Developing an Attitude Scale for Science and Technology Laboratory Experiments at Primary Education Program

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Abstract

The aim of this study is to develop a scale for assessing attitudes towards Science and Technology Laboratory Practices Course for classroom teaching program. Examining the current attitude scale developed for science laboratories had been carefully scrutinized and item pool was created. For item pool the views of experts was taken and the first draft of scale that consisting of 28 Likert-type items was prepared by choosing statements. The first draft of scale was carried out a pilot study. The first obtained data from the pilot study was performed exploratory factor analysis with SPSS 21 program. 6 items has been removed from the analysis. After the exploratory factor analysis data set was performed confirmatory factor analysis with the LISREL 8.52 program and 3 items has been removed from the analysis. An attitude scale consisting of 19 items in one dimension were obtained in the analysis. Scale explains approximately 45% of the variance and Cronbach's alpha coefficient is 0.932 for the reliability.

Key Words*:* Likert Type Scale; Science Laboratory; Attitude Scale; Reliability and Validity.

1. Introduction

The century which we are in is heading towards the information society from being and industrial one. In this process, developmental levels of countries are measured in parallel to the importance given to science by them. In order to advance in science the main objective of the education system should be to provide ability to access the information rather than directly transfer. To go further in science, more importance should be given to research and laboratory activities (Ocak, Kıvrak and Özay, 2005; Ceyhun and Karagölge, 2001). Laboratory activities are considered to be very important in many aspects both inside and outside the classroom. According to Zuzuvosky (1999) applied version of science teaching based on experiments in laboratories is highly crucial in terms of epistemological and educational aspects (as cited in Akpınar and Yıldız, 2006). While students' attraction can easily be distracted in traditional classroom settings, experiments based on concrete experience in laboratories enable students to be more concentrated. For the passive students in the classroom to take more active roles in the activities can be possible through showing an interest in scientific research processes and science experiments enabling improvements on scientific perspective, cooperation and communication skills. In addition, experimental studies are thought to help students have clear ideas on any given situations and learn basic concepts about those situations. Conducting an experiment aims at improving practical skills and technique as well as problem solving and research skills (Morgil, Güngör Seyhan and Seçken, 2009; Akpınar and Yıldız, 2006).

When this field is observed it is seen that science teachers are inclined to conduct experiments which they are more able to perceive the outcomes and they find easier to do.

This means that the teachers might lack the sufficient information and skills to overcome the difficulties that may have during the experiments (Yıldız Feyzioğlu, Tatar, Akpınar and Güldalı, 2014). In the study performed by Ceyhun and Karagölge (2001) it is seen that elementary school teachers generally prefer display experiments. In addition, teachers are generally ineligible to explain the objectives and the potential contributions of experiments on learning. In Şimşekli and Çalış's (2008) study on primary school teaching students, prospective teachers in this department are considered to be insufficient in determining the potential improvements in students' levels through theoretical and practical activities pre-planned by scientific processes.

To enhance the scientific process skills, prospective science teachers should have a positive attitude towards science labs. This shows the importance of lab experiments during the teacher training education. The first four years which is called as primary schooling is very important in Turkish education system. Therefore primary school teachers also have important roles. Primary school teachers should help their students to develop positive attitudes towards science while preparing them to the further levels of education together with teaching how to read and write. To develop positive attitude towards science, conducting activities in laboratories rather than in class is very important. Thus the teachers and prospective teachers should primarily have positive attitudes themselves. The term attitude is defined as the way to pursue, style and manners by Turkish Language Association (2015). When it is looked up in terms of education, it means the personal experiences of an individual towards an event or an object (Koçakoğlu and Türkmen, 2010). Morgan (1991), states that attitude is the principal determinant for the human behaviours and the attitude significantly affects the love, hate and other general behaviours of people (as cited in Kan and Akbaş, 2005).

Attitude is seen as an important descriptive of behaviour with its cognitive, affective and behavioural aspects (Ekici, 2002). As the attitude is a significant indicator of an individual's behaviours, it might be said that it has also highly important role on success in educational perspective. Different aspects of attitude affect behaviour and accordingly it affects learning so it is effective for individuals on using cognitive strategies (Kozcu Çakır, Şenler and Göçmen Taşkın, 2007). One of the methods for determining the attitude is to use Likert type scales. When the general teaching departments are observed it is seen that there are attitude scales for laboratory activities in physics, chemistry and biology teaching departments, but in primary school teaching departments there are not any adequate attitude scales towards science and technology lab experiments. For this reason, with the aim of filling a gap in education, this scale is developed for determining the attitudes of primary school teaching students' attitude towards the science and technology lab experiments.

