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| Research Article / Araştırma Makalesi |

Adaptation of the Science Experience Scale in Informal Environments into Turkish: Validity and Reliability Study

İnformal Ortamlarda Fen Deneyimi Ölçeğinin Türkçeye Uyarlanması: Geçerlik ve Güvenirlik Çalışması

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Keywords

1. scale
2. validity
3. reliability
4. secondary school
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Anahtar Kelimeler

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Abstract

Purpose: The purpose of this study is to adapt the Science Experience Scale in Informal Environments (ScESInE), which was developed by Gafoor and Narayan (2008), to Turkish culture and to evaluate the validity and reliability of the scale.

Design/Methodology/Approach: In the study, the Turkish translation study of the scale was performed by using exploratory factor analysis and confirmatory factor analysis for validity and Cronbach's alpha internal consistency coefficient and item analysis for reliability. A total of 500 students participated in the study. The students were studying in the 5th, 6th, 7th, and 8th grades of the secondary schools in the central district of the province of Karaman in the fall semester of the 2019-2020 academic year.

Findings: As a result of the exploratory factor analysis, it was found that 41.01% of the total variance of the scale consisting of four factors was explained. Scale item factor load values varied between .45 and .79. As a result of the analysis done for reliability, Cronbach's alpha internal consistency coefficients for overall scale and observation, addition, activity, and experiment sub-dimensions were found as 85, .71, .87, .63, and .71, respectively. As a result of item analysis for reliability, the corrected item total correlations were found between .30 and 68. Finally, as a result of the confirmatory factor analysis good fit indexes were obtained ($\chi 2$ = 788.78, sd = 395, $\chi 2$ / sd = 1.99, p = 0.00; RMSEA = .045, RMR = .026, SRMR = .056 , GFI = .90, AGFI = .89, CFI = .95, NFI = .91, NNFI = .95, IFI = .99, RFI = .90).

Highlights: As a result of all these analyses, it can be said that the Turkish version of the scale is valid and reliable and can be used by researchers in scientific research.

Öz

Çalışmanın amacı: Bu çalışmanın amacı Gafoor ve Narayan (2008) tarafından geliştirilen İnformal Ortamlarda Fen Deneyimi Ölçeği (InOFeDÖ)'nin Türk kültürü için Türkçeye uyarlanarak geçerlik ve güvenirlik çalışmasını yapmaktır.

Materyal ve Yöntem: Araştırmada ölçeğin Türkçe çeviri çalışması, geçerlik için açımlayıcı faktör analizi ve doğrulayıcı faktör analizi ile güvenirlik için ise Cronbach alfa iç tutarlık katsayısı ve madde analizi yapılarak gerçekleştirilmiştir. Araştırmaya 2019-2020 eğitim öğretim yılı güz döneminde Karaman ilinin merkez ilçesine bağlı ortaokulların 5, 6, 7 ve 8. sınıflarında öğrenim görmekte olan öğrencilerden kolay ulaşılabilir durum örneklemesi ile seçilen 500 öğrenci katılmıştır.

Bulgular: Yapılan açımlayıcı faktör analizi sonucunda dört faktörden oluşan ölçeğin toplam varyansının %41.01'inin açıklandığı görülmüştür. Ölçek madde faktör yük değerleri .45-.79 arasında değişmektedir. Güvenirlik için yapılan analiz sonucunda ölçek toplamı, gözlem, toplama, aktivite ve deney alt boyutları için Cronbach alfa iç tutarlık katsayıları sırasıyla 85, .71, .87, .63 ve .71 olarak bulunmuştur. Güvenirlik için yapılan madde analizi sonucunda düzeltilmiş madde toplam korelasyonları .30-68 arasında bulunmuştur. Son olarak ölçeğin geçerliği için yapılan doğrulayıcı faktör analizi sonucunda iyi düzeyde uyum iyiliği indeksleri elde edilmiştir ($\chi 2$=788.78, sd=395, $\chi 2$/sd=1.99, p=0.00; RMSEA=.045, RMR=.026, SRMR=.056, GFI=.90, AGFI=.89, CFI=.95, NFI=.91, NNFI=.95, IFI =.99, RFI = .90).

