether there were problems in the readability of the test.

- The study was conducted with 302 students; however, 28 students were excluded from the analysis due to missing values or for giving the same answer to a great majority of the items. SPSS 22 program was sued to analyze the data.

- Following this, item analysis was conducted. The data obtained from the pilot study of AAS were entered in SPSS 22.0 program and data analysis was conducted. The scale used 5 Likert. After the data entry which consisted of 25 positive and 20 negative items was completed, the scoring of answers to negative items were transformed to "1-5; 2-4; 3-3; 4-2; 5-1" in SPSS program (Table 4). After the scoring, the highest score a person can get from 45 items is 225, while the lowest score is 45 and the score interval from the scale is between 45 and 225.

Table 4. Scoring used in the assessment of AAS.

	Positive Items	**Negative Items**
Totally Disagree	1	5
Disagree	2	4
Indecisive	3	3
Agree	4	2
Totally Agree	5	1

Figure 1 presents the AAS development process in a scheme in order to understand and see the process better.

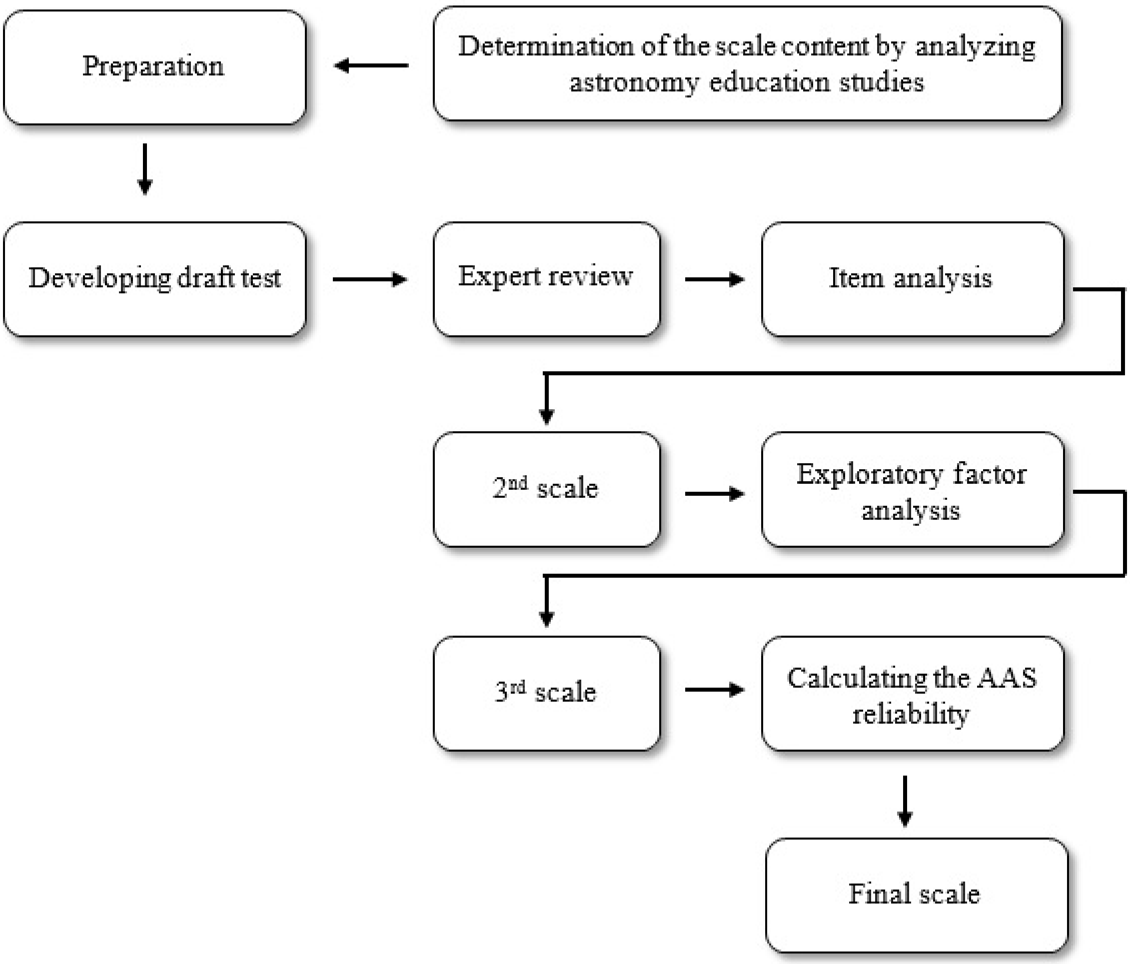

Figure 1. AAS development process

3. Findings and Discussion

The following steps were followed for the analysis of draft AAS and the stated results were found.

