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EXPLORATORY FACTOR ANALYSIS STUDY FOR THE SCALE OF HIGH SCHOOL STUDENTS' ATTITUDES TOWARDS CHEMISTRY

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ABSTRACT

It is important to develop students' positive attitudes chemistry lessons in school because research has suggested that attitudes are linked with academic achievement. Therefore, how to evaluate the attitudes is an important topic in education. The purpose of this study was to develop a Likert-type scale that could measure high school students' attitudes toward chemistry. In order to develop this scale, it was benefited from some studies in the literature and expert ideas. After adjustments based on expert recommendations, a scale which is consisted of 25 items was developed and applied to 200 high school students. In order to determine the construct validity, exploratory factor analysis was performed. In this way, a final scale consists of 20 items. The factor analysis results indicated that the scale has two factors explaining 45.9% of the total variance. In addition, the scale' reliability coefficient (Cronbach' alpha) was found as 0.89. Obtained results showed that the scale which is reliable and valid measurement tool can be used to determine the attitudes of secondary school students to chemistry.

Key Words: Chemistry education, attitude scale, validity, reliability.

INTRODUCTION

The definitions concerning attitude are distributed to a wide range of literature. Therefore, the attitude's definition is very difficult to summarize in one sentence. However, the all definitions for the attitude are within a consensus in which they are positive or negative thoughts, feelings or behaviors towards the objects around us (Petty, 1995). The attitude is a psychological construct which has cognitive, affective and behavioral components (Eagly and Chaiken, 1993). The *cognitive* component contains a set of beliefs about the attributes of the attitudes' object. The *affective* component includes feelings about object. The *behavioral* component consists the way people act toward the object (Eagly & Chaiken, 1993; Salta & Tzougraki, 2004). This construct is an important predictor of the feelings, emotions or behaviors one person has toward an event or an object (Anderson, 1988). The attitude is viewed as "a learned, positive, or negative feeling about science that serves as a summary of a wide variety of beliefs about science" (Koballa and Crawley, 1985). Therefore, the accurate acquisition of attitudes will be useful for improving the quality of teaching chemistry. The statements like that "I like chemistry" or "I hate chemistry" indicate negative or positive feelings towards leaning chemistry. That two students which have these different feelings are subjected to the same training will lead to different conclusions. Affective dimension acts as a bridge between the behavioral and the cognitive dimensions in learning. If the teacher is unable to build this bridge on her/his students, (S)he would not perform an effective teaching. As well as cognitive factors, concerns, attitudes, affective factors and self-efficacy beliefs are extremely important in learning (Krylova, 1997; Turner & Lindsay, 2003).

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Research has suggested that attitudes are linked with academic achievement (Freedman, 1997; Salta &Tzougraki, 2004; Weinburgh, 1995).Also, there is an agreement among educators on the importance of students' attitudes toward science courses in school (Osborne, Simon, & Collins,2003). However, there is not an agreement about how to evaluate the attitudes. The attitude scales were generally used to evaluate the attitudes.The *Test of Science Related Attitudes (TOSRA)* developed by Fraser (1981) has an important place in this process. Cheung (2009) developed the *Attitudes towards Chemistry Lessons Scale (ATCLS)* by making use of *"*Enjoyment of Science Lessons", which is *a sub-scale of TOSRA.* In our country, the studies on the development of attitude scale are quite common (Berberoğlu, 1990;Şimşek, 2002; Kan & Akbaş, 2007; Tüysüz &Tatar,2008).

Although the attitude was widely investigated in the literature, it still continues to be an issue needed to be studied because it is an important predictor for learning. Because the students have difficulty to understand chemistry consisting of abstract concepts, it becomes important to investigate students' attitudes toward chemistry. In this respect, the attitude scales that evaluate the attitude' dimensions have great significance in education.

The Purpose of the Study

The purpose of the present study is to develop a reliable and valid measurement tool in a Likert-type which evaluates high school students' attitudes towards chemistry.

METHOD

The reliability of the scale was evaluated by Cronbach's α, which is the most important reliability index and is based on the number of the scale' items, as well as on the correlations between the items (Nunnally, 1978). The alpha (α) is the most important index of internal consistency. Then Principal Components Analysis with Varimax Rotation was used to determine the scale construct validity. Two statistical tests were used to evaluate if the sub-scales were suitable for factor analysis. The first is the Bartlet Test of Sphericity, in which it is examined if the subscales of the scale are inter-independent, and the latter is KMO (Kaiser-Meyer Olkin Measure of Sampling Adequacy) which examines sample sufficiency.

Sample

The sample of study is consisted of 200 students (95 girls and 105 boys) in high school in Trabzon. The number and grades of the students in the sample are shown in Table 1.

