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PSYCHOMETRIC EVALUATION ON THE TURKISH ADAPTATION OF THE SCIENTIFIC ATTITUDE INVENTORY

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Abstract. *The purpose of this study is to adapt Scientific Attitude Inventory-II into Turkish and to examine its factor structure. The English and Turkish versions of the scale were tested out on the students in the Department of English Language Teaching (N=40) at Dokuz Eylul University a week apart and a high degree of correlation was found between the scores of the two applications. Then Confirmatory Factor Analysis (CFA) was conducted with the data collected from 292 students in order to examine the factor structure of the scale. Following the CFA, 12, 6, 3 and 1 factor structures did not fit the data. When Exploratory Factor Analysis was conducted with the same data set, it was determined that the items in the scale could be grouped under four factors. The scale was tested out on different 255 students and CFA was conducted again. After the CFA, the four-factor structure was found to be adequate fit with the data.*

Key words: *confirmatory analyses, exploratory analyses, psychometric evaluation, scientific attitude inventory.*

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Introduction

One of the fundamental aims of science education is to develop the scientific attitude of students (Fraser, 1978; Heiss, 1958; Lawrenz, 1975). Having a positive attitude towards science facilitates individuals' learning, enables them to be successful, and renders their development continuous by influencing their thoughts (Başaran, 1978). Therefore, students' attitudes towards science, their views about scientists, and their desire to become scientists have been researched by many scholars for years (Moore and Foy, 1997).

Moore and Sutman (1970) describes scientific attitude as "an opinion or position taken with respect to a psychological object in the field of science" (p.86). Enabling individuals to approach the problems they face like a scientist and come up with rationalist solutions is only possible through training students with a developed scientific attitude. Billey and Zakhariades (1975) sets forth the qualities that an individual with a developed scientific attitude should possess as rationality, curiosity, open-mindedness, aversion to superstitions, objectivity and suspended judgment. On the other hand, Rao (2003) compiles the definitions in literature and describes an individual with a developed scientific attitude as someone who is open-minded, honest, unsuperstitious, thoughtful, inquisitive, curious about cause-effect relationships, enthusiastic about experimental scrutiny, able to distinguish between fact and theory, someone who listens to others' points of view, and does not pass judgment before obtaining exact information. Gauld (1982) emphasizes that scientists use these and similar traits (open-mindedness, fairness, detachedness, the ability to reach conclusions based on experimental evidence, etc.) when they

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solve problems. Hence the development of scientific attitude is crucial since it improves the qualities mentioned above, and encourages students to work like a scientist. Additionally, development of positive scientific attitude positively influences the students' learning, comprehension and interpretation of science subjects (Gauld, 1982); thus, individuals become scientifically literate and can produce solutions by using logical data when they face a problem in daily life. Consequently, determining students' scientific attitude is significant during the process of education.

When studies that measure scientific attitude are examined, it is seen that such studies go back to the 1920's, and the interest in this topic begins to increase after Noll's research (1935) and many studies enter the literature from that time on (Moore & Sutman, 1970; Lawrenz, 1975; Haladyna & Shaughnessy, 1982; Stefanich & Kelsey, 1989; Moore & Foy 1997; Caleon & Subramaniam, 2007; Oven et. al, 2007; Lichtenstein et. al., 2008).

One of the most popular scales which were developed to measure individuals' scientific attitude is Scientific Attitude Inventory (SAI) developed by Moore and Sutman (1970). SAI is a four point likert scale, containing 60 items. The scale has a 12 factor structure and under each factor, there are five items. Six of the factors include positive items while the other six include negative items. Moore and Foy (1997) revised SAI and developed SAI-II by taking into account the developments in order to expand the area of use and to increase the reliability of the scale. The gender-related language of SAI was eliminated, the vocabulary that obstructed readers' comprehension was taken out and the number of items was reduced from 60 to 40 to make the use of the scale easier (Moore & Foy, 1997). 10 of the items remained the same while the changes mentioned above were made in 30 items (Moore & Foy, 1997). At the same time, the "undecided" choice was added to the scale, changing it to a five point-likert scale. Like its original, SAI-II includes six positive and six negative factors, for a total of 12 factors.