Önemli Vurgular: Yapılan tüm bu analizler sonucunda ölçeğin Türkçe uyarlaması gerçekleştirilen formunun geçerli ve güvenilir olduğu ve bilimsel araştırmalarda araştırmacılar tarafından kullanılabileceği söylenebilir.

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INTRODUCTION

The learning process has been persisting since the first existence of humanity on Earth. Especially the feeling of curiosity showing up in childhood is a very important factor in learning. Conducting theoretical studies on child development, Vygotsky has proposed a sociocultural perspective to learning. According to this point of view, learning and development have passed from social contexts to individual understanding. In other words, information is a phenomenon that is first encountered in the interaction with people and then attributed to students (Kozulin, 2003; Wertsch, 1991, as cited in Zhai, 2015). For this reason, daily experiences of individuals are important in the flow of natural life.

Learning from daily experiences is learning without forcing by paying selective attention to the experiences that an individual need to understand (Gafoor and Narayan, 2012). The daily experiences initiate the learning activities of individuals, and they help individuals associate the learned information with daily life more easily, thereby creating meaningful learning (Andrée, 2003; Ayas and Özmen, 1999; Bodner, 1990; Coştu and Ayas, 2005). Learning in informal settings is associated with learning from daily experiences.

Maarschalk (1988) and Tamir (1990) grouped learning environments into three groups as formal, non-formal, and informal. Learning in schools or courses is formal, while environments including formal and informal settings such as out-of-school learning environments are non-formal. Informal settings, on the other hand, are learning environments that can show up in any place where unstructured, spontaneous learning takes place (Eshach, 2007). Learning in places, such as museums and zoos, as well as learning by watching TV, from friends, and from the Internet, can be informal (Salmi, 1993). In other words, informal learning occurs naturally as a result of the experiences of people in the flow of life (Çavuş, Umdu Topsakal, and Öztuna Kaptan, 2013).

Learning in school is (formal) compulsory, teacher-centered, externally motivating, and while learning is often pursued to get good grades in a formal setting, learning in informal environments is voluntary, student-centered, intrinsically motivating, and takes place with the individual's own choices and interests (Gafoor & Narayan, 2012). This information, which we call "preliminary information" that students bring to the school, is the information they obtain in informal settings. Students' knowledge is structured from daily experiences at a very early age, and they build the information learned in school on the information learned from daily experiences (Gardner, 1975; Hatano and Inagaki, 1996). For this reason, as the information students learn in informal settings will make up the basis of the information they have learned in school, obtaining this informal information is important in terms of the meaningfulness of the information learned in school.

To prepare individuals for life and to have them make sense of daily experiences, the science course and courses related to this field are important (Coştu, Ünal, and Ayas, 2005) because the gains of the science course are closely related to the events and facts we encounter in daily life. The special objectives of the 2018 science course include "achieving taking responsibility for daily life problems and utilizing knowledge of science, scientific process skills, and other life skills in solving these problems". Also, in this program, “firstly, students are expected to define a need or problem from daily life related to the subjects discussed in the units within the scope of science, engineering, and entrepreneurship applications. The problem is expected to aim at improving tools, objects or systems used or encountered in daily life" (Ministry of National Education [MoNE], 2018). According to the science curriculum, daily life experiences are considered important because knowledge of students' daily life experiences in informal settings makes learning meaningful and helps utilize knowledge in daily life more by associating daily experiences with the gains of science course (Bodner, 1990; Coştu and Ayas, 2005). Besides, out of school experiences play an active role in individuals' interest in science (Gafoor and Narayan, 2012). Studies on the use of what is learned in a science course in daily life have shown that students cannot use the knowledge learned in the science course in daily life at the desired level (Canpolat and Ayyıldız, 2019; Özmen, 2003; Korkmaz and Buyruk, 2016). Therefore, this reveals the necessity for knowing students' daily life experiences in the science field.

