ISSN 1648-3898

ATTITUDES SCALE TOWARDS "NANO TECHNOLOGY" FOR CHEMISTRY TEACHERS

Nilgün Seçken

Abstract. *The aim of the study is to develop a valid and reliable attitude scale in order to measure the chemistry student-Teachers' attitudes towards nano technology. During the development phase, a total of twenty-one items that included eleven negative and ten positive statements about nano technology were produced based on experts' views. These items were statistically analysed in terms of different aspects. The data obtained through these analyses were analyzed by using SPSS software. In the study, the scale was administered to 550 undergarduate students. The data obtained was analysed through factor analysis and reliability analysis. At the final stage, the scale was found to include four factors with sixteen items. After the factor analysis, according to Varimax Rotated (rotated Component Matrix) results, has been found to be four factors and Cronbach-Alpha internal integrity of the final version of the scale was found to be 0,859.The article also includes suggestions about how this scale can be employed.*

Key words: *nanotechnology, scientific attitude, statistical process scale.*

Nilgün Seçken
Hacettepe University, Ankara, Turkey

Introduction

Communities try to make individuals attain targeted characteristics through education. These targeted characteristics are supported by not only school life but also all experiences. Since education involves interaction, people change their communities as they change through education. Interaction changes knowledge, skills and attitudes. Various characteristics that individuals attain during this process of change and improvement could affect positively or negatively the behavioral changing process called learning (Güven and Uzman, 2006). The first of the behaviors that affect the learning of individuals is the cognitive entry behaviors of the student. Cognitive entry behaviors could be explained as the degree of attaining prerequisite behaviors according to the targeted characteristics. Another characteristic that affects an individual's learning is the affective entry behaviors. A Study indicated that there were proofs of the effects of affective entry characteristics on students' achievement and that these characteristics were important factors determining and affecting achievement Bloom (1979). Many research findings supporting Bloom's view on the importance of affective characteristics in learning (Caine and Caine, 1991; Lackney, 1998) showed that individuals do not lose their affective characteristics related to a topic even though they forget their knowledge learnt (Stodolsky et all., 1991). Among these characteristics, attitudes towards learning come first. It is impossible to observe the attitudes of individuals directly. Attitudes refer to implicit orientation of individuals towards a certain social objects and have cognitive, affective and behavioral aspects. In other words, individuals have various attitudes in regard to several objects, ideas and actions. It is the attitudes of individuals that often determine their reactions to objects, ideas and actions. Being familiar with the attitudes of individuals allow for making predictions about their future behavior. On the other hand, the effects of education on attitudes are quite large and such an effect appears to vary in relation to educational level. An attitude is a