An examination of the studies about the structural validity of the scale reveals different conclusions. When Moore and Foy (1997) conducted Exploratory Factor Analysis to test the structure validity of the scale, they determined that 30 out of 40 items were grouped under five factors. However, the items grouped under these factors did not form meaningful groups and SAI-II was structured independent of the factor analysis results (Moore & Foy, 1997). Instead of factor analysis, top and bottom 27 percent groups based on the scores obtained from the scale were compared using an independent sample t test in order to prove the validity of the scale (Moore & Foy, 1997). Test results indicated that each dimension showed a significant level of difference from the others. Munby (1997) criticizes this situation as follows:

> "It is true that this technique shows the scales to contribute to the total score, because internal reliability is being examined here. But it is not clear that this technique helps to establish validity, for two reasons. First, there is little in the field trial to establish what this new version, the SAI II, measures; and second, there is nothing in the field test to assure us that what is measured by each scale is a conceptually discrete component of an attitude toward science" (p. 337).

In their study, Lichtenstein et al. (2008) examined the structure validity of SAI-II and tested the scale, which included 40 items, by using exploratory and confirmatory factor analyses. Following their analyses, they determined that the structure suggested by the developers of the scale was incompatible and suggested a three-factor structure instead for the scale. However, the researchers stated that this structure did not show sufficient compatibility with data sets, either (Lichtenstein et. al. 2008). In Turkey, on the other hand, the structure validity of the scale adapted to Turkish by Demirbaş and Yağbasan (2006) was examined by using EFA. In the studies of intercultural scale adaptation, however, it is necessary to examine the factor structure of the scale by using CFA (Çokluk, Şekercioğlu and Büyüköztürk 2010). The goal in CFA is to specify whether a model which was prepared beforehand adjust to a new data set sufficiently. In a case the factor structure in the culture where the scale is developed does not give consistent results with the data gathered from the culture to which is adapted, it might be considered to specify new factor structures with EFA (Çokluk, Şekercioğlu and Büyüköztürk 2010).

In line with the studies mentioned above, it is seen that there are some gaps to be filled about the structure validity of the scale and its adaptation to Turkish. Hence, bearing in mind the trouble about the structure validity of the scale, CFA and EFA were decided to be used in order to determine which factor structure is compatible with our data set and the SAI-II adapted into Turkish.

In this context, answers to the following research questions are sought in the study:
For the scale which was adapted to Turkish,

1. Does the data set support the factor structure which was put forward by Moore and Foy (1997)?
2. Does the data set support the three factor structure which was put forward by Lichtenstein et. al. (2008)?
3. Is there any other more appropriate factor structure which is supported by the data set?

Methodology of Research

The first phase of this study consists of the adaptation of the scale, originally written in English, into Turkish. The scale was translated by a language expert and then was read by two other experts in order to evaluate the translation. After the changes suggested by the experts were made, the scale was read by a Turkish language expert to determine the suitability of the sentences in Turkish. Then the Turkish and English versions of the scale were given to 40 students in the DEU Department of English Language Teaching one week apart. A high degree of correlation ($r=0.880$, $p=0.00$) was found between the participants' responses in the Turkish and English versions of the scale. In the second phase of the study, the factor structure of the scale was evaluated using CFA and EFA and a new factor structure compatible with our data set was created.

Sample of Research

In gathering the research data, to ensure that the students' answers to the scale are honest, voluntary participation was considered as the basis. The participants of the study are 547 students attending Dokuz Eylul University, Faculty of Education, who are willing to fill in the scale. The scale, which was translated into Turkish, was initially given to 292 students; then, the compatibility of the 12 (structure suggested by the developers of the scale), 6 and 3 (structure suggested by Lichtenstein et. al. (2008) factor structures with our data set was explored through the use of CFA. 47% (N=137) of this group are male students, and 53% (N=154) are female students. Using the data collected from the same group, a new factor structure compatible with our data set was then determined with EFA. In order to test the new factor structure, the scale was given to 255 more students, conducting CFA once again. The second group of students was 43% (N=110) male, 57% (N=145) female.