The daily experiences that individuals obtain in informal settings vary according to gender and the region where they live (Christdou, 2006; Gafoor and Narayan, 2010). According to Brown (2007), the types of experiences individuals have in informal settings affect learning. In all countries, while boys have more experience in mechanical activities, girls are engaged in nature-related activities more (Sjoberg, 2000). For example, female students are more successful in biology course than male students (Özay, Ocak, and Ocak, 2003). This stems from the experiences of girls and boys in informal settings. Also, the information gained from daily experiences forms pre-learning, thereby playing a mediating role in helping students to understand science (Rivet and Krajcik, 2008). According to Turkmen (2010), informal settings imparts individuals the ability to find solutions to problems they may encounter in their daily lives by increasing their knowledge.

METHOD

In this section, the study group, the data collection tool, the research process, and information about the data collection tool and data analysis are presented under related headings.

The Study Group

The data of this study were collected from secondary school students in the public schools of the central district of Karaman province in the fall semester of the 2019-2020 academic year. The Science Experience Scale in Informal Environments, which was

developed by Gafoor and Narayan (2008) and originally called the Scale of Out-of-School Science Experiences (SOSSE), was designed for 10-14-year-old middle school students in India. For this reason, the study group of this study consisted of middle school students. The study group included a total of 500 middle school students, including 265 girls (53.0%), and 235 boys (47.0%). According to Comrey and Lee (1992), in scale development studies, a sample size of 300 is good, 500 is very good, and 1000 is excellent. Accordingly, the sample size was considered to be good and sufficient for the study. Participants were selected using the convenience sampling method. This method is appropriate when researchers want to reach participants more easily and spend less money (Canbazoğlu, Bilici, 2019). Of the total participants, 89 (17.8%) were fifth grade, 135 (27.0%) sixth grade, 107 (21.4%) seventh grade, and 169 (33.8%) eighth grade students. The ages of the students in the study group ranged from 10 to 13 (11.71 ± 1.47).

The Data Collection Tool

The Science Experience Scale in Informal Environments (ScESInE)

This scale was developed by Gafoor and Narayan (2008) to determine the science experience levels of secondary school students in informal settings. The ScESInE has a three-point Likert type rating structure (1 = never, 2 = sometimes, 3 = generally) and consists of 89 items and four subscales (observation 27 items, addition 11 items, activity 34 items, and experiment 17 items). An overall score is calculated, and increased scores obtained from the scale show increased levels of science experience in informal settings by participants. In the development study of the scale, Cronbach's alpha internal consistency coefficient was calculated as .93, .80, .73, .82, and .81 for the overall scale and observation, addition, activity, and experiment subscales, respectively. The test-retest reliability coefficient for the overall scale was found as .78. The test/split-half-test reliability coefficient was calculated as .88, .75, .68, .70, and .81 for the overall scale and observation, addition, activity, and experiment subscales, respectively. As a result of the fit validity of the scale, a correlation coefficient of .56 was obtained with the Science Interest Scale. The scale was not subjected to factor analysis in its original study, but within the scope of this study, factor analysis was performed during adapting it to the Turkish context.

The study process

First, the permission of the authors of the scale was obtained to carry out the adaptation study of the scale to the Turkish context and to do its validity and reliability analyses. Then, the adaptation process was launched. In the first stage, the scale was translated from English to Turkish by three experts. After that, the Turkish version of the scale was translated back to English by two experts. The English and Turkish forms of the scale were compared, the appropriateness of the translation was reviewed by two experts, and the scale form was created. Finally, the scale was submitted to the opinion of a Turkish language expert for grammar and intelligibility, and the final form was created. The Turkish form of the final version of the scale was submitted to the opinions of three experts for an assessment of its appropriateness in measuring science experiences in informal environments. As a result of the positive evaluations of the experts, the Turkish form of the scale became ready for validity and reliability studies. All the procedures performed also constituted the evaluator validity of the scale.