2. Method

2.1. Sampling

Sampling of this study includes 291 prospective teachers who were attending Inonu University Faculty of Education Primary Education Department Primary School Teaching Program in academic year 2014-2015.

2.2. Data Collection Tool

Developing an attitude scale for primary school teaching program science and technology laboratory experiments course is a study of a tool development model which is a lower model of exploratory pattern included in mixed method. Exploratory pattern is a two-stage approach. The first stage is composed of qualitative part and the second part is formed by the data obtained from quantitative part (Yıldırım and Şimşek, 2013).
In this study, scale is developed by following the process steps given below.

1. Designing an Item Pool

In this study of developing an attitude scale towards Science and Technology lab experiments in Primary School Teaching program, other attitude scales developed for Science labs in the Science field (i.e Science Teaching, Physics, Chemistry and biology) were analysed at first (Azizoğlu and Uzuntiryaki, 2006; Ekici, 2002; Nuhoğlu and Yalçın, 2004; Yamak, Kavak, Bilici Canbazoğlu, Bozkurt and Peder, 2012). The dimensions in these scales and the items in these dimensions were analysed and an item pool was designed.

2. Receiving an Expert opinion

Attitude definitions in the item pool were analysed in terms of the field consistency, attitude and linguistic by the field experts. In line with the expert opinions, required corrections were made in attitude definitions and an item pool of 28 items are designed.

3. Designing a Testing form

After the expert opinion a five-fold Likert type testing form having 28 items was designed. Items were scored like Totally Disagree (1), Disagree (2), Slightly Agree (3), Agree (4) and Totally Agree (5).

2.3. Data Collection

Testing form was applied to 291 prospective teachers studying at İnonu University Faculty of Education Primary School Teaching Program in 2014-2015 academic years. Implementation time was less than 30 minutes.

2.4. Data Analysis

Data obtained from this application were first analysed by SPSS 21 program with exploratory Factor analysis. In accordance with the findings obtained here the data were subjected to confirmatory factor analysis by LISREL 8.52 program.

3. Findings

Data obtained by applying the testing form were loaded in SPSS program. Data set consisting of 291 participants was reduced to 275 due to the reasons such as extreme values and gaps in the scales etc. In the data set, the items numbered as 3, 4, 6, 8, 11, 13, 14, 15, 18, 20, 21, 23 and 25 which include negative statements that needed to be scored reversely were scored again. For the blank values in the data set, the average scores of the set were used. It is seen that Skegness and Kurtosis values are in the range of ±1, 96 for each item. Data set shows normal distribution and exploratory factor analyse is applied to the set.

3.1. Exploratory Factor Analysis

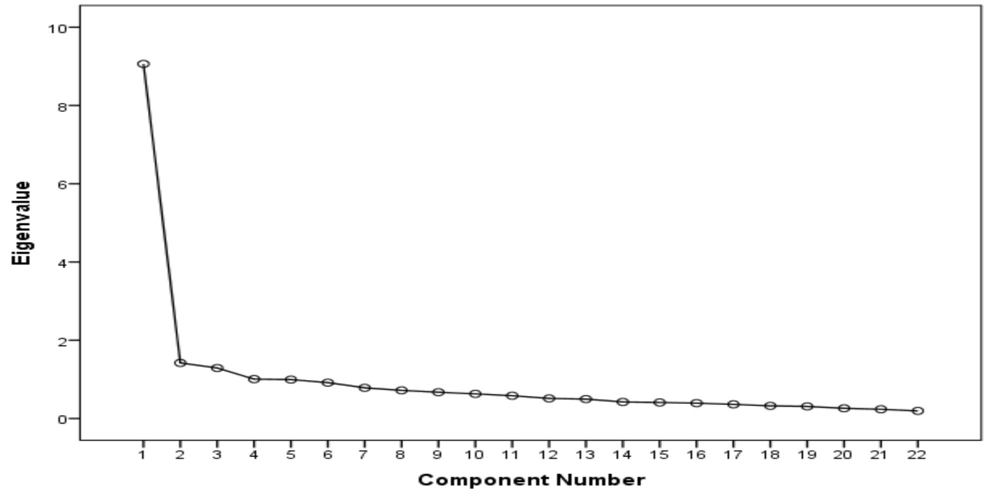
Exploratory factor analyse is done for finding out a structure composed of different components, developing measurements tools for measuring a specific feature, grouping the excessive amount of data and in this way enabling this data to be processed and interpreted with minimum loss of content (Can, 2014). SPSS21 program was used for exploratory factor analysis. Varimax was used as spinning method. Tabachnick and Fidell (2001) stated that the factor load of a given item should be 0, 32 and above (as cited in Çokluk, Şekercioğlu and Büyüköztürk, 2014). In this study, factor breakpoint was taken as 0, 32. Variance explanations and core values obtained in the first factor analysis on the data set are as shown in Table1 and Graphic 1 respectively.