Data Analysis

Data analysis began with confirmatory factor analysis (CFA) in order to test the factor structure of the scale. CFA is a statistical method used in testing the compatibility of a proposed model with data. CFA makes use of χ^2 statistics in order to test the null hypothesis formed as the proposed model is fit with the data. χ^2 goodness-of-fit statistics determines the size of discrepancy between sample and fitted covariance matrices (Hu & Bentler, 1999). If the value for p determined by relevance test is too small, this results in the rejection of the null hypothesis. Small values for p indicate the incompatibility of the model. However in χ^2 statistics, the value for p is affected by the size of data set, so large sample selection may lead to smaller values for p (Marsh & Balla, 1986, Şimşek 2007). Hence, in order to test the compatibility of the model, the ratio of the value for χ^2 to degree of freedom (χ^2/df) is examined. If the χ^2 value is relatively larger than degree of freedom, the model is rejected (Marsh & Balla, 1986). On the other hand, if the χ^2/df ratio is less than two, this indicates that the model fits the data. "Another popular way of evaluating model fit is the so-called fit indexes that have been offered to supplement the χ^2 test" (Hu & Bentler, 1999 p.2). In this study, Comparative Fit Index (CFI), Tucker-Levis Index (TLI) and Root Mean Square Error of Approximation (RMSEA) indexes were used. CFI and TLI may have values

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varying between 0 and 1. CFI and TLI values over 0.95 indicate perfect fit with the model, whereas values between 0.95 and 0.90 indicate adequate fit (Hu & Bentler, 1999; Marsh, Balla & Mc Donald 1988). For RMSEA, values 0.06 and below indicate good fit whereas values between 0.06 and 0.08 indicate acceptable fit (Hu & Bentler, 1999).

Results of Research

Confirmatory Factor Analysis (CFA)

The 40 items on the scale were matched with 12 sub-dimensions (six positive, six negative, for a total of 12 dimensions) in accordance with the original structure set forth by Moore, and CFA was conducted. The analysis results were as follows: χ^2 (674) =1368 (χ^2/df= 2.03), CFI= 0.76 and RMSEA= 0.056. The results indicate that the 12-factor structure of the scale is not adequate fit with the data set. Although the χ^2/df ratio is at an acceptable level, CFI and RMSEA values indicate weak results. However, the factor load of nine items (i8, i12, i16, i26, i32, i34, i35, i37, i39) in the scale remain below .30. Afterwards, considering that the positive and negative items may be grouped under the same dimension, CFA was conducted for six-factor structure. The results were very poor, with χ^2 (614) = 1381.50 (χ^2/df= 2.25), CFI= 0.69, TLI =0.69 and RMSEA= 0.064.

Moore and Foy (1997) have not emphasized the scores received from sub-scales in scoring the scale. The total score is calculated by adding the scores from all items regardless of the sub-dimensions. Hence, CFA was conducted for a single-factor structure, supposing that the scale could be made up of one dimension. Findings do not support a single-factor structure, either: χ^2 (740) =2071.49 (χ^2/df= 2.80), CFI= 0.51, TLI =0.49 and RMSEA= 0.079.

Lichtenstein et.al (2008) suggests three-factor structure for SAI-II. Factors are termed as "Science is about understanding and explaining", "Science is rigid" and "I want to be a scientist" and the scale consists of 27 items in total. When three-factor structure is analyzed with CFA, Lichtenstein et.al (2008) determined that their model is not sufficiently compatible with data sets but that the structure most compatible with data sets is three-factor structure. When CFA is conducted for three-factor structure, the following results were found: χ^2 (321) = 834.43 (χ^2/df= 2.60), CFI= 0.75, TLI=0.73 and (RMSEA) = 0.074. Since this structure also shows a weak fit with the data set, Exploratory Factor Analysis (EFA) was conducted with the data set to determine the number of factors forming the scale.