ISSN 1648–3898

psychological construct that is viewed as a significant and critical predictor of individuals' behavior with its cognitive, affective and behavioral aspects (Anderson, 1988). Furthermore, attitudes are not visible behavior, instead are actions that makes ready the individuals for a certain behavior. In this process, individuals firstly gain some information about an attitude objects and finally transform this information into behavior (Kağıtçıbaşı, 1988). Measuring attitudes naturally requires the definition of them. In other words, several dimensions of attitudes should be presented providing their degree and quantity. In terms of measurement techniques, several dimensions are much more significant than the others. "Direction", "degree3 and "intensity" of attitudes are more significant. Direction of attitudes refers to its emotional quality such like-dislike, and being positive-being negative. Degree of attitudes refers to emotional levels of accepting or rejecting. Intensity of attitudes refers to the potential of an attitude transforming into an external behavior as well as its strength in this regard in contrast to other attitudinal areas. The attitude of an individual affects all his/her behaviors in general including dislikes and likes. It is a part of an individual's personality (Allport, 1935; Özgüven, 2003). There are many definitions of attitudes today. An attitude is "emotional readiness or tendency observed within the individuals' recognizing an individual, a group or an institution". Attitudes stem from the beliefs about the object that is the subject of the attitude. Attitudes and knowledge are always used together. A knowledge that goes with an attitude is called an "opinion". Opinions, which are the verbal expressions of the emotions, symbolize the attitudes. A study said that attitudes could be assessed through the opinions, which are the verbal expressions of the attitudes (Thurstone, 1929). The opinion that the behaviors of the individuals are results of their personal attitudes is very common. Moreover attitudes, which are defined as "the states of emotional and mental readiness, which are constructed as a result of the experiences and which guide or dynamically affect the behaviors of an individual towards objects and situations", have the power of affecting an individual's learning negatively or positively (Allport, 1935). A Study defined attitude as appositive or negative sequenced and degreed density towards a psychological object Thurstone (1967). In a study expressed that attitudes make an important part of the affective field behaviors and defined it as "the tendency of an individual towards reacting positively or negatively when faced with a stimulant Oppenheim (1992). The main responsibility in increasing the productivity and constructing attitudes towards an object or a thought mostly belongs to the teacher. Teacher tries to share his/her cognitive, affective and psycho-motor characteristics with the student while presenting teaching experiences. In this sharing process, "affective characteristics may affect the attainment of other characteristics positively or negatively". If the effect is positive, the responsibility of the teacher in the learning and teaching process is facilitated and the targets could be reached at a shorter time and in a more effective way. In case this affect occurs in the opposite direction, it becomes more difficult for the teacher to accomplish, s/he may experience problems with his/her student or the targets could be almost impossible to achieve. In the light of all these, with the aim of aiding the teachers and the researchers that might study in this field, it was aimed to develop a "nanotechnology attitude scale" in order to determine the attitudes toward nanotechnology, which is one of the most important topics of today, as a concept we read at the price tickets in the supermarkets or hear about in the communication sector if we are interested in computers. For seeking the answers to the questions "is it important to determine the attitudes of individuals towards nanotechnology?" and "what would its benefits be?" We should define nanotechnology and explain its interdisciplinary aspects as well as its importance in chemistry dimension. Today nanotechnology is very much common in speculation science fiction and popular science. It is also something that is eminently possible, and that may indeed change the world in a dramatic way, and lead to what is referred to as the Singularity. The word nanotechnology comes from the Greek prefix nano. In modern scientific parlance, a nanometer is one billionth of a meter, about the diameter of ten atoms placed side by side in a nanometer. Nanotechnology is about building things one atom at a time, and in doing so constructing devices with unprecedented capabilities. Humans have unwittingly employed nanotechnology for thousands of years, for example in making steel, paintings and in vulcanizing rubber (Indian craftsmen, artisans used nanotech nearly 2000 years ago). Each of nanotechnological processes depends on the properties of stochastically-formed atomic assembles mere nanometers in size, and are distinguished from chemistry in that they don't rely on the properties of individual molecules. But the development of the body of concepts now subsumed under the term nanotechnology has been slower. The first mention of some of the distinguishing concepts in nanotechnology (but predating use of that name) was in 1867 by James Clerk Maxwell when he proposed as a thought experiment a tiny entity known as Maxwell's Demon able to handle individual molecules (Heimann, 1970). The first observations and size measurements of nano-particles were made during the first decade of the 20th century. They are mostly associated with Richard Adolf Zsigmondy who made a detailed study of gold sols and other nanomaterials with sizes down to 10 nm and less (Zsigmondy, 1914). He used ultramicroscope that employes the dark field method for seeing particles with sizes much less than light wavelength. Zsigmondy (1914) was also the first who used nanometer explicitly for characterizing particle size. He determined it as 1/1,000,000 of millimeter. Moreover, he developed the first system classification based on particle size in the nanometer range. There have been many significant developments during the 20th century in characterizing nanomaterials and related phenomena, belonging to the field of interface and colloid science. In the 1920s, Irving Langmuir and Katharine B. Blodgett introduced the concept of a monolayer, a layer of material one molecule thick. Langmuir won a Nobel Prize in chemistry for his work. In the early 1950s, Derjaguin and Abrikosova conducted the first measurement of surface forces (Derjaguin, 1954). Under the umbrella of the term "nanotechnology" an intriguing diversity of formerly distinctive fields of science and engineering research flourishes, including physicists, chemists, materials scientists, and biomedical scientists as well as electrical, chemical, and mechanical engineers, such that great hopes exists of the synergistic effects of interdisciplinarity. You'll get only part of the story if you just use chemistry to get at the properties of atoms on the nano level – adding physics and quantum mechanics to the mix gives you a truer picture of the phenomenon. Chemists, physicists, and medical doctors are working alongside engineers, biologists, and computer scientists to determine the applications, direction, and development of nanotechnology – in essence, nanotechnology is many disciplines building upon one another. Industries such as materials manufacturing, computer manufacturing, and healthcare will all contribute, meaning that all will benefit – both directly from nanotechnological advances, and indirectly from advances made by fellow players in the nano field. (Imagine, for example, quantum computers simulating the effectiveness of new nanobased medicines). Nanotechnology will increase your standard of living – no ifs, ands, or buts. Done right, it will make our lives more secure, improve healthcare delivery, and optimize our use of limited resources. Pretty basic stuff, in other words. Mankind has spent millennia trying to fill these needs, because it has always known that these are the things it needs to ensure a future for itself. If nanotechnological applications pan out the way we think they will pan out, we are one step closer to ensuring that future. Looking at nanotechnology as an interdisciplinary subject from the perspective of chemistry, it is observed that modern chemists are interested in nanotechnology because of the control and kinetics of chemical reactions, chemical reactions' being directed by smart molecules, controlling of biocatalytic events, crystal organization, crystal structure defects and making use of them, surface chemistry and the research of surface and the development of analysis and control techniques appropriate to these techniques. This has made it an obligation to involve teaching and education activities regarding nanotechnology within the formal chemistry education. As a result, there are many studies on nanotechnology within educational framework (Taylor, et. all, 2008; Jones, et. all, 2007; Jones, et. all, 2003; Walters, 2008. Today, courses involving nanotechnology are taught at as early as graduate levels in the USA (Dungey, 2005; http://mrsec.wisc.edu/edetc/index.html; http://www.begbroke.ox.ac.uk/nanotech/interface.html; http://www.nnin.org/nnin_k12teachers.html). Nano-structured materials, nano biotechnology, nano particle science and engineering and nano-size productions are among the courses taught at various universities (http://www.materials.manchester.ac.uk/postgraduate/degreelist/course/?code=06741&pg=all; http://sites.google.com/site/ntbtlab/teaching; https://www.bu.edu/meller/resources.html; http://www.nanoigert.umn.edu. Nano science and nanotechnology has entered our lives rapidly in many fields (Jones, 2004; http://www.wtec.org/loyola/nano/societalimpact/nanosi.pdf; Bowles, 2004; Tomasko et. all, 2005). This effect starts from communication and information and goes along with defense industry, space and aircraft technologies, molecular biology and genetics engineering (Lee, 1998; Sahoo, et. all., 2007; Niosi and Reid, 2007). Countries with nano technology will be more powerful in terms of welfare, national defense and economy in the future. This opportunity could be used through empowering the expertise as well as promoting education and technological experience that would be transferred from generation to generation. Construction of the infrastructures of universities and high schools, their improvement and spreading through legal actions and announcement of the new technology to the