Table 1, Variance Explanations as a Result of the First Analysis

Factor	Core Value	Variance Rate (%)
1	9,442	33,721
2	2,211	7,895
3	1,444	5,156
4	1,313	4,690
5	1,258	4,492
6	1,166	4,165

Factors having more than 1 SPSS core value are considered significant. However it might not give reliable results only by taking this value. To determine the factor rate, it is required to look at line graph as well together with the variance rates of each given factor (Can 2014). When Table 1 is analysed, it is seen that while 1st factor describes its variance as % 33,721 by itself, other factors could contribute to the variances approximately in the range of % 4- 4. In addition, in the scree plot (Figure 1) although it is seen as there are two-factor structures, it is actually one factor when it is taken together with the variance rate.

(Figure 1, Scree Plot as a Result of First Analyse)



In the one factor structure, items numbered as 20, 21, 23, 25, 27 and 28 which have factor loads lower than 0, 32 taken as factor breakpoint were excluded from the analysis. As a result, for the one factor structure comprising of 22 articles, Kaiser Meyer Olkin (KMO) value as a sampling adequacy scale was measured as 0,935. This scale defines the %41 of the variance. Internal consistency coefficient of the scale was measured as Cronbach's Alpha 0,927.

Table 2, Factor Loads of Items as a Result of Exploratory Factor Analysis

Item	Factor Load
M15	0,801
M10	0,777
M17	0,776
M13	0,757
M2	0,744
M18	0,743
M14	0,740
M1	0,737
M4	0,702
M5	0,694
M16	0,686
M12	0,652
M11	0,633
M9	0,612
M22	0,601
M8	0,582
M26	0,526
M6	0,469
M7	0,467
M19	0,377
M3	0,351
M24	0,343

After this stage, confirmative factor analyse was applied to the data set.

3.2. Confirmatory Factor Analysis

Confirmatory factor analysis can be defined as an analyse process in which a previously defined and limited structure is tested as whether it is confirmed or not (Çokluk, et al., 2014). As a result of exploratory factor analysis conducted with 28 item testing scale, six items were excluded from the analyse as their factor loads were lower than 0,32. In the first analyse, it was observed that *t* values related to the interpretation of observed variables by latent variables of single type model were significant in 0,01 level as they were higher than 2,56 (Çokluk, et al., 2014).

Table 3, *t* Values after the first analyse

Item	t Values
M1	13,19
M2	13,62
M3	5,25
M4	12,44
M5	12,41
M6	7,65
M7	7,81
M8	9,75
M9	10,23
M10	14,46
M11	10,68
M12	11,02
M13	14,67
M14	13,91
M15	15,75
M16	11,90
M17	14,37
M18	13,92
M19	5,60
M22	9,67
M24	4,88
M26	8,66

It is seen in the Table 4 that error variances of observed variables are high for some items (0, 91 for item 24, 0, 90 for item 3 and 0, 89 for item 19).

(Table 4, Error variances obtained from the first analyse)

Item	Error Variances
M1	0,50
M2	0,48
M3	0,90
M4	0,54
M5	0,55
M6	0,80
M7	0,79
M8	0,69
M9	0,67
M10	0,43
M11	0,64
M12	0,62
M13	0,42
M14	0,46
M15	0,36
M16	0,57
M17	0,44
M18	0,46
M19	0,89
M22	0,70
M24	0,91
M26	0,75

In addition, it was seen that factor loads of the items obtained by the exploratory factor analysis were lower than 0, 40. At this stage, it was decided to go on analysing by excluding the three items out of the process. After excluding the three items fit index values were created for the obtained model. These values were compared by the break points that were accepted in the field (Çokluk, et al., 2014).