Table 1: The number and grades of the students in the sample

Grade Level	**Number of Students**		**Gender**			
			Boy		**Girl**	
	f	*%*	*f*	*%*	*f*	*%*
9th grade	50	25	26	13	24	12
10th grade	48	24	25	12.5	23	11.5
11th grade	53	26.5	28	14	25	12.5
12th grade	49	24.5	26	13	23	11.5
Total	200	100	105	52.5	95	47.5

According to Table 1, 9th grade students are 50, 10th grade students are 48, 11th grade students are 53 and 12th grade students are 49. There are different ideas about the required sample size for factor analysis. According to Comrey and Lee (1992), the sample is very weak when it is 50, weak when it is 100, medium when it is 200, good when it is 300, very good when it is 500 and perfect when it is 1000. On the other hand, according to Kline (1998), the appropriate sample size for factor analysis must be up to 10 times of variable (item) number. Taking into account all of these views, our sample (N=200) is medium level for factor analysis.

FINDINGS AND DISCUSSION

The Development of the Scale

First, an item pool which is consisted of 37 items was constituted by making use of Test of Science-Related Attitudes (TOSRA) which is designed to measure seven distinct science-related attitudes among secondary school students (Fraser, 1981). These sub-scales are called "Social Implications of Science", "Normality of Scientists", "Attitude to Scientific Inquiry", "Adoption of Scientific Attitudes", "Enjoyment of Science Lessons","Leisure Interest in Science", and "Career Interest in Science". TOSRA was found to be highly reliable and used in a variety of studies in science education (White &Richardson, 1993; Joyce &Farenga, 1999; Lang, Wong&Fraser, 2005).The items in the present scale were adapted from TOSRA. Then a panel of three judges evaluated the items for content validity and readability and the list was reduced to 25 items (13 positive and 12 negative statements) based on the evaluation. The instrument contained 25 items on a 5 point Likert-type scaleranging from 1 = strongly disagree to 5 = strongly agree. The scale has a possible minimum score of 25 and a maximum score of 125. Tavşancıl (2002) suggested that it is easier to develop a Likert-type scale than the others. In this study, the width of the class interval is found by *dividing* the data *range* by the the chosen *number* of classes (Kan, 2009). From this, range= highest value-lowest value=5-1=4, and the class interval is 4/5=0.80. Accordingly, in order to evaluate the findings obtained from data analysis, the following intervals were used: 4.21–5.00 strongly agree, 3.41 to 4.20 agree, 2.61 to 3.40 neutral, 1.81 to 2.60 disagree and 1.00 to 1.80 strongly disagree. Negative sentences were reverse scored. The scale was tested with 200 high school students. The item-total correlation values were determined for items and also mean of each item was calculated. The scalegenerated a mean of 3.14 (SD=1.17).The item-total correlation values ranged from 0.74 to -0.42.Item-total correlations should not be negative and smaller than 0.25 (Özdamar, 1997; Punch, 2005). However, it was found that correlation values of items 3, 17 and 18 were negative, and those of items 13 and 21 were smaller than 0.25. Because these items adversely affect the internal consistency of the scale, they were removed from the scale prior to the factor analysis.

Exploratory Factor Analysis and the Construct Validity

Before the explanatory factor analysis, we determined if the sample data are suitable for the analysis. The table 2 gives information about two assumptions of factor analysis. To determine if the subscales were suitable for factor analysis, the Bartlett Test of Sphericity and KMO (Kaiser-Meyer Olkin Measure of Sampling Adequacy) tests were used. The first test examined if the subscales of the scale are inter-independent, and the latter examined sample sufficiency. As can be seen from Table 3, KMO=0.89>0.70 indicated that the sample data are suitable for factor analysis(Büyüköztürk, 2004; Hair et al., 2006). The Bartlett's Test (p<0.001) showed that the correlations coefficients are not all zero (Table 2). As a result, both assumptions required for factor analysis are satisfied.

Table 2:The results of KMO and Barlett's tests

Kaiser-Meyer-Olkin Measure of sampling adequacy		0.89
Bartlett's Test of Sphericity	Approx. Chi-Square	1609.1
	df	190
	Sig.	.000

Figure 1 shows a scree plot of eigenvalues plotted against the factor numbers. The criterion of Eigenvalue ≥1 was used for determining the number of the factors. In Figure 1, a high curved decrease was observed after the second factor. From this, it could be said that the scale has two factors (Field, 2002).

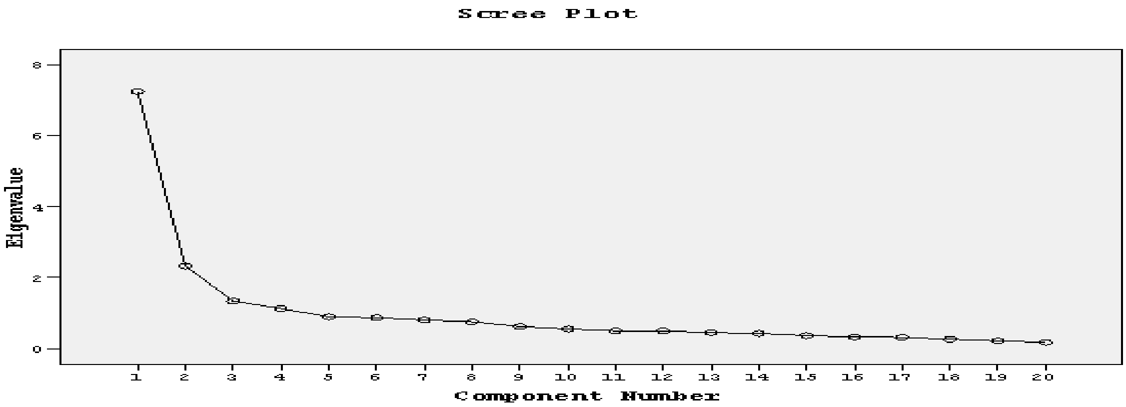

Figure 1:The Scree plot graph of the scale of attitude towards chemistry.