ISSN 1648–3898

wider audiences are the major requirements to serve this aim. It is aimed for the university and high school curriculum to be updated continuously in terms of contents in such a way that they include the latest and most important techniques. This would not only improve students' attention and motivation, but also prepares them for their academic lives or future careers in the industry in a better way (Geoffrey, et. all, 2005). Although there is vast number of graduate study programs as well as journals on nanotechnology, undergraduate programs on nanotechnology are relatively rare, especially in under developed countries as well as in developing countries. Students and the community are not informed adequately although they are curious about it (Waldron and Spencer, 2006). By determining the attitudes of the students at various levels of formal education, their professional choices could be guided. Although many studies have been going on in the USA and Europe, curriculum development attempts have not started at some levels in our country yet. Nanotechnology should be included within the science content. Since nanotechnology is the modern technology of our age; as the curricula are developed, by determining the students' attitudes previously, it should be taken into account how they look at nano technology, what aspects of it they appreciate, what content of it they found challenging, important or meaningful or what their fears and hesitations are. It is very difficult to acquire knowledge or make improvement studies on a field without having interest in it (Tekin, 2000). There are various ways to determine the attitudes towards objects or individuals. Such techniques include prediction using physiological reactions, prediction using explicit behavior, and development of attitude scales. In the current study, the technique of developing attitude scales is chosen because of its cost-effective characteristic. Therefore, the basic aim of the study is to develop a Likert-type attitude scale towards nanotechnology. Scores obtained through the use of the developed scale were analyzed in terms of the reliability of the scale and therefore, necessary evidence was gathered in regard to reliability of the scale. It is hoped that through the use of the attitude scale developed, individuals' attitudes towards nanotechnology can be identified and related variables in regard to positive and negative attitudes towards nanotechnology can be revealed. Since direction and magnitude of the attitudes towards nanotechnology are influential concerning orientation and interest towards this field as well as the use of nanotechnology, it is significant to develop valid and reliable measurement tool to uncover the attitudes towards nanotechnology. Although there are some researches on several dimensions of attitudes using different groups of subjects in the field of nanotechnology, the current study approaches to the topic from a different angle. For instance, Bainbridge (2002) in his article "Public attitudes toward nanotechnology" attempts to measure the public perceptions of nanotechnology with the group of 3909 participants. Scheufele and Lewenstein (2005) employ a national telephone survey to measure people's information about and attitudes towards nanotechnology. The findings obtained in these studies confirm previous research that suggests that people form opinions and attitudes even in the absence of relevant scientific or policy-related information. Waldron and Spencer, (2006) concludes that "The growing importance of nanotechnology in industry and society has not been accompanied by a widespread understanding of the subject among the general public The results suggest that the general public, especially middle-school children, has no firm foundation to understand nanotechnology and likely will continue to be equally impressed by credible scientific information as well as pure fictional accounts of nanotechnology.

Methodology of Research

The study has a scanning model. Scanning model is a research approach aiming at describing a current oe past state of affairs as it is. The study topic that can be either an individual or an object is described under his/her or its own conditions (Karasar, 2002).

Sampling

During the development of the scale, 550 students participated in the study on voluntarily. The age of the subjects ranges between 18 and 23. Of them, 198 subjects are males and 350 females. All participants are undergraduate students attending to chemistry education departments in various universities. They are randomly selected.

Development of the assessment tool

In order to develop the attitude scale, the following stages were followed:

- Developing attitude items
- Presenting the items developed to field experts
- Reliability analysis of the scale
- Factor analysis and the finalization of reliability analysis

Results of Research

Developing attitude items

45 individuals out of the sample were asked to write about their feelings, ideas and behavior towards nanotechnology in the form of essay. Twenty-nine items of the scale were developed based on review of the related literature as well as factor analysis of the essays. These items reflect cognitive, affective and behavioral aspects of nanotechnology. During the development of attitude items, the following points were taken into consideration: items should include desired and undesired features; items should be explicit and relevant; the number of positive and negative items should be balanced and equal. Items are ranked randomly in the scale. The scale is a Likert-type scale with five options. The most important reason for choosing this scale was that the Likert type could give more sensitive results as it is degreed (Oppenheim, 1996). Five options provided fro each item in the scale are as follows: (5) strongly agree (4) I agree (3) undecided (2) disagree (1) strongly disagree. Another reason for the Likert-type scale choice was that the statements involved various types in terms of sentence structures. Moreover, as the scale was being developed, in order to increase the reliability of the data, more than one statement to assess a single attitude was written (Frankaenkel, 1996). Next, the statements were evaluated and necessary corrections were made in order to reach appropriate length, clear meaning, plain language, accurate grammar and students' attention levels. As the statements were corrected, it was taken into account that they did not involve conceptual expressions, carry subjectivity, or have double negativities. The statements of the scale were tried to be expressed in such a way that they did not cause extra meanings and displayed plain structures. The statements that involved extreme reactions were corrected (Tezbaşaran, 1996). The required duration for the administration of the scale was determined as 25 minutes in order to avoid the inner reliability to be affected from the time factor (Oppenheim, 1996; Frankaenkel, 1996).

Presenting the items developed to field experts

In order to establish appropriateness of the scale developed to measure the attitudes towards nanotechnology, items of the scale were reviewed by both Turkish language experts and educational measurement experts. Items were revised based on the experts' views and suggestions.

Validity analysis of the scale

Validity refers to "the degree of an assessment tool in terms of measuring the target study topic for which it has been developed." The scale was analyzed in terms of both content validity and construct validity.

Content validity refers to the degree of the whole scale and all items within it serve for the aim for which the scale has been developed. Expert views are needed to establish the appropriateness of items for the scale depending on the scale's representativeness of the related scale (Tyler, 1971; Balcı, 1995). The alternative is to identify the correlation between previously developed valid and reliable scale and the newly developed one. Since there is no related previous reliable assessment tool, Pearson moments correlation was not calculated after the scale was administered to the sample. In order to develop a valid and reliable assessment tool a draft form of 29 attitude statements was prepared. Before the statements were administered, they were discussed with a group of experts and students about whether

ISSN 1648–3898

they reflected attitudes towards nanotechnology. Then the scale was analyzed in terms of its content validity. The adequacy degrees of these statements, their clarity and preventability were submitted to expert opinions. It was concluded that the scale of attitudes towards nanotechnology was an appropriate data collection tool. Some attitude statements were removed from the draft, some were changed some were added and the scale was finalized as having 21 statements. Therefore, the tool was prepared for the statistical validity and reliability analysis. A Likert-type scale consists of statements that display the negative and positive attitudes regarding the attitude of an individual towards a single object. (Köklü, 1992). Therefore, 11 of the statements in the draft were positive and 10 of them were negative attitude statements. Table 1 displays the scale of attitudes towards nano technology.