Data collection

At the outset, the approval of the Ethics Committee of Karamanoğlu Mehmetbey University (issue: 95728670-900-E.11207) and the permission of the Karaman Directorate of National Education were obtained, and then the administration of the scale in the public schools was launched. The scale was administered to 600 secondary school students in the 2019-2020 academic year. During the administration, scale forms were only given to volunteer participants in the classroom environment. Before the application, the purpose and importance of the study were explained, and it was stated that no personal data were needed and that the results of the study would not be evaluated individually but would be used for scientific purposes. It took an average of 30 minutes to fill out the scale forms. The scale forms of 100 students were not included in the study because they were filled out incorrectly and incompletely. The validity and reliability studies of the scale were carried out using the data supplied by 500 students.

Data analyses

In this study, first, the exploratory factor analysis (EFA) was conducted to determine the construct of the Turkish form of the scale. Later, Cronbach's alpha internal consistency coefficient and corrected item-total correlations were calculated to determine the reliability of the scale. Moreover, the confirmatory factor analysis (CFA) was carried out to determine whether the construct of the scale obtained as a result of the EFA was confirmed. SPSS 21.0 and LİSREL 9.1 software packages were used in the analysis of the study data.

FINDINGS

In this section, findings regarding the validity and reliability of the scale are presented under subheadings, respectively.

The EFA results

At this stage, the EFA was conducted to reveal the construct of the scale. Before doing the EFA, the Kaiser-Meyer-Olkin (KMO = .84) coefficient of the scale and Bartlett's test of sphericity ($\chi 2$ = 4053.10, sd = 435) were examined. Accordingly, it was decided that the scale could be subjected to the factor analysis. While carrying out the EFA, the varimax vertical-axis rotation was used as the rotation technique. As a result of the EFA analysis, a four-factor structure was obtained as in the original form. The items on the scale with a factor load of less than .40 and those yielding a loading on more than one factor were re-analyzed, respectively (1, 2, 3, 5, 6, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25, 33, 38, 39, 40, 41, 42, 43, 44, 45, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 63, 64, 65, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 81, 82, 85, 89). Factors and item factor loading values obtained as a result of the EFA of the scale are presented in Table 1.

Table 1. The EFA results for the Science Experience Scale in Informal Environments

Items	New item no	Observation	Addition	Activity	Experiment
4	1	**.56**	.10	.06	.06
7	2	**.50**	.14	.03	.01
13	3	**.57**	.05	.27	-.02
20	4	**.58**	.06	-.01	.10
21	5	**.53**	.11	-.10	.13
26	6	**.72**	.07	.06	.03
27	7	**.62**	.11	-.02	.14
28	8	.16	**.62**	.25	.09
29	9	.18	**.62**	.15	.16
30	10	.02	**.79**	.03	.06
31	11	.04	**.78**	.04	.02
32	12	.04	**.72**	.06	.13
34	13	.04	**.58**	.03	.26
35	14	.14	**.66**	.01	.13
36	15	.16	**.70**	.07	.07
37	16	.16	**.64**	.08	.14
46	17	.07	.19	**.52**	.20
60	18	-.07	.00	**.63**	-.04
61	19	.09	.09	**.45**	.13
62	20	.09	.06	**.47**	.17
66	21	.02	.00	**.71**	-.16
67	22	.02	.11	**.63**	.07
78	23	.03	.17	.16	**.53**
79	24	.16	-.01	.13	**.48**
80	25	.07	.05	.15	**.53**
83	26	.18	.01	.05	**.51**
84	27	-.02	.21	-.09	**.61**
86	28	.08	.09	.05	**.59**
87	29	.02	.20	-.20	**.58**
88	30	-.02	.26	.12	**.61**
Eigenvalues		2.10	6.00	1.98	2.22
Explained variance		%7.01	%20.00	%6.61	%.7.40
% Explained total variance		%41.01			

The examination of Table 1 indicated that the item factor loading values of the subscales ranged between .53 and .72 for the observation subscale, .58 and .79 for the addition subscale, .45 and .71 for the activity subscale, and .48 and .61 for the experiment subscale. Moreover, the total explained variance of the scale consisting of four sub-dimensions was 41.01%.