3.1. Descriptive Findings

Before starting the item analysis, in order to analyze in the first step whether the distribution was suitable, skewness and kurtosis values were analyzed based on attitude scores. Table 5 gives the descriptive statistics that include these values.

Table 5. Draft AAS results of descriptive statistics

	Statistics	**Error**
Mean	153,2117	
Median	151,0000	
Variance	644,006	
Standard deviation	25,37728	
Minimum	59,00	
Maximum	212,00	
Skewness	,097	,147
Kurtosis	-,014	,294

Skewness is a concept which defines data distribution to get an asymmetric shape that gets away from the normal and appears skewed to the right or to the left. In a normal distribution, skewness coefficient will be 0. As skewness increases, mode and mean get away from each other. Skewness coefficient can take values between –infinite and +infinite. We can talk about two kinds of skewness, as positive and negative. If the mean is smaller than the median, then the distribution is skewed to left (negative). If the mean is greater than the median, then the distribution is skewed to right (positive). When skewness gets values between ± 3 (may also be ±2), it is considered to be normal. Skewness value is the value which is found by dividing the statistical value of skewness value in the descriptive statistics table which results from analysis output by the error value. If this value has a significance level of 5% and if it is between +1,96 and -1,96, the data can be said to be close to normal. If this value is positive, this means that the data is skewed to right; if this value is negative, it means that the data is skewed to left. Skewness value of the draft AAS was found as 0,659.

Kurtosis shows how peaked or flat normal distribution curve is. Kurtosis coefficient of an exact bell-shaped curve is zero. If Kurtosis coefficient is positive, then the curve is more peaked than the normal. If it is negative, then it is more flat than normal. If the value which is found by dividing the statistical value of skewness kurtosis value in the descriptive statistics table which results from analysis output by the error value has a significance level of 5% and if it is between the values +1,96 and -1,96, then it can’t be said to be peaked. Kurtosis value of the draft AAS was found as -0,047. This value shows that the data have suitable distribution.

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In addition, AAS data were analyzed by Kolmogorov-Smirnov normality test and the results were presented in Table 6. Kolmogorov-Smirnov normality test results of draft AAS.

Table 6. Kolmogorov-Smirnov normality test results of draft AAS

Statistics	df	Sig. (p)
,054	274	,052

According to the Kolmogorov-Smirnov normality test results (p=0,052, p>0,05) in Table 6, draft AAS results show a normal distribution.

3.2. *Item analysis*

Item analysis was conducted on the items in the scale based on correlation. In the determination of the correlation between the scores of the items and scores of the scale, the score of the related item was excluded and scores of the scale were recalculated, in other words, the score of the rest of the test was found. Item analysis was completed by calculating the correlation between the scores of each student to separate items and the total score obtained from the answers given to all of the items. Table 7 gives the results of item total correlations.

Table 7. Item total correlations of draft AAS

Item No	Item Total Correlation	Item No	Item Total Correlation	Item No	Item Total Correlation
1	,714	16	,619	31	,128
2	,612	17	,640	32	-,032
3	,377	18	,381	33	,344
4	,377	19	,563	34	,589
5	,577	20	,329	35	,632
6	,677	21	,271	36	,494
7	,586	22	,303	37	,327
8	,558	23	,443	38	-,111
9	,436	24	,593	39	,558
10	,565	25	,406	40	,532
11	,633	26	,507	41	,058
12	,569	27	,178	42	,382
13	,702	28	,397	43	,584
14	-,042	29	,493	44	,609
15	,373	30	,467	45	,562

When the table was reviewed, item total correlations of the items 14, 21, 27, 31, 32, 38 and 41 were found to be less than 0,30. Thus, the aforementioned items were excluded from the scale.