(Table 5, Fit index results for one dimensional model)

Fit index	Acceptable value	Excellent value	Value of the Model	Result
p	< .01 or .05	> .01 or .05	0,000	Acceptable
X^2/sd	3-5	≤ 3	601,28/152=3,95	Acceptable*
GFI	≥ .90	≥ .95	0,81	Low
AGFI	≥ .90	≥ .95	0,77	Low
RMSEA	≤ .08	≤ .05	0,104	Low
RMR	≤ .08	≤ .05	0,091	Low
SRMR	≤ .08	≤ .05	0,059	Acceptable
CFI	≥ .90	≥ .95	0.86	Low
NFI	≥ .90	≥ .95	0,82	Low
NNFI	≥ .90	≥ .95	0,85	Low

* Although for X^2/sd rate values of 2 and lower than 2 are accepted as excellent value in the field, in larger samplings (such as 200 and more) this value is accepted as 3 and lower (Çokluk, et al., 2014).

After this stage, modification recommendations were analysed in order to improve one dimensional model and it is observed that there is a decrease in X^2 level as a result of the modifications between the items 5 and 2 and items 15 and 14 [chi-square in 1 degree of freedom = 467,73 (p = 0.000)]. Re-tested fit index values of one – dimensional model are shown in Table 5.

Table 6, Second fit index results for one dimensional model

Fit Index	Acceptable Value	Excellent Value	Value of the Model	Result
p	< .01 ya da .05	> .01 ya da .05	0,000	Acceptable
X^2/sd	3-5	≤ 3	467,73/150=3,11	Excellent*
GFI	≥ .90	≥ .95	0,85	Low
AGFI	≥ .90	≥ .95	0,81	Low
RMSEA	≤ .08	≤ .05	0,08	Acceptable
RMR	≤ .08	≤ .05	0,05	Excellent
SRMR	≤ .08	≤ .05	0,05	Excellent
CFI	≥ .90	≥ .95	0,90	Acceptable
NFI	≥ .90	≥ .95	0,85	Low
NNFI	≥ .90	≥ .95	0,88	Low

* Although for X^2/sd rate values of 2 and lower than 2 are accepted as excellent value in the field, in larger samplings (such as 200 and more) this value is accepted as 3 and lower (Çokluk et al. 2014).

When the Table 6 is analysed it is seen that *p* value, RMSEA and CFI fit indexes are at acceptable level, X^2/sd rate, RMR and SRMR fit indexes are at excellent levels. On the other hand, GFI, AGFI, NFI and NNFI fit indexes are at lower levels. *p* value is desired not to be meaningful in confirmatory factor analyse. However in situation which have large amount of sampling it is normal for p level to be meaningful (Doğan, 2013; Çokluk et al. 2014).

4. Conclusion- Comment

In this study that aims at developing attitude scale towards Science and Technology Lab Experiments in Primary School Teaching program, a testing scale consisting of 28 items was designed. As a result of the exploratory factor analysis conducted on the data obtained by the testing scale, 28 items were reduced to 22 items. After the confirmatory factor analysis, items which had error variance were excluded from the analysis. Following this stage modification recommendations were studied and the fit indexes were compared with the acceptable criteria found in the field. Although GFI, AGFI, NFI and NNFI values were below the acceptable rates, it was seen in the Table 4 that there was not a major difference between the values obtained from this study and the acceptable rates in the field. In this case it might be accepted that the structure of the scale is confirmed. In conclusion, total variance of attitude scale of Primary School Teaching Program Science and Technology Lab Experiments consisting of 19 items is defined as % 45, 90 and inner consistency coefficient is Cronbach's Alpha 0,932. This values show that this scale can be used.

References

Akpınar, E. & Yıldız, E. (2006). Açık Uçlu Deney Tekniğinin Öğrencilerin Laboratuvara Yönelik Tutumlarına Etkisinin Araştırılması. *Dokuz Eylül Üniversitesi Buca Eğitim Fakültesi Dergisi*, 20, 69-76.