Reliability

To determine the reliability of the scale, Cronbach's alpha internal consistency coefficient was calculated. Cronbach's alpha internal consistency coefficients for the overall scale and observation, addition, activity, and experiment subscales were found as .85, .71, .87, .63, and .71, respectively.

Item Analysis

In this study, an item analysis was implemented in addition to Cronbach's alpha internal consistency coefficient for the reliability of the scale. In the item analysis, the corrected item-total correlation and arithmetic mean and standard deviation values were calculated. The results of the item analysis are presented in Table 2.

Table 2. The results of the item analysis

	Items	*r*	x̄	SD
Observation	1	.40	2.23	.67
	2	.34	2.28	.63
	3	.40	2.41	.65
	4	.41	2.15	.71
	5	.38	1.75	.69
	6	.54	2.04	.75
	7	.45	1.90	.73
Addition	8	.58	1.76	.77
	9	.58	1.57	.76
	10	.68	1.70	.77
	11	.67	1.62	.74
	12	.64	1.49	.69
	13	.53	1.38	.64
	14	.58	1.54	.69
	15	.64	1.62	.73
	16	.60	1.80	.70
Activity	17	.32	2.10	.74
	18	.37	2.50	.64
	19	.30	2.24	.62
	20	.32	2.18	.71
	21	.47	2.63	.57
	22	.43	2.30	.66
	23	.42	1.64	.72
Experiment	24	.35	1.96	.69
	25	.39	1.78	.71
	26	.37	1.84	.73
	27	.43	1.23	.52
	28	.41	1.53	.67
	29	.39	1.23	.55
	30	.48	1.44	.63

As seen in Table 2, the corrected item-total correlation, arithmetic mean, and standard deviation values were .34 -.54, 1.75 - 2.41, and .63 - .75 for the observation subscale; .53 - .68, 1.38 - 1.80, and .64 - .77 for the addition subscale; .30 - .47, 2.10 - 2.63, and .57 - .74 for the activity subscale; .35 - .48, 1.23 - 1.96, and .52 - .73 for the experiment subscale.

Results of the Confirmatory Factor Analysis

In this part, the CFA was carried out to determine whether the construct obtained as a result of the EFA of the scale was confirmed. All the goodness of fit indices obtained as a result of CFA were found to be at a good level (χ2=788.78, sd=395, χ2/sd=1.99, p=0.00; RMSEA=.045, RMR=.026, SRMR=.056, GFI=.90, AGFI=.89, CFI=.95, NFI=.91, NNFI=.95, IFI =.99, and RFI = .90). Moreover, the CFA model was found to be significant. The standardized coefficients and factor loading values of the CFA of the scale are presented in Figure 1.