A Principal component analysis with Varimax Rotation was used to confirm the scale construct validity. The results of factor analysis, factor loadings and the variance explained were given in Table 3. As can be seen in Table 3, two factors explaining 49.5% of total variance were obtained. First factor explained 27.6% of total variance and has factor loadings ranging from 0.301 to 0.801.Second factor explained 18.3 % of total variance and has factor loadings ranging from 0.421 to 0.737. The reason behind use of Oblimin rotation is the relation between its factors of the scale (Tabachnick & Fidell, 1996). By this way, a two-factored construct consisting of 20 items explaining 45.9% of total variance is obtained.

Table 3:The results of factor analysis

				Rotated Component Matrix	
	Factors				
Scale items		**M**	**SD**	**I**	**II**
1	Chemistry lessons are funny.	3.22	1,04	,801	
18	I don't like chemistry.	2.78	1,12	,811	
20	Chemistry does not interest me.	3.81	1.10	.796	
7	Chemistry lessons bore me.	2.64	1.23	.783	
10	Chemistry is easy for me to learn.	3.24	1.15	.773	
3	I hate chemistry.	2.86	1.27	.758	
19	I have positive attitude towards chemistry.	3.59	1.16	.758	
5	I'm not good at chemistry.	3.37	1.31	.705	
14	Although I endeavored, I didn't understand chemistry lessons.	2.96	1.24	.626	
13	I'm looking forward to chemistry lessons.	2.62	1.08	.582	
2	Chemistry is necessary to solve daily life problems.	3.11	1.15	.417	
9	Chemistry is one of the most interesting lessons.	3.44	1.32	.322	
16	Chemistry knowledge is important to find a good job.	2.57	1.05	.301	
8	It may be interesting to work in a laboratory to earn money.	3.67	1.19		.737
15	I want to become a scientist after high school.	2.94	1.29		.721
6	I don't want to work in a laboratory after graduating from high school.	2.84	1.12		.712
4	After graduating, I would like to work with people who make discoveries for chemistry.	2.92	1.07		.687
12	To be a scientist is boring.	3.47	1.16		.650
11	To make career about chemistry is boring and routinized.	3.30	1.12		.619
17	I like chemistry projects.	3.49	1.25		.421
	Variance Explained (%)			**27.6**	**18.3**
	Cronbach's α (%)			**0.90**	**0.81**
	Total Variance Explained (%)				**45.9**

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Each factor was named in accordance with the construct explained by the items. First factor was labeled as "Liking for chemistry lessons". The items under this factor are related to the reactions of the students to the chemistry lesson activities. The factor consists of 13 items with loadings between 0.30 and 0.80 and explains 27.6 % of total variance. Two examples of the statements in the factor 1 are; "Chemistry does not interest me" and "chemistry is joyful." The items of second factor are related to chemistry in students' future plans. Considering that, the factor was named as "Career plans for chemistry". The factor 2 consists of 7 items. The factor loadings of the items listed under this factor were ranged from 0.73 to 0.42. Two examples of the statements under the factor 2 are:- "I do not want to work in the Chemistry Laboratory" and "It may be interesting to work in a laboratory to earn money ."

Reliability Analysis of the Scale

Cronbach alpha reliability coefficients are calculated for each scale and sub-dimension of the scale reliability. Cronbach alpha internal reliability coefficients are found as 0.90 for the factor 1 and 0.81 for the factor 2. Cronbach alpha reliability coefficient for the whole scale is found as 0.89. Nunnally (1967) suggested that scale is highly reliable if Cronbach Alpha is $0.80 \leq \alpha < 1.00$. Similarly, Spooren et al. (2007) asserted that Cronbach alpha value above 0.70 is sufficient. Therefore, it can be said that the items in the scale are consistent with each other and measure same property. In other words, the scale is a reliable and valid measurement tool.

CONCLUSION AND RECOMMENDATIONS

Therefore, a model of two factors has reached after the examination of the validity and reliability of the initial students attitudes toward chemistry. The scale constitutes of 20 items and a tool useful for measuring students' attitudes towards chemistry. Principal component analysis made evident two subscales, named as: Liking for chemistry lessons and Career plans for chemistry. The reliability of the scale is $\alpha = 0.89$, which is satisfactory. The reliability coefficients of the sub-scales are found as 0.90 and 0.81, respectively. These are satisfactory, too.

The scale developed in the present study could be used by researchers in experimental and descriptive studies. Further studies that will use the present scale might cope with testing its factor structure as well as its use in different samples. Also, the teachers can use it to determine their students' attitudes toward chemistry the beginning and end of the academic year.

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