Following the item total correlation, item analysis was conducted on draft AAS according to the internal consistency criteria. After the items in the scale were scored, the results were

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ordered from the highest score to the lowest one. 27% of the participants at the highest point of the result distribution was determined as the upper group while 27% of the participants at the lowest point of the result distribution was determined as the lower group. The participants in the upper group show those who have positive attitudes towards the attitude measured by the scale, the participants in the lower group show those who have negative attitudes. Independent groups t-test was used to examine whether the difference between the average item total scores of the upper group and the average item total scores of the lower group was significant or not for each item. Table 8 gives the results of this analysis.

Table 8. Independent groups t-test results for higher-lower groups in draft AAS

Item No	t-test	Signature (2 tailed)	Item No	t-test	Signature (2 tailed)	Item No	t-test	Signature (2 tailed)
1	14,484	,000	16	11,584	,000	31	1,410	,161
2	11,813	,000	17	13,658	,000	32	,055	,956
3	5,745	,000	18	5,000	,000	33	5,238	,000
4	6,232	,000	19	10,694	,000	34	11,096	,000
5	10,452	,000	20	3,803	,000	35	13,411	,000
6	15,923	,000	21	4,067	,000	36	9,383	,000
7	12,245	,000	22	5,127	,000	37	3,440	,001
8	8,215	,000	23	6,830	,000	38	-1,274	,205
9	6,318	,000	24	10,541	,000	39	10,368	,000
10	9,125	,000	25	5,747	,000	40	8,200	,000
11	13,008	,000	26	8,165	,000	41	,288	,774
12	10,630	,000	27	2,729	,007	42	5,410	,000
13	15,166	,000	28	6,318	,000	43	11,271	,000
14	-1,386	,168	29	6,955	,000	44	12,217	,000
15	4,725	,000	30	7,058	,000	45	10,681	,000

When Table 8 was analyzed, it can be seen that the items 14, 27, 31, 32, 37, 38 and 41 are not significant according to $p<0,01$ level. It can be seen that of these items, 14, 27, 31, 32, 38 and 41 were among the items which were decided to be excluded after the item total correlation in Table 7.

As a result of the findings presented in Table 7 and 8, items 14, 21, 27, 31, 32, 37, 38 and 41were decided to be excluded from AAS.

3.3. Exploratory Factor Analysis

After the items were excluded from the scale as a result of the item analysis, factor analysis was conducted for the structure validity of the scale. Factor analysis respectively;

- ✓ Analyzing the data’s adequacy for factor analysis
- ✓ Obtaining and transforming the factors
- ✓ Naming the factors

Analyzing the data's adequacy for factor analysis: The adequacy of the data for factor analysis can be measured by Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's test of sphericity value (Büyüköztürk, 2007; Karagöz & Kösterelioğlu, 2008). KMO and Bartlett's test values of AAS are presented in Table 9.

Table 9. KMO and Bartlett's test values of AAS

Kaiser-Meyer-Olkin Value	KMO	,896
Bartlett's Test of Sphericity Value	Approx. Chi-Square	5193,430
	df	990
	p	,000

Kaiser-Meyer-Olkin value is the common variance amount which is formed by variables. A value close to 1,00 shows that the data is adequate for factor analysis, while a value less than 0,50 means that the data is not adequate for factor analysis. 0,60 KMO value is considered as average, while 0,70 is considered as good, 0,80 is considered as very good and a value of 0,90 and higher is considered as perfect (Bryman & Cramer, 1999). 0,896, $p<0.01$ KMO value in this study shows that the sample is adequate for factor analysis.

Bartlett's test of sphericity value and its significance tests whether the variables are correlated with each other. If the significance of this test, that is Sig. value, is 0,10 and higher, it can be said that this data is not adequate for factor analysis. Bartlett's test result in our study (5193,430) and its significance of $p<0.01$ showed that the assessment tool could be dissociated to factor structures.

As can be seen, both values (Kaiser-Meyer-Olkin and Bartlett's test of sphericity) show that the data is adequate for factor analysis.

Obtaining and transforming the factors: AAS factor analysis was conducted through Principle Component Analysis technique. For the construct validity of the scale, care was taken to choose items which had load factor values of 0,45 and higher (Büyüköztürk, 2010). Values of load factor for items are shown in Table 10.