Exploratory Factor Analysis (EFA)

An oblique rotation procedure was used in EFA's because, factors should be correlated. It was determined that the scale is formed under nine factors (explaining 52.8% of the total variance) when eigen values greater than one rule is used, and four factors (explaining 36% of the total variance) when scree test is used. Then, factor rotation (direct oblimin rotation) was done and items that correlate highest with the factors were determined. Since the correlating items were grouped under the same dimension in four-factor structure, it was decided to subsume the scale under four factors, considering the convenience of giving names to the factors. In this case, five items whose factor-loads were under 0.35 (i9, i12, i28, i35, i37) were removed from the scale, and EFA was conducted again. At the end of the EFA, Kaiser-Meyer-Olkin (KMO) value was calculated as 0.811, and it was determined that the scale explained 40.4% of the total variance. After referring to the experts, the sub-dimensions of the scale were termed as "I want to be a scientist", "Scientists have specific characteristics and attitudes", "Science should to be understood by everyone" and "Scientific opinions need to be criticized".

CFA for Four-Factor Structure

In order to test the compatibility of the four-factor structure, the scale was given to 255 more undergraduate students and CFA was conducted. CFA results were as follows: χ^2 (489) = 1069.55 (χ^2/df= 2.19), CFI= 0.79, TLI= 0.77 and Root Mean Square Error of Approximation (RMSEA) = 0.062. Six items whose factor-load values were under .35 (i4, i7, i15, i17, i19, i21) were removed from the scale, and CFA was conducted again. The results were as follows: χ^2 (293) = 506.30 (χ^2/df= 1.73), CFI= 0.87, TLI=0.85 and RMSEA= 0.054. The sub-dimensions of the scale and factor-loads are seen in Table1.

Table 1. Four factor structure for SAI-II.

Factor I	**I want to be a scientist.**	
Item Number		Loadings
36	I would like to be a scientist.	0.83
30	I may not make great discoveries, but working in science would be fun	0.78
22	I do not want to be a scientist.	0.78
40	Working in a science laboratory would be fun.	0.76
1	I would enjoy studying science.	0.73
27	I would like to work with other scientists to solve scientific problems.	0.64
13	The search for scientific knowledge would be boring.	0.44
14	Scientific work would be too hard for me.	0.42
Factor 2	**Scientists have specific characteristics and attitudes.**	
Item Number		Loadings
10	Scientists cannot always find the answers to their questions.	0.72
33	The senses are one of the most important tools a scientist has.	0.65
25	Scientists must report exactly what they observe.	0.64
18	Good scientists are willing to change their ideas.	0.56
20	A scientist must have a good imagination to create new ideas.	0.54
39	Scientists have to study too much.	0.51
26	If a scientist cannot answer a question, another scientist can.	0.47
34	Scientists believe that nothing is known to be true for sure.	0.43
Factor 3	**Science should to be understood by everyone.**	
Item Number		Loadings
29	Every citizen should understand science.	0.62
23	People must understand science because it affects their lives.	0.60
6	Only highly trained scientists can understand science.	0.47
8	Most people are not able to understand science.	0.44
38	Scientific work is useful only to scientists.	0.44
Factor 4	**Scientific opinions need to be criticized.**	
Item Number		Loadings
5	If one scientist says an idea is true, all other scientists will believe it.	0.76
32	Scientists should not criticize each other's work.	0.70
3	It is useless to listen to a new idea unless everybody agrees with it.	0.54
11	When scientists have a good explanation, they do not try to make it better.	0.53
16	Scientific ideas can be changed.	0.49

All loadings are statically significant at p<0.05

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Considering the results obtained with modification indexes, errors were correlated between i13 and i14, i18 and i25, i6 and i8. In this case, the results were as follows: χ^2 (290) = 447.28 (χ^2/df= 1.54), CFI= 0.91, TLI= 0.90 and RMSEA= 0.046. These results indicate a sufficient fit between four-factor model and the data set. The four-factor model specified for SAI-II is shown in Figure 1.