Table 1. The Scale of attitudes towards nano technology.

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1. It makes me so happy that nano technology will enter my life.					
2. I feel happy that money will not be important any more when nano technology will enter our lives.					
3. The idea that nano technology allows the substances to be examined at atomic size and everything could be copied/cloned a million times scares me.					
4. Since it is going to make my life easier, I want nano technology to develop and make my life easier as soon as possible.					
5. The idea that work power will lose its importance when nano technology enters our lives worries me.					
6. Teaching nano technology at schools makes sense to me.					
7. Since everything will be in our hands with nano technology, I am worried that people will not have to take mental actions in order to achieve things.					
8. The idea that nano technology will decrease our motor (physical) activities makes me upset.					
9. I want nano technology to enter my life as soon as possible, because; I believe that people will have more time for each other.					
10. I feel happy especially when I think about the developments it has brought and will bring to the field of health.					
11. I don't believe that the utilization of nano technology and its facilities would be successful in our country.					
12. The idea that its minimal size could cause great pollution and damage in the environment scares me.					
13. The idea of what nano technology will bring to or take away from my life makes me feel desperate.					
14. Having no idea about the developments in nano technology prevents me from considering what I might experience.					
15. I enjoy following the articles on nano technology in the media.					
16. I wish there were more information about the developments in nano technology in media.					
17. I wish nano technology education could start at schools as soon as possible.					
18. I am worried that individuals who have completed their formal education and did not receive training on nano technology will not facilitate from nano technological developments adequately.					
19. Even the word "Nano" is enough for me to feel happy about this technology.					
20. I am worried that the fields of employment for people will decrease in number because of nano technology.					
21. I feel excited that nano technology is developing in our country and my country is keeping up with the modern ages.					

The structural validity of the scale of attitudes towards nano technology was also analyzed together with the content validity. Construct validity refers to the account for results and what the results are related to. In other words, it indicates at which level the assessment tool can measure an abstract fact correctly. Structural validity is related to what the assessed characteristic is and has a philosophical dimension (Büyüköztürk, 1997). Factor analysis is employed in order to determine the construct validity of an assessment tool and construct validity is primarily significant in psychological tests. Factor analysis is the strongest method in analyzing the structural validity. In order to test the structural validity of the tool by looking whether it assessed a single concept related to nano technology, the principle components analysis was administered as a factor analysis technique. Factor analysis is administered in order to turn the related data structures into new independent data structures less in number (Kleimbaum et.all., 1998). It is a technique that is applied to group the variables and define major and minor factors by classifying an existence, its reasons, and the default variables it explains. It is a method that is similar to main component analysis. In both techniques, there is data reduction. However, in factor analysis, common factors could be defined by grouping the variables. Factor analysis has two aims;

- Reducing the number of variables,
- Creating some new structures by using the relationships between the variables.

This second criteria is applied in order to combine the variables under a single factor by classifying them, and create new explanatory factor structures. Factor analysis aims to identify random factors that could not be observed at the p variable at observable and interrelated X data matrix, but could be created by combining the variables. These new variables derived are called factors (Özdamar, 1999). When deciding upon a statement to take part in the scale, the condition was that the factor loading of a statement should be 0.45 or higher. In the literature, the statements are expected to have high factor loads (0.45 or higher), however, scales could involve statements with a factor loading over 0.30 (Kerlinger, 1973), (Tabachnick and Fidell, 1989). Moreover, the difference between a statement's loading value through a factor and the loading values it takes from the other factors should be 0.10 or higher. Therefore, the independence between the factors were tried to be increased (Büyüköztürk, 1997), (Karaman, 2000). For the validity analysis of the scale of attitude towards nanotechnology, firstly, the data obtained from the administration of the assessment tool were applied factor analysis. "Principle components analysis" as a factor analysis technique was administered for testing the validity of the instrument. According to a study data obtained from 200 sampling was adequate (Tabachnic and Fidell, 1989 Furthermore, data obtained may not be proper for factor analysis. In order to determine whether or not data obtained are proper for factor analysis, Kaiser-Meyer-Olkin (KMO) test is recommended for use (Kline, 1994; Tabachnick and Fidell, 1989; Tavşancıl, 2002; Afacan and Aydoğdu, 2006). The values of KMO are concerned with appropriateness of the correlation between sample and items of the assessment tool. The values of KMO should be higher than 0, 60 to have proper data set for the use of them in factor analysis (Kaiser, 1974).

Factor analysis

There are for basic steps in factor analysis. These are; evaluation of the data set fro the factor analysis, obtaining the data, rotation of the factors and naming of the factors (Kalaycı, 2006).

Two methods were applied in order to evaluate whether the data set was appropriate for the factor analysis. These were;

a. Bartlett,
b. Kaiser-Meyer-Olkin (KMO) tests.

a) Bartlett test of Sphericity:

It tests the possibility of high correlations between at least some of the variables in the correlation matrix. In order to continue the analysis, the zero hypotheses that "correlation matrix is the unit matrix" must be rejected. If the zero hypotheses are rejected, this shows that the data set is appropriate for the factor analysis since there are high correlations between the variables (Hair et.all., 1998).

b) Kaiser-Meyer-Olkin (KMO) sampling adequacy criterion:

ISSN 1648–3898

Tavşancıl (2002) states that Kaiser-Meyer-Olkin (KMO) test should be employed to determine whether or not data obtained are proper for factor analysis, The values of KMO are concerned with appropriateness of the correlation between sample and items of the assessment tool (Kaiser, 1974). It is an index that compares the values of the observed correlation coefficients to the values of the partial correlation coefficients. KMO ratio should be more than 0.5. The higher the ratio is, the more appropriate the data set is for the factor analysis (Sharma, 1996). Table 2 shows the results of the KMO and Bartlett tests employed to determine the appropriateness of the data gathered in the study.