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Table 10. Item values of load factors for draft AAS

Item No	Load Factor Value	Item No	Load Factor Value	Item No	Load Factor Value
1	,742	15	,480	30	,473
2	,695	16	,575	33	,471
3	,695	17	,697	34	,664
4	,579	18	,633	35	,612
5	,528	19	,623	36	,509
6	,589	20	,548	39	,533
7	,508	22	,539	40	,533
8	,633	23	,453	42	,390
9	,577	24	,505	43	,585
10	,551	25	,539	44	,534
11	,710	26	,632	45	,460
12	,613	28	,675	-	-
13	,680	29	,598	-	-

As can be seen from Table 10, since the load factor value of the 42nd item in the scale was below 0,45, the item was excluded from the scale. After its exclusion, the load factor values of 36 items were found to vary between 0,453 and 0,742.

Determining the number of factors and variables: Factors with eigenvalues of 1 or higher can be defined as significant factors (Bryman & Cramer, 1999). Factor structure of AAS is shown in Table 11.

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Table 11. Factor structure of draft AAS

Factor	Eigenvalue	Variance %	Total Variance %	Eigenvalue	Variance %	Total Variance %
1	10,204	28,346	28,346	10,204	28,346	28,346
2	4,003	11,119	39,464	4,003	11,119	39,464
3	1,813	5,037	44,501	1,813	5,037	44,501
4	1,423	3,954	48,455	1,423	3,954	48,455
5	1,293	3,591	52,047	1,293	3,591	52,047
6	1,104	3,066	55,112	1,104	3,066	55,112
7	1,041	2,891	58,003	1,041	2,891	58,003
8	,972	2,701	60,704			
9	,927	2,575	63,278			
10	,869	2,414	65,692			
11	,833	2,315	68,007			
12	,797	2,215	70,222			
13	,748	2,078	72,300			
14	,722	2,004	74,305			
15	,689	1,914	76,219			
16	,657	1,826	78,045			
17	,610	1,695	79,740			
18	,591	1,642	81,383			
19	,549	1,525	82,907			
20	,545	1,513	84,420			
21	,509	1,413	85,833			
22	,494	1,373	87,206			
23	,463	1,286	88,492			
24	,441	1,225	89,718			
25	,416	1,156	90,874			
26	,389	1,080	91,954			
27	,384	1,066	93,020			
28	,355	,985	94,005			
29	,339	,943	94,948			
30	,333	,924	95,872			
31	,297	,826	96,699			
32	,279	,776	97,475			
33	,265	,737	98,212			
34	,241	,668	98,881			
35	,214	,595	99,476			
36	,189	,524	100,000			

When Table 11 is examined, 7 factors with eigenvalues higher than 1 were found. It was found that the cumulative eigenvalues variance level explained 58,003% of the total variance.

In studies of social sciences, a ratio of total variance between 40% and 60% is an indicator that the study has a strong factor structure (Scherer, Wiebe, Luther & Adams, 1988). This result shows that the value of the scale's ratio of total variance was adequate.

Determining factor variables: After determining the number of factors, the next step is determining the distribution of items to factors. In this study, varimax method, and orthogonal rotation method, was used to be able to find out which factors the items had the strongest correlation due to its ease in interpretation and its frequency of use (Kurnaz & Yiğit, 2010).

In order to present the factor structure of the scale, unrotated and rotated principal components analysis based on primary axis were used. If the load of an item on a factor in the scale was higher than 0,30 and if this value was 0,10 or higher than the load of this item on another factor, the item was considered to be in that factor (Büyüköztürk, 2010).

Unrotated principal components analysis results of the items are presented in Table 12. The table does not show load values less than 0,30.

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Table 12. Unrotated principal components analysis results of the items

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
13	,742						
1	,737						
6	,694			-,520			
11	,674		-,375				
17	,670		-,448				
35	,662						
2	,638			-,388			
24	,627						
34	,622	-,381					
44	,620						
12	,611		-,330				
43	,606	-,402					
19	,594		-,378				
7	,588			,490			
16	,583	,358					
39	,582	-,330					
45	,581						
40	,541						
10	,538	,345			-,316		
5	,536	,323					
36	,523	-,310					
8	,509	,500					
30	,428			,370			
33	,360	-,359					
29	,428	,572					
28	,331	,532			,482		
23	,394	,514					
26	,460	,507			,305		
25	,343	,485					
9	,385	,480					
15	,312	,337	,332				
4	,377		,399	-,360			
22	,313	-,319			,322		
18	,329	,386				,444	,346
20		,408	-,384			,416	
3	,326		-,310			-,341	,497

When Table 12 is examined, it can be seen that some items have load values of less than 0,10 on multiple factors.