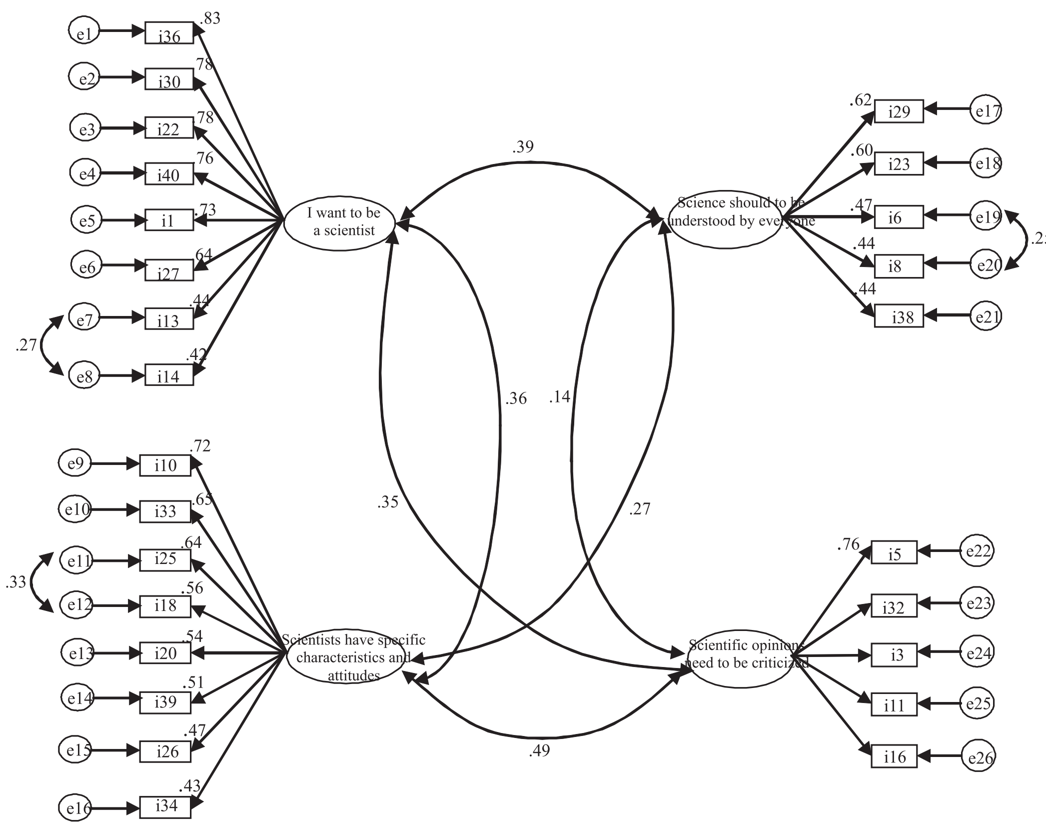

Figure 1: Confirmatory factor analysis for four-factor structure.

Reliability

Moore & Foy (1997) report Cronbah's alpha reliability coefficient as 0.781 for SAI-II. When the reliability of the scale for the new structure formed as a result of factor analysis is examined, Cronbah's alpha reliability coefficient was calculated as 0.783 with the first set of data collected (n=292), and as 0.771 with the second set of data (n=255). Split-half reliability coefficient was calculated as 0.804 with the first set of data collected, and as 0.811 with the second set of data. Findings indicate that the scale consisting of 26 items has a high level of reliability.

In order to determine whether or not the scale and the sub-scales differentiate between students who score high and those who score low, t test was used. For this, using the data collected from 292 students, the top and bottom 27% groups based on the scores received from the whole scale and each of the subscales were determined. That there is a meaningful difference between the average scores of bottom and top groups in favor of the top group shows that the scale and the sub-scales could differentiate statistically between the students who score high and those who score low at significant level. The number of items for each sub-scale, score intervals, average scores of top and bottom groups, standard deviations and the results of the t test are shown in Table 2.

Table 2. The results of the t test for the average scores of top and bottom groups.