Table 2. KMO and Bartlett's test results.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,734
Bartlett's Test of Sphericity	Approx. Chi-Square	3352,15
	df	120
	Sig.	,000

Table 2 indicates that the scale of attitudes towards nanotechnology developed in the study has a KMO value of 0,734 and a Bartlett value of 3352, 15 and that it is statistically significant (sig.: 0, 00). These values are quite high. Kaise points out that the value of 0, 90 and higher values are perfect ones (Rivera and Ganaden, 2001). These results clearly show that data can be used for factor analysis and that the correlation among the items of the scale developed is high. Therefore, it is safe to argue that the attitude scale developed is nearly perfect. As stated earlier, the value of Bartlett test is found to be 3352, 15 ($p<0.01$). Bartlett Test specifically tests the hypothesis that "correlation matrice is equal to unit matrice." Rejection of this hypothesis means that correlation among variables is higher than 1.00 and that this correlation is a result of multi-variable normal distribution (Norussis, 1995).

Determination of the number of factors

Based on the analysis results, those items with facyot loading 0, 45 or more are included in the related factor. Data obtained from component matrix indicate that two items on the first and third factors have factor loadings with the difference more than 0,1 and that ninth, tenth, sixth, twentieth and twenty first items are excluded since all items lead to a factor loading lower than 0,45. Thus, analysis is continued with sixteen items. Data analysed through varimax rotated principle component analysis indicate that four factors that cannot be described through unrotated constituents analysis can be described using this analysis. Table 3 provides the numbers of factors based on the Eigen Value Statistics as well as the rate of the variance that can be accounted for.

Table 3. The number of factors depending on the eigen value statistics and the percentage of the variance explained.

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5,19	32.49	32.49	2,62	16.38	16.38
2	1,72	10.77	43.26	2,45	15.29	31.68
3	1,49	9.31	52.57	2,34	14.61	46.29
4	1,17	7.32	59.89	2,18	13.60	59.89
5	,94	5.84	65.74			
6	,87	5.46	71.19			
7	,72	4.48	75.68			
8	,67	4.18	79.86			
9	,60	3.76	83.62			

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
10	,58	3.59	87.22			
11	,55	3.43	90.66			
12	,44	2.77	93.42			
13	,37	2.31	95.73			
14	,29	1.86	97.59			
15	,21	1.33	98.92			
16	,17	1.07	100.00			

Table 3 indicates that sixteen items that were analysed are grouped under four factors with the real value of more than one. All these four factor accounts for 59.89 % of to variance. Since the reasonable level is stated to be 41 % (Kline, 1994), the rate of variance explained by four factors can be regarded as efficient to form a scale. Additionally, it is seen that these four factors accounts for the majority of total variance. As seen in Table 4, common variance (communalities) of four factors appears to range between 0, 46 and 0, 76. On the other hand, in order to determine the number of factors, their scree graph was also analysed.

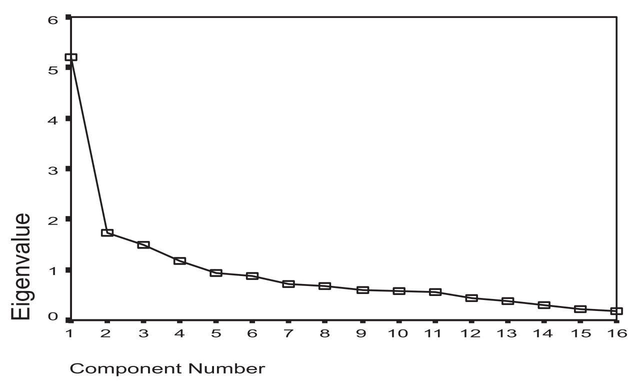

Figure 1. Line graph of factor analysis.

Scree graph given in figure 1 show that there is a high decrease after the first factor. It may indicate that the attitude scale is composed of only one factor. Büyüköztürk (2003) argues that sharp decreases in graphs provide the number of factors. The related graph indicates that the items are grouped under four factors with the real value of more than one.

Common variance of the variables

Communality refers to the amount of variance shared by variables in the analysis (Hair et. all., 1998). It is possible to exclude those variables with lower levels of common variance in the factor analysis and then, to repeat the factor analysis. Therefore, both KMO and statistics of variance value may have higher values. If the value of communality is found to be higher than one, either data set is very small or a few factors are determined. Table 4 below provides the values communality found in the analysis.

ISSN 1648–3898

Table 4. Common variance table.

	Initial	Extraction		Initial	Extraction
S1	1,000	,73	S11	1,000	,59
S2	1,000	,51	S12	1,000	,47
S3	1,000	,63	S13	1,000	,67
S4	1,000	,60	S14	1,000	,61
S5	1,000	,62	S15	1,000	,55
S6	1,000	,63	S17	1,000	,62
S7	1,000	,46	S18	1,000	,51
S8	1,000	,61	S19	1,000	,79

Looking at Table 4, it is observed that the 7th variables (0, 46) have the lowest common variance whereas the 19th variables (0, 76) have the highest.

Rotation step

Rotation was made in order to obtain significant factors and the Rotated Component matrix results are given in Table 5. It is the final result of factor analysis. In the matrix, original variable and the correlation among its factors are seen. The highest value as an absolute value that any variable has under any factor indicates that that variable is closely related to that factor. For the number of observation that is 350 or more, the factor load should be 0, 30 or more. If that value is 0, 50 or more, it is regarded as quite well (Hair vd, 1998). The value found in the study is 0, 47 and more indicating that these values are under reasonable category.

Table 5. Rotated component matrix results.

	Component			
	1	2	3	4
S6	,75			
S5	,68			
S2	,59			
S13	,56			
S7	,47			
S14		,77		
S19		,67		
S15		,65		
S11		,57		
S12		,48		
S8			,78	
S1			,77	
S4			,73	
S17				,74
S18				,68
S3				,65

Looking at Table 5, it is observed that there are 5 statements under the first factor, 5 statements under the 2nd factor, 3 statements under the 3rd factor and 3 statements under the 4th factor.