Azizoğlu, N. & Uzuntiryaki, E. (2006). Kimya Laboratuvarı Endişe Ölçeği. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, (30), 55–62.

Can, A. (2014). *SPSS ile Bilimsel Araştırma Sürecinde Nicel Veri Analizi* (2.Baskı). Ankara: Pegem Akademi.

Ceyhun, İ. & Karagölge, Z. (2001). İlköğretim Öğretmenlerinin Yetiştirilmesinde Fen Bilgisi Laboratuvarının Önemi. *Eğitim ve Bilim*. 26 (121), 37-40.

Çokluk, Ö., Şekercioğlu, G., & Büyüköztürk, Ş. (2014). *Sosyal Bilimler İçin Çok Değişkenli İstatistik: SPSS ve LISREL Uygulamaları* (3.Baskı). Ankara: Pegem Akademi.

Doğan, M. (2013). *Doğrulayıcı Faktör Analizinde Örneklem Hacmi, Tahmin Yöntemleri ve Normalliğin Uyum Ölçütlerine Etkisi* (Yüksek Lisans Tezi). Eskişehir Osmangazi Üniversitesi Fen Bilimleri Enstitüsü, Eskişehir.

Ekici, G. (2002). Biyoloji Öğretmenlerinin Laboratuvar Dersine Yönelik Tutum Ölçeği (BÖLDYTÖ). *Hacettepe*

Üniversitesi Eğitim Fakültesi Dergisi, (22), 62–66.

Kan, A., & Akbaş, A. (2005). Lise Öğrencilerinin Kimya Dersine Yönelik Tutum Ölçeği Geliştirme Çalışması. *Mersin Üniversitesi Eğitim Fakültesi Dergisi*, *1*(2), 227–237.

Koçakoğlu, M., & Türkmen, L. (2010). Biyoloji Dersine Yönelik Tutum Ölçeği Geliştirilmesi. *Ahi Evran Üniversitesi Eğitim Fakültesi Dergisi*, *11*(2), 229–245.

Morgil, İ., Güngör Seyhan, H. & Seçken, N. (2009). Proje Destekli Kimya Laboratuvarı Uygulamalarının Bazı Bilişsel ve Duyuşsal Alan Bileşenlerine Etkisi. *Türk Fen Eğitimi Dergisi*, 6 (1), 89-107.

Nuhoğlu, H., & Yalçın, N. (2004). Fizik Laboratuvarına Yönelik Bir Tutum Ölçeğinin Geliştirilmesi ve Öğretmen Adaylarının Fizik Laboratuvarına Yönelik Tutumlarının Değerlendirilmesi. *Gazi Üniversitesi Kırşehir Eğitim Fakültesi*, *5*(2), 317–327.

Ocak, İ., Kıvrak, E. & Özay, E. (2005). Biyoloji Laboratuvarlarının Önemi ve Laboratuvar Uygulamalarında Karşılaşılan Problemlerin Öğretmen Görüşlerine Dayanılarak Tespiti (Erzurum İl Örneği). *Erzincan Eğitim Fakültesi Dergisi*, 7(2), 65-75.

Şimşekli, Y. & Çalış, S. (2008). Sınıf Öğretmenliği Öğrencilerinde Bilimsel Süreç Becerilerinin Gelişimine Fen Bilgisi Laboratuvarı Dersinin Etkisi. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi*, 11(1), 183-192.

Türk Dil Kurumu. (TDK). Erişim Tarihi 23 Ağustos 2015, http://tdk.gov.tr/index.php?option=com_gts&arama=gts&guid=TDK.GTS.55d9a1ed8b9191.29387794

Yamak, H., Kavak, N., Canbazoğlu Bilici, S., Bozkurt, E., & Peder, Z. B. (2012). Fen Bilgisi Laboratuvarına Yönelik Tutum Ölçeğinin Geliştirilmesi: Geçerlik Ve Güvenirlik Analizleri. *X. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi*. Niğde.

Yıldırım, A., & Şimşek, H., (2013). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri*. Seçkin Yayıncılık: Ankara.

Yıldız Feyzioğlu, E., Tatar, N., Akpınar, E. & Güldalı, S. (2014). Fen ve Teknoloji Öğretmenlerinin Fen Deneylerinin Açıklık Düzeyine İlişkin Görüşleri. *İlköğretim Online*, 13(2), 394-411.