Results of the rotated principal components analysis of the items based on primary axis are presented in Table 13. The table does not show load values less than 0,30.

Table 13. Results of the rotated principal components analysis of the items based on primary axis

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
34	,777						
35	,697						
43	,665						
44	,659						
36	,633						
40	,600	,327					
39	,591	,391					
33	,581						
24	,514				,334		
45	,499	,326					
22	,401			,326		-,303	
11		,784					
12		,734					
19		,711					
17		,684				,318	
13	,397	,640					
6		,458			,451		
9			,716				
10			,670				
8			,598				,391
15			,567				
16		,394	,536				
23			,509	,418			
5			,479				,413
28				,762			
26			,335	,683			
25			,441	,586			
29			,470	,561			
4					,713		
2					,690		
1	,345	,301			,636		
7			,322		,368		,339
18				,633		,714	
20			,587			,676	
30	,316			,352		,434	
3						,714	,788

When Tables 12 and 13 are examined together, it can be seen that the items 3, 6, 7, 18, 20, 22, 23, 29 and 30 had load values of less than 0,30 on more than one factor. These items were excluded from the scale since it is not possible to determine which factor these items belong to.

Items 3, 6, 7, 18, 20, 22, 23, 29 and 30 were excluded from AAS and the factor structure determination process was repeated for the remaining 27 items.

The factor structure of the final AAS after the process of item exclusion is shown in Table 14.

Table 14. Factor structure of final AAS

Factor	Eigenvalue	Variance %	Total Variance %	Eigenvalue	Variance %	Total Variance %
1	8,664	32,088	32,088	8,664	32,088	32,088
2	3,024	11,201	43,289	3,024	11,201	43,289
3	1,603	5,937	49,226	1,603	5,937	49,226
4	1,226	4,542	53,768	1,226	4,542	53,768
5	1,143	4,234	58,002	1,143	4,234	58,002
6	,893	3,309	61,310			
7	,882	3,266	64,577			
8	,859	3,181	67,758			
9	,787	2,914	70,672			
10	,733	2,716	73,388			
11	,656	2,429	75,818			
12	,614	2,273	78,090			
13	,574	2,128	80,218			
14	,557	2,064	82,282			
15	,525	1,946	84,228			
16	,492	1,823	86,051			
17	,478	1,772	87,823			
18	,435	1,613	89,436			
19	,406	1,504	90,940			
20	,393	1,456	92,396			
21	,362	1,342	93,738			
22	,349	1,294	95,032			
23	,339	1,255	96,287			
24	,286	1,058	97,344			
25	,258	,957	98,302			
26	,242	,896	99,198			
27	,217	,802	100,000			

Bryman and Cramer (1999) state that the factors with eigenvalues of 1 or higher than 1 should be considered as significant factors. Within this framework, when Table 4 is examined, it can be seen that the final AAS consists of 5 factors and the accumulated eigenvalues variance value is seen to explain 58,002% of the total variance. Principal components analysis value and the explained variance of these five factors are given in Table 15.

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Table 15. Principal component analysis and explained variance values of the factors

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Principal component value	8,664	3,024	1,603	1,226	1,143
Explained variance (%)	32,088	11,201	5,937	4,542	4,234

The first factor explains 32,088% of the total variance, the second factor explains 11,201%, the third factor explains 5,937%, the fourth factor explains 4,542% and lastly, the fifth factor explains the 4,234% of the total variance. It can be seen that the amount of accumulated eigenvalues variance explains the 58,002% of the total variance.

*Determining the final AAS factor variables:*Following the exclusion of some of the items in AAS as a result of the load intensity on more than one factor, unrotated and rotated principal components analyses were conducted again in order to reveal the factor structure of AAS.

Table 16 gives the unrotated principal components analysis results of the final AAS items. The table does not show load values less than 0,30.

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Table 16. Unrotated principal components analysis results of the final AAS items

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
3	,759				
1	,730			-,389	
35	,698				
11	,692		-,447		
17	,676		-,425		
34	,665	-,312			
43	,652	-,331			
2	,649			-,471	
44	,648				
24	,641				
12	,627		-,394		
19	,623		-,446		
39	,622				,313
45	,599				
40	,577				
36	,558		,364		
16	,546	,424			
10	,510	,442			
5	,503	,398			
33	,399	-,327			
26	,412	,598			,370
9	,343	,577			
25		,570			,326
8	,449	,549			
28		,544			,501
15		,431			
4	,388		,355	-,603	

When Table 16 is examined, the results of the unrotated principal components analysis of the final AAS show that none of the items carries load factor values of less than 0,10 on more than one factor.