The first factor; the first factor forms 16, 38 % of total variance. It includes five attitude items with loadings ranging between 0, 75 and 0, 47.

2. I feel happy that money will not be important any more when nano technology will enter our lives.

5. The idea that work power will lose its importance when nano technology enters our lives worries me.

6. Teaching nano technology at schools makes sense to me.

7. Since everything will be in our hands with nano technology, I am worried that people will not have to take mental actions in order to achieve things.

13. The idea of what nano technology will bring to or take away from my life makes me feel desperate.

Items in the first factor deal with material and spiritual concerns regarding nano technology and also with the anxiety resulting from the fact that nano technology will decrease the significance of labour. Only the sixth item in this factor is concerned with the education on nano technology which has also relevance for labour.

The second factor; the second factor constitutes 15. 29 % of total variance. It is made up of five attitude items with loadings ranging between 0, 77 and 0, 48.

11. I don't believe that the utilization of nano technology and its facilities would be successful in our country.

12. The idea that its minimal size could cause great pollution and damage in the environment scares me.

14. Having no idea about the developments in nano technology prevents me from considering what I might experience.

15. I enjoy following the articles on nano technology in the media.

19. Even the word "Nano" is enough for me to feel happy about this technology.

Items in the second factor are concerned with positive and negative attitudes about advances in nano technology and their reflections in daily life.

The third factor; the third factor forms 14. 61 % of total variance. It includes three items with loadings ranging between 0, 78 and 0, 73.

1. It makes me so happy that nano technology will enter my life.

4. Since it is going to make my life easier, I want nano technology to develop and make my life easier as soon as possible.

8. The idea that nano technology will decrease our motor (physical) activities makes me upset.

The third factor includes items dealing with positive and negative attitudes concerning the capability of nano technology to make the life of people easier.

The fourth factor; the fourth factor forms 13. 60 % of the total variance. It contains three attitude items with loadings ranging between 0, 74 and 0, 65.

3. The idea that nano technology allows the substances to be examined at atomic size and everything could be copied/cloned a million times scares me.

17. I wish nano technology education could start at schools as soon as possible.

18. I am worried that individuals who have completed their formal education and did not receive training on nano technology will not facilitate from nano technological developments adequately.

Items included in the fourth factor deal with the attitudes towards the place of nano technology within educational context. Four factors of the scale contain items in regard to attitudes towards the following aspects of nano technology: labour, anxiety, life and educational context.

ISSN 1648–3898

Findings related to the reliability analysis of the assessment tool

The Cronbach Alpha formula was administered for the reliability analysis. In order to distinguish the positive and negative attitudes, each statement was analyzed by its distinguishing (substance total correlations). The alpha inner consistency coefficient of the scale of attitudes towards nanotechnology calculated for 16 statements was found to be 0.86. On the other hand, the statement-total correlations calculated for the distinctiveness of the 16 statements in the scale and their statement reliability changed between .34 and .57 and was statistically significant.

Discussion

In this study, the scale of attitudes towards nanotechnology was prepared in order to assess the attitudes of the individuals. According to the findings of the study, the scale was qualified in assessing the attitudes of the individuals towards the utilization of nanotechnology. The scale of attitudes towards nanotechnology was a 16-statement assessment tool with 4 factors prepared according to the 5-point Likert-type scaling. The statements in the first factor reflected the "financial and psychological dimensions" of the utilization of nanotechnology; the statements in the second factor referred to the "developments in nantotechnology and their effects; indiated attitudes towards "life", the statements in the third factor involved the attitudes towards the statements "life help of nano technology"; and in the fourth factor involved the attitudes towards "nanotechnoogy in education and teaching" as statements to assess attitudes. The statements' factor loading values being greater than .40 and the variance explained by 4 factors reaching up to 59, 89 % showed that the scale could be explained through 4 factors. The inner consistency coefficient of the scale was calculated as 0, 85, and this value was taken adequate for the reliability. Using this scale of 16 statements to determine the affective field characteristics of the individuals towards nanotechnology, modifications could be made in the program development studies of elementary and high schools as well as universities. After the preparation of the curricula and the initiation of their administration, teachers could determine the students' attitudes towards nanotechnology in their classes and take the opportunity to improve the positive ones or turn the negative ones into positive.

Conclusions

The instrument could be used to evaluate the effectiveness of interventions designed to influence positively student attitude towards nano technology. In this study, a scale with four factors in which sixteen statements are employed has been developed to measure the attitudes of chemistry student-teachers towards nano technology. As stated by Erden (1995), in order to make positive changes in the attitudes of students the factors leading to the formation and development of the attitudes should be revealed. The findings obtained in the study "Attitude scale towards nano technology" that is both reliable and valid measurement tool can be employed to determine the relationship between chemistry student-teachers' attitudes towards nano technology and certain variances. Having positive attitudes towards nano technology on the part of chemistry student-teachers will certainly affect their future teaching about nano technology assisting to transferring more appropriate attitudes to their future students. Knowledge about indivduals' attitudes towards nano technology which is one of the significant topicsa in our time will certainly help to carry out studies that attempt to integrate the topic of nano technology into educational programs in a way that meets the needs of them and is both meaningful and interesting. Given that statements within the first dimension of the scale that are concerned with the negative thoughts about replacement of labour by nano technological activities will reveal the concerns of the student-teachers, necessary steps van be taken through the educational programs in which nano technology is included or course outlines. Statements about positive and negative attitudes towards the place of nano technology in everyday life will reveal negative attitudes so that the reasons for such attitudes can be examined and then, necessary steps can be taken to eliminate them or to transform such attitudes into positive ones. The items of the third factor in the scale are concerned with the positive and negative attitudes towards capacity of nano technology in regard to make everyday life easy. For instance, the eighth item is related to negative attitudes. It may help to uncover negative attitudes as well as to eliminate them. The fourth dimension is generally concerned with the relationship between nano technology and education. For instance, the eighteenth item is about the fact that those who completed their formal education process will not have information about nano technology. Therefore, data obtained through this item may help to formulate informal educational activities in order to make such people more informed about nano technology.