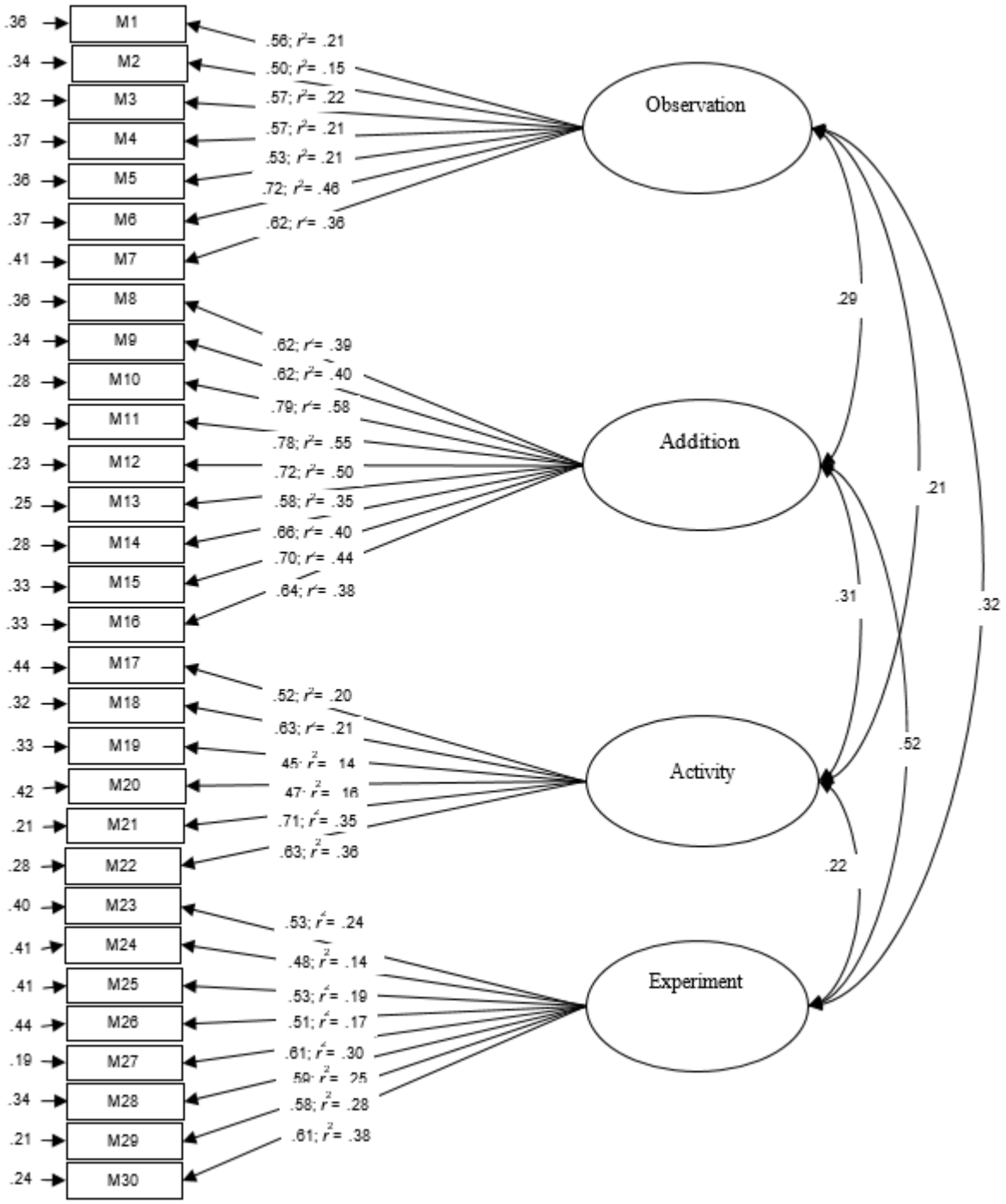

Figure 1. Path diagram and factor loadings of the scale

As a result of the CFA, the explanation ratios of the implicit variables for the observed variables were found between .45 and .79. In addition, it was observed that t values of all items on the scale were significant.

DISCUSSION

In this study, the ScESInE, developed by Gafoor and Narayan (2008), was adapted to the Turkish context for secondary school students. In this context, the validity and reliability study results of the scale are discussed below.

The EFA was not conducted in the original study of the scale. While adapting the scale to the Turkish context, first, KMO (.84) and Bartlett's Test of Sphericity ($\chi 2$ = 4053.10, sd = 435) were examined, and the results obtained were found to be suitable for the EFA. As a result of the EFA done, items with an item factor loading value below .40, and those overlapping due to loading on more than one factor were removed from the scale, respectively, and the analyses were repeated. As a result of the EFA, a structure with four factors and 30 items was obtained as in the original scale. It was found that the scale consisting of four

subscales explained approximately 41% of the total variance. A total variance of 30% or more is considered as a sufficient value (Büyüköztürk, 2007). Therefore, this criterion was met, too. The item loading values of the scale ranged from .45 to .79. A scale item loading value of .40 or above is considered as an adequate value (Şencan, 2005).