			High		Low			
Scale	No. of Items	Scale Range	M	SD	M	SD	t	p
1	8	8-40	38.73	1.17	25.46	3.78	29.81	0.00*
2	8	8-40	31.18	1.29	24.29	2.11	24.76	0.00*
3	5	5-25	22.35	1.13	16.11	1.49	30.03	0.00*
4	5	5-25	24.10	.81	17.41	1.58	33.36	0.00*
Total	26	26-180						

**p<0.05*

At the end of the analysis, it was found that the top and bottom 27% groups could be statistically differentiated at a significant level with each sub-scale. In this sense, the sub-scales could be said to differentiate between students with a high scientific attitude and those with a low scientific attitude.

Discussion

This study finds that our data set supports the four-factor structure the best for SAI-II translated into Turkish. The 12-factor structure proposed by Moore & Foy (1997) and three-factor structure set forth by Lichtenstein et.al (2008) did not yield compatible results with our data set. It was determined that six-factor and single-factor structures were also incompatible for the scale. Even though 12-factor structure yielded results which could be corrected by modification indexes, elimination of items with factor loads less than .35 and representation of some of the factors with two items and some with one item would be necessary. Since the presence of one or two items under the factors would not be meaningful, new factor structures were sought without taking modification indexes into account.

It was determined with EFA that the scale could be grouped under nine or four factors. Although the nine-factor structure explains a greater percentage of the variance, items grouped under these factors did not form meaningful groups. Hence, the four-factor structure, which explains a smaller percentage of the variance but forms more meaningful groups, was given preference.

The first of the factors determined consists of eight items. These items are exactly the same as eight of the ten items in groups 6-A and 6-B of the scale proposed by Moore and Foy (1997), and the eight items in the group termed as "I want to be a scientist" by Lichtenstein et.al (2008). Consequently, the term given by Lichtenstein et.al. (2008) was used without any change. The second factor, which consists of eight items, includes students' opinions about scientists and is termed as "Scientists have specific characteristics and attitudes" The third factor includes items about the understandability of science and is termed as "Science should to be understood by everyone" This factor includes five of the six items in groups 5-A and 5-B proposed by Moore and Foy (1997). The last factor we termed as "Scientific opinions need to be criticized" includes five items which test students' belief about whether scientific knowledge comprises of inalterable truths or not. The rearranged scale contains 14 (i1, i10, i16, i18, i20, i23, i25, i27, i29, i30, i33, i34, i36, i40) of the 20 positive items and 12 (i3, i5, i6, i8, i11, i13, i14, i22, i26, i32, i38, i39) of the 20 negative items included in SAI-II. Positive items should be scored as 5, 4, 3, 2, and 1 from "I completely agree" to "I completely disagree" whereas negative items should be scored as1, 2, 3, 4, and 5. The total score for scientific attitude, which could be received from the scale, could take values between 26 and 130.

The four-factor structure necessitated the elimination of 14 items from the scale which contained 40 items. Although this increases the unexplainable variance, it also makes it easier to use since it reduced

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the response time. In addition, because the reduction in the number of items will ensure reading and responding to all items by the students without getting bored, the collected data will be more reliable and data loss will be lessened.

A review of literature reveals that the analyses regarding the structure validity of the scale have been conducted with data collected from elementary and secondary school students (Moore & Foy, 1997; Demirbaş and Yağbasan, 2006; Lichtenstein et. al., 2008). The findings we obtained through the data collected from undergraduate students are significant in that they reveal the kind of results found when conducted at higher education level.

Conclusion

The current analyses show that the structures put forward by neither Moore and Foy (1997) nor Lichtenstein et. al. (2008) are the appropriate models for the SAI-II which was adapted to Turkish. Besides, a new structure with four factors is reached in the research by using explanatory and confirmatory analyses. The four factor structure is rather compatible with the data set. The scale prepared in line with this new structure is formed to consist of 26 out of 40 (14 positive, 12 negative) items which take place in the original SAI-II. The scale which has good psychometric properties can be used to determine students' scientific attitudes as a valid and reliable instrument.