It is important that the scale developed should be further analysed in terms of its validity and reliability on the sample of other chemistry student-teachers and of other different groups with similar characteristics. The findings of such research should be compared in order to get more information about the validity and reliability of the scale.

Given the detailed nature of the instrument, the Nano Technology Attitudes Scale could also be used to examine differences in students' attitude towards nano technology in terms of gender, ethnicity, and social class. Finally, the Nano Technology Attitudes Scale could be easily adapted for other disciplines including biology, physics and the other sciences. The instrument would require revalidation—using the techniques we have described above—for any of these administrations.

Since attitude is an entity that make people ready for any behaviour, just measuring the attitudes of chemistry student-teachers towards nano technology cannot provide any information about the fact that whether or not such attitudes are transformed into behaviour. Although the attitudes are found to be positive, it is necessary to establish that such attitudes are transformed into behaviour. Therefore, other scales are needed to obtain information about whether or not such attitutdes are transformed into behaviour.

References

Afacan, Ö. and Aydoğdu, M. (2006). The Science Technology Society (STS) Course Attitude Scale. *International Journal of Environmental and Science Education*, 1(2), 189-201.

Allport, G.W. (1935). *Attitudes, Handbook of Social Psychology*. Clark University Press. Massachusetts.

Anderson, L.W. (1988). *Attitudes and their measurement*. In Keeves, J. P. (Ed.), Educational Research, Methodology and Measurement: An International Handbook. Pergamon Press, NY. Bainbridge, W. S. (2002). Public Attitudes toward Nanotechnology. *Journal of Nanoparticle Research*, 4(6), 561-570.

Balcı, A. (2005). Sosyal Bilimlerde Araştırma. Ankara: Pegem A Yayıncılık.

Bloom, B. (1979). *Human Qualifications and Learning at School.* (Translated by: D. Ali Özçelik). Ankara, MEB Publication.

Bowles, K. (2004). Nanotechnology in the High School Curriculum: From Energy Conversion to Science Ethics, *REU RET, Nanotechnology Symposium*.

Büyüköztürk, Ş., (1997). Developing an Anxiety Scale towards Research. Educational Administration in Theory and Practice, 3(4), 459.

Büyüköztürk, Ş., (2003). Sosyal Bilimler İçin Veri Analizi El Kitabı. Ankara: Pegem A Yayıncılık.

Caine, R.N. and Caine, G. (1991). *Teaching and Human Brain*. Alexandria, VA: Association for Supervision and Curriculum Development.

Derjaguin, B.V. (1954). Discuss. Faraday Soc., No. 18, 24-27, 182-187, 198, 211, 215-219. Dungey, K.E., Muller, D.P. and Gunter, T. (2005). Preparation of Dppe-Stabilized Gold Nanoparticles. *Journal of Chemical Education*, 82(5), 769-770.

Erden, M. (1995). Öğretmen Adaylarının Öğretmenlik Sertifikası Derslerine Yönelik Tutumları, *Hacettepe Üniversitesi Eğitim fakültesi Dergisi*, 11, 99-104.

Feynman, R.P. (1960). There's Plenty of Room at the Bottom. *Eng. Sci.,* 23, 22-36.

Exploring the Nanoworld. *http://mrsec.wisc.edu/edetc/index.html* (accessed July, 2009).

Frankaenkel, J.R. and Wallen, N.E. (1996). *How to design and evaluate research in education.* (pp. 244-245). WMC, Graw Hill Inc.

Geoffrey, L.W., Vohs, K.J., Brege, J.J. and Fahlman, D.B. (2005). Supercritical Fluid Facilitated Growth of Copper and Aluminum Oxide Nanoparticles. *Journal of Chemical Education,* 82, 771-774.

Güven, B. and Uzman, E. (2006). A study on developing an attitude scale towards secondary level geography course. *Kastamonu Education Periodical*, 14(2), 527-536.

Hair, J.F. Jr, Anderson, R.E., Tatham, R.L., Black, W.C. (1998), *Multivariate Data Analysis*, 5th ed., Prentice-Hall, Upper Saddle River, NJ, .

ISSN 1648–3898

Heimann, P.M., (1970). Molecular forces, statistical representation and Maxwell demon. *Stud. Hist. Phil. Sci.* 1, 189–211.

Jones, M.G., Tretter, T., Paechter, M., Kubasko, D., Andre, T., Negishi, A., Bokinsky, A. (2007). Differences in African American and European American students' engagement with nanotechnology experiences: Perceptual position or assessment artifact? Journal of Research in Science Teaching, 44(6), 787-789.

Jones, M.G., Andre, T., Superfine, R., Taylor, R. (2003). Learning at the nanoscale: The impact of students' use of remote microscopy on concepts of viruses, scale, and microscopy. Journal of Research in Science Teaching, 40(3), 303-322.

Jones, R.A.L. (2004). Soft Machines Nanotechnology of life. Oxford University Pres.

Kağıtçıbaşı, Ç. (1988). İnsan ve İnsanlar. İstanbul: 7. Basım, Evrim Basım Yayın Dağıtım.

Kaiser, H.F. (1974). An index of factorial simplicity. Psychometrica, 39, 31-36.

Kalaycı, Ş. (2006). *Multivariable Statistical techniques with SPSS Practice*. Ankara: Asil Publishing Inc.

Karaman, K.Y. (2000). A Scale of Attitude Towards Human Rights Education. *Educational Research*, 1, 53.

Karasar, N. (2002). *Bilimsel Araştırma Yöntemi.* Ankara: Nobel Yayıncılık.

Kerlinger, F.N. (1973). *Foundations of Behavioral Research*. NY: Holt, Rinehard and Winston.