Cronbach's alpha internal consistency coefficient for the reliability of the scale was found to be 85, .71, .87, .63, and .71 for the overall and observation, addition, activity, and experiment subscales, respectively. Cronbach's alpha internal consistency coefficients calculated for the reliability were both equal or above .60 (Nunnally & Bernstein, 1994; Şencan, 2005) and close to the values obtained in the original study, which showed that the scale was reliable. In addition, the corrected item total correlation values were calculated for the reliability of the scale. These values were found to range between .30 and .68. A corrected item total correlation value of .30 and above is considered adequate (Sümer, 2000).

For the validity of the scale, the CFA was carried out in addition to all these procedures. As a result of the CFA, the construct of the scale consisting of four sub-dimensions and 30 items was confirmed. All goodness of fit indices obtained in the CFA model were found to be at a good level (Hu and Bentler, 1999; Sümer, 2000; Tabachnick and Fidell, 2007). As a result, it can be said that the construct of the scale adapted to the Turkish context was confirmed.

After all analyses carried out in the study, we obtained a scale with 30 items and four subscales that determines the middle school students' levels of science experience in informal environments. As a result of the analyses, it was observed that all subscales available in the original scale were included in the Turkish version. The names of the subscales are observation, addition, experiment, and activity. The items in these dimensions demonstrate students' observations, objects that they collect, that is, they add to their collection, and experiments and activities they carry out in informal environments in informal education. The items included in the subscales were found to measure the targeted areas.

This study has some limitations. First, the study was conducted with middle school students. Its validity and reliability should be calculated again when it is used in elementary and high school students. Second, the convenience sampling method was used in this study. Other sampling methods (random, purposive, etc.) are recommended for new studies. Finally, this scale is based on self-report. We recommend that students' experiences should be supported with qualitative data research methods.

As a result of all validity and reliability analyses carried out under the adaptation of the scale to the Turkish context, it can be said that it can be used to determine middle school students' level of science experience in informal environments in Turkey (Appendix 1).

Ethics Committee Approval

First, the approval of the Ethics Committee of Karamanoğlu Mehmetbey University (issue: 95728670-900-E.11207) and the permission of the Karaman Directorate of National Education was obtained, and then the scale was administered in the state schools.

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Appendix 1. The Science Experience Scale in Informal Environments (ScESInE)

Dear Students,

The sentences below aim at finding out about your out of school experiences with science. For each statement, please mark one of the three choices with an "X" to show the frequency of your experiences.

Example:

	Never	Sometimes	Often
17. Blowing soap bubbles		**X**	

Out-of-school science experiences are given in 4 sections. Please read the instructions for each section carefully and mark your answer in the section provided.

PART 1 (Observation)

You see some observations about science below. Please mark the suitable box with an "X" according to how often you make these observations.

	Never	Sometimes	Often
1. Animal behaviors			
2. Places where animals live			
3. Raindrops			
4. How machines work			
5. Spraying insecticides			
6. Rotting of an apple			
7. Rusting of iron			

Part 2 (Addition)

You see some of the things that you collect related to science below. Please mark the suitable box with an "X" according to how often you collect these objects.

	Never	Sometimes	Often
8. Leaves			
9. Feathers			
10. Animal pictures			
11. Bird pictures			
12. Pictures of extinct animals and birds			
13. Photos of space travelers			
14. Pictures of natural disasters			
15. Different soil types			
16. Batteries			

Part 3 (Activity)

You see some activities related to science below. Please mark the suitable box with an "X" according to how often you do these activities.

	Never	Sometimes	Often
17- Blowing soap bubbles			
18. Brushing teeth twice a day			
19. Doing exercise			
20. Eating a variety of vegetables			
21. Keeping the environment clean			
22. Telling others to keep the environment clean			

Part 4 (Experiment)

You see some experiments related to science below. Please mark the suitable box with an “X” according to how often you carry out these experiments.

	Never	**Sometimes**	**Often**
23. Jetting water towards the sunlight to create a rainbow			
24. Reflecting sunlight using a mirror			
25. Reading words by looking at their reflection in the mirror			
26. Making sounds by vibrating a stretched rubber band			
27. To spread oil on a piece of paper to make a tracing paper			
28. Mixing oil and water			
29. Using kerosene to remove paint stains			
30. Making a model using clay			