The findings of the study are limited to data collected from students in the Physics, Chemistry, and Science Teaching Departments at Dokuz Eylul University. Additional data to be collected from social sciences students to those already collected from physical sciences students will be important in terms generalizing the findings.

References

Başaran, İ. E. (1978). *Eğitim psikolojisi*. Ankara: Bilim Matbaası

Billey, V. Y., & Zakhariades, G. A. (1975). The development and application of a scale for measuring scientific attitudes. *Science Education, 59* (2), 155-165.

Caleon, I. S., & Subramaniam, R. (2007). Attitudes towards science of intellectually gifted and mainstream upper primary students in Singapore. *Journal of Research in Science Teaching, 45* (8), 940-954.

Çokluk, Ö., Şekercioğlu, G. & Büyüköztürk, Ş. (2010). *Sosyal bilimler için çok değişkenli istatistik: LISREL ve SPSS uygulamaları*. Ankara: Pegem Akademi.

Demirbaş M., Yağbasan, R. (2006). Fen Bilgisi öğretiminde bilimsel tutumların işlevsel önemi ve bilimsel tutum ölçeğinin Türkçeye uyarlama çalışması. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi, 19* (2) 271-299.

Fraser, B. J. (1978). Development of a test of science related attitudes. *Science Education, 62* (4), 509-515.

Gauld, C. (1982). The scientific attitude and science education: A critical reappraisal. *Science Education, 66* (1), 109-121

Haladyna, T., & Shaughnessy, J. (1982). Attitudes toward science: A quantitative synthesis. *Science Education, 66* (4), 547-563.

Heiss, E. D. (1958). Helping students develop a scientific attitude. *The Science Teacher, 25*, 371-373.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.

Lawrenz, F. (1975). The relationship between science teacher characteristics and student achievement and attitude. *Journal of Research in Science Teaching, 12* (4), 433-437.

Lichtenstein, M. J., Owen, S. V., Blalock, C. L., Liu, Y., Ramirez, K. A., Pruski, L. A., Marshall, C. E., & Toepperwein, M. A.(2008). Psychometric reevaluation of the scientific attitude inventory-revised (SAI-II). *Journal of Research in Science Teaching, 45* (5), 600-616.

Marsh, H. W., & Balla, J. R. (1986). *Goodness-of-fit indices in confirmatory factor analysis: The effect of sample size*. Retrieved from ERIC database. (ED267091).

Marsh, H. W., Balla, J. R., & McDonald, R. P. (1988). Goodness-of-fit indexes in confirmatory factor analysis: The effect of sample size. *Psychological Bulletin, 103* (3), 391-410.

Moore, R. W., & Foy, R. L. H. (1997). *The Scientific Attitude Inventory: A Revision (SAI II). Journal of Research in Science Teaching, 34* (4), 327-336.

Moore, R. W., & Sutman, F. X. (1970). The development, field test and validation of an inventory of scientific attitudes. *Journal of Research in Science Teaching, 7*, 85-94.

Munby, H. (1997). Issues of validity in science attitude measurement. *Journal of Research in Science Teaching, 34*, (4), 337-341.

Noll, V. H. (1935). Measuring the scientific attitude. *Journal of Abnormal and Social Psychology, 30*, 145-154.

Owen S. V., Toepperwein, M. A., Pruski L. A., Blalock C. L., Liu Y., Marshall C. E., & Lichtenstein, M. J. (2007). Psychometric reevaluation of the women in science scale (WISS). *Journal of Research in Science Teaching, 44* (10), 1461–1478.

Rao, D. B. (2003). *Scientific attitude.* Delhi: Arora Ofset Press.

Stefanich, G. P., & Kelsey, K. W. (1989). Improving science attitudes of preservice elementary teachers. *Science Education, 73* (2), 187-194.

Şimşek, Ö. F. (2007). *Yapısal Eşitlik Modellemesine Giriş: Temel İlkeler ve LISREL Uygulamaları.* Ankara: Ekinoks.

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