Kleimbaum, D.G., Lawrence, L.K. and Keith, E.M. (1988). *Applied Regression Analysis and Other Multivariable Methods*, Duxbury Press.

Kline, P. (1994). *An Esay Guide to factor Analysis*. NY: Routledge.

Köklü, N. (1992). Developing an Attitude Scale towards Research. *Education and Science*, 86(16), 27-36.

Lackney, J. (1998). Design Principles Based on Brain-Based Learning Research. *http://www.designshare.com/research/brainbasedlearn98.htm.* (accessed July, 2009).

Lee, C.S. (1998). Biotechnology for nanotechnology. *Trends in Biotechnolog*. 16(6), 239-240.

Merkle, R.C. (1999). Nanotechnology and Meaning, *7. foresight Conference on Molecular nanotechnology,* Santa Clara CA.

Nanotechnology Educational Resources and Activities for K–12 Teachers, Nanotechnology in the Curriculum. *http://www.nnin.org/nnin_k12teachers.html* (accessed July, 2009).

Nanostructured Materials PhD Nano. *http://www.materials.manchester.ac.uk/postgraduate/ degreelist/course/?code=06741&pg=all* (accessed July, 2009).

Nano-/BioTechnology Lab. *http://sites.google.com/site/ntbtlab/teaching* (accessed July, 2009).

Single Molecule Biophysics and Nano-Biotechnology. *https://www.bu.edu/meller/resources.html* (accessed July, 2009).

Nanoparticle Science and Engineering. *http://www.nanoigert.umn.edu/* (accessed July, 2009).

Societal Implications of Nanoscience and Nanotechnology. *http://www.wtec.org/loyola/nano/ societalimpact/nanosi.pdf* (accessed July, 2009).

Niosi, J. and Reid, S.E. (2007). Biotechnology and Nanotechnology: Science-based Enabling Technologies as Windows of Opportunity for LDCs? *World Development*, 35(3), 426-438.

Norussis M.J. (1995) *SPSS for Windows* Release 6.1.3. SPSS, p: 128, Chicago.

Oppenheim, A.N. (1992). *Questionnaire Design, Interviewing and Attitude Measurement*. New Edition. NY: Printer Publishers.

Oppenheim, A.N. (1996). Questionnaire Design and Attitude Measurement. London: Heinemann Educational Books Hd..

Özdamar, K. (1999). Statistical data analysis with package software. (pp. 233-234). İstanbul: Kaan Publishing,

Özgüven, İ. E., (2003). Psychological Tests, Ankara: 5th edition. PDREM Publishing.

Stodolsky, S.S., Salk, S. and Glaessner, B. (1991). Student Views about Learning Math and Social Sciences. American Educational Research Journal, 28(1), 89-116.

Rivera, T.C. and Ganaden, M.F. (2001). The Development and Validation of a Classroomenvironment Scale for Filipinos. The International Online Journal of Science and Mathematics Education. 1.

Sahoo, S.K., Parveen, S. and Panda, J.J. (2007). The present and future of nanotechnology in human health care. Nanomedicine: Nanotechnology, Biology and Medicine, 3(1), 20–31.

Scheufele, D.A. and Lewenstein, B.V. (2005). The Public and Nanotechnology: How citizens make sense of emerging technologies. Journal of Nanoparticle Research, 7, 659-667.

Sharma, S. (1996). Applied Multivariate Techniques. NY: John Wilwy and Sons INC.

Tabachnick, B.G. and Fidell, L.S. (1989). *Using Multivariate Statistics*, USA: Harper Collins Publishers.

Tavşancıl, E., (2002). *Tutumların Ölçülmesi ve SPSS ile Veri Analizi*. Ankara: Nobel Yayınları.

Taylor, A., Jones, M.G. and Pearl, T. (2008). Nanoscale science and the curriculum. *Science Scope*, 31, 28-35.

Tekin, H. (2000). *Assessment and Evaluation in Education*, Ankara: Yargı Yayınevi.

Tezbaşaran, A. (1996). *Developing a Likert-Type Scale*. Ankara: Society of Psychologists Publishing

The Universty of Wisconsin-Madison Materials Research Science and Engineering Center Interdisciplinary Educations Group. *http://mrsec.wisc.edu/edetc/index.html* (accessed July, 2009).

The Basics of Nanotechnology. *http://www.begbroke.ox.ac.uk/nanotech/interface.html* (accessed July, 2009).

Thurstone, L.L. and Chave, E.J. (1929). *The Measurement of Attitude*. Chicago: University of Chicago Pres.

Thurstone, L.L. (1967). Attitudes Can Be Measured, *Readings In Attitude Theory And Measurement.* Ed: Martin Fishbein. (pp. 77–89). New York: John Wiley&Sons, Inc.

Tomasko, D.L., Hansford, D., Merrill, J. and Wilbur W.Jr. (2005). *Tomasko, Nanotechnology Curriculum and Research Opportunities in Undergraduate Engineering Education.* 35th ASEE/IEEE, Indianapolis, IN.

Tyler, L. E. (1971). *Tests and measurements* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Waldron, A. and Spencer, D. (2006). The current state of public understanding of nanotechnology. *Journal of Nanoparticle Research*. 8(5), 569-575.

Walters, C., Keith A. and Bullen, Heather A .(2008). Development of a Nanomaterials One-Week Intersession Course. *Journal of Chemical Education,* 85*,* 1406.

Zsigmondy, R. (1914). *Colloids and the Ultramicroscope*: *A manual of colloid chemistry and ultramicroscopy* NY: J.Wiley and Sons Inc.

Received 29 March 2009; accepted 03 September 2009.

Nilgün Seçken	Assist. Prof. Dr. Department of Chemistry, Faculty of Education, Hacettepe University, 06800 Beytepe, Ankara, Turkey. Phone: 00903122976746 E-mail: nsecken@gmail.com Website: http://www.hun.edu.tr/english/index.php