Table 17 shows the results of the rotated principal components analysis based on primary axis. The table does not show load values less than 0,30.

Table 17. The results of the rotated principal components analysis based on primary axis

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
34	,749				
43	,709				
44	,692				
35	,688				
36	,627				,310
39	,624	,380			
40	,593				
33	,561				
45	,539				
24	,533				,300
11		,772			
17		,754			
19		,739			
12		,702			
13	,414	,609			
9			,724		
8			,700		
10			,678		
16		,448	,638		
15			,557		
5			,547		
4				,777	
28				,765	
26			,382	,701	
25			,405	,604	
1		,320			,684
2	,329	,347			,613

When Table 17 is examined, it can easily be seen on which factors the items are distributed to. In addition, it can be seen again that none of the items carries load factor values of less than 0,10 on more than one factor.

Naming the factors: After the results of the unrotated and rotated principal components analysis based on primary axis were completed, the factors were classified and named in terms of the items they included. The results of this process is shown in Table 18.

Table 18. Factor groups based on the results of the factor analysis

Factor Name	Items
Daily Life	**34.**I believe that I will use my astronomy knowledge in many places during my life.
	43. Thanks to astronomy, I comprehend the importance of science in my life.
	44.I like trying to understand natural phenomena by using my knowledge in astronomy.
	35. I am interested in new developments in astronomy.
	36. I follow current developments in astronomy.
	39. Thanks to astronomy, I can observe the events around me better.
	40. Thanks to astronomy, I can have knowledge about nature.
	33. Astronomy is in every phase of life.
	45. Astronomy subjects increase my interest in science.
	24. It is easy to understand astronomy concepts.
Application	**11.** I want to learn astronomy subjects by conducting experiments.
	17. I understand astronomy subjects better when they are applied.
	19. I understand astronomy subjects better on hands-on models.
	12. Astronomy is an extremely technical field.
	13. I can learn the science of astronomy.
Being Interested	**8.** It is a waste of time to try to understand astronomy subjects.
	9. I forget the astronomy subjects in a short time.
	10. I don't like talking about astronomy with my classmates.
	16. Astronomy is an insignificant field.
	15. Astronomy is a complex field.
	5. I get very bored while listening to astronomy lesson.
Self-confidence	**4.** I am assertive about the field of astronomy.
	28. I feel unconfident when I have to do my astronomy homework.
	26. I feel under stress in astronomy lesson.
	25. I get the feeling that I will fail in astronomy exams.
Liking	**1.** Astronomy is a field that I like.
	2. I like getting astronomy lessons.

The results of the factor analysis shows that AAS is grouped in six dimensions. The first dimension was named "Daily life", the second dimension was named "Application", the third dimension was named "being interested", the fourth dimension was named "self-confidence" and the fifth dimension was named “liking”.

Calculating the AAS reliability: In order to determine the reliability level of a Likert type attitude scale, it is suitable to use Cronbach’s Alpha coefficient, which is a criterion of internal consistency (Tavşancıl, 2005). A high Cronbach’s Alpha coefficient is an indicator that the items in the scale have a high homogeneity. The scale’s coefficient defines whether the items in the scale are consistent with each other and whether they show the same properties. The Cronbach’s Alpha reliability value of our study which was conducted with 274 students and which had 27 items was given in Table 19.

Table 19. Reliability value of AAS

Cronbach’s alpha	Cronbach's alpha based on standardized items	Number of items
,913	,912	27

When Table 19 is examined, it can be seen that Cronbach’s Alpha coefficient is 0,912. The reliability coefficient being greater than 0,70 is enough for the reliability of the items (Büyüköztürk, 2010).

Cronbach’s Alpha reliability coefficient of each sub dimension in AAS was calculated and presented in Table 20.

Table 20. Cronbach’s alpha values of the factors in AAS

Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
,875	,869	,786	,721	,715

When the Cronbach’s Alpha coefficients were examined in terms of sub dimension, 0,875 was found for Factor 1, 0,869 was found for Factor 2, 0,786 was found for Factor 3, 0,721 was found for Factor 4 and 0,715 was found for Factor 5. Thus, it is clear that the scale has a quite high reliability in terms of factors.

4. Conclusions

A valid and reliable scale was developed in this study to measure students’ attitudes towards astronomy (Final AAS is in the appendix). The study included item analysis, process of validity and reliability and analyses. The study was conducted with 302 students; however, 28 students were excluded from the analysis due to missing values or for giving the same answer to a great majority of the items. SPSS 22 program was sued to analyze the data. General features of the AAS developed as a result of the analyses are presented in Table 21.

Table 21. General features of AAS

Features	Results
Target population	Middle school students
The number of students the scale was conducted on	274
Likert type	5 Likert type – Totally agree – Agree – Indecisive – Disagree – Totally disagree
Number of items	27 Positive:17 Negative:10
Construct validity	5 experts Item total correlations Upper-lower group analysis
Reliability value	0,912 (Cronbach's Alpha)
Number of factors	5 factors – Daily Life – Application – Being Interested – Self-Confidence – Liking
Factor reliability values	Factor 1: 0,875 Factor 2: 0,869 Factor 3: 0,786 Factor 4: 0,721 Factor 5: 0,715
Factor load value interval	0.533 - 0.777
Total explained variance percentage	58,002
KMO value	0,896
Kolmogorov-Smirnov normality value	0,052

One of the basic elements of a successful education is a successful assessment process. To do this, it is extremely important to find out the existing states of the students at the beginning of the teaching process and to consider the results throughout the process. Teaching materials and strategies as well as the stages of assessment and evaluation should proceed according to the existing situation determined before teaching. For this, the assessment instruments should be valid and reliable. Thus, it is thought that AAS will be important for the assessment activities in astronomy education.

We are of the opinion that a researcher or teacher who wants to learn students' attitudes towards astronomy can use the AAS which was developed. In addition, the researchers who used this scale can measure the efficiency of any teaching method used, the relationship of astronomy with daily life and the changes in students' attitudes such as self-confidence, being interested and liking towards astronomy as a result of the five dimensions AAS contains.

5. Research Limitations and Future Directions

In this section, some recommendations were given to researchers in this field within the context of the experience gained while developing AAS and the results obtained.

- AAS is a scale which was developed by studying middle school students. However, this scale can be conducted on high school and university levels and its applicability dimension can be developed.

- It can be used as a data collection tool in studies of astronomy education.

- We are of the opinion that as well as studies which present the existing situation or conceptual errors in studies of astronomy education, it will be of use to conduct studies which present students' attitudes and the changes in their attitudes.

- The test's reliability and validity can be tested by conducting it on different samples.

- The test can be developed by adding different questions or by revising the questions, after using suitable strategies to measure the reliability and validity of each new item.

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Appendix.Astronomy Attitude Scale(Final Form)

Female ☐ **Male** ☐ **School:** **Grade:**	**Totally disagree**	**Disagree**	**Indecisive**	**Agree**	**Totally agree**
1. Astronomy is a field that I like.					
2. I like getting astronomy lessons.					
3. I am assertive about the field of astronomy.					
4. I get very bored while listening to astronomy lesson.					
5. It is a waste of time to try to understand astronomy subjects.					
6. I forget the astronomy subjects in a short time.					
7. I don't like talking about astronomy with my classmates.					
8. I want to learn astronomy subjects by conducting experiments.					
9. Astronomy is an extremely technical field.					
10. I can learn the science of astronomy.					
11. Astronomy is a complex field.					

12. Astronomy is an insignificant field.					
13. I understand astronomy subjects better when they are applied.					
14. I understand astronomy subjects better on hands-on models					
15. It is easy to understand astronomy concepts.					
16. I get the feeling that I will fail in astronomy exams.					
17. I feel under stress in astronomy lesson.					
18. I feel unconfident when I have to do my astronomy homework.					
19. Astronomy is in every phase of life.					
20. I believe that I will use my astronomy knowledge in many places during my life.					
21. I am interested in new developments in astronomy.					
22. I follow current developments in astronomy.					
23. Thanks to astronomy, I can observe the events around me better.					
24. Thanks to astronomy, I can have knowledge about nature.					
25. Thanks to astronomy, I comprehend the importance of science in my life.					
26. I like trying to understand natural phenomena by using my knowledge in astronomy.					
27. Astronomy subjects increase my interest in science					