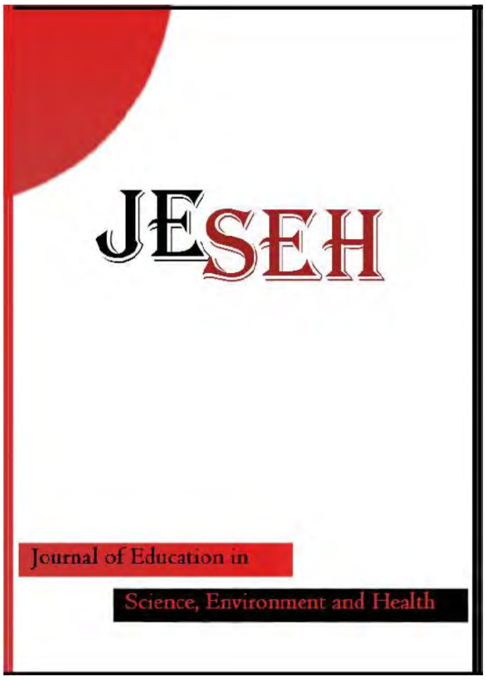

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A Study to Adapt "Puppet Interview Scales of Competence in and Enjoyment of Science" to Turkish Culture

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Abstract

Children interact with science from the moment of their birth. By means of the scientific experiences they have as a result of this interaction, children acquire numerous skills related to science at the early ages. These scientific skills and children's orientation towards science such as awareness, attitude, proficiency, inquisitiveness, as well as interest and ability in researching, exploring, problem solving are especially enhanced by effective science education in early childhood. A valid and reliable assessment tool is needed to determine whether children's scientific attitude and orientation are at desirable levels. The aim of this study, which was developed in line with this need, is to examine validity and reliability of Puppet Interview Scales of Competence in and Enjoyment of Science (in original version; Samarapungavan, Mantzicopoulos& Patrick, 2008) in the context of Turkish culture. Data was gathered from 1158 children in 15 provinces in various regions of Turkey. KR-20 was computed to be .96 for the first subscale, .90 for the second subscale, .80 for the third subscale and .87 for the forth subscale. As a result of exploratory factor analysis for validity, the scale was gathered with 41 items and in four sub-dimensions in total. The total variability of all the factors was computed to be 49.35%. The confirmatory factor analysis conducted on another sample revealed that error is within an acceptable range (.63) and adaptation statistics is above .80. The CFI and NFI values -the indicators of the goodness-of-fit index- are above .90. Additionally, IFI value is .98 and the SRMR value is lower than .08. These indicate high model-data conformity. As a result of this study, Puppet Interview Scales of Competence in and Enjoyment of Science were found to be a reliable and valid scale for the Turkish society.

Introduction

Science plays a significant part in individuals' life (Bornstein & Lamb, 2005; Farenga, Joyce & Ness, 2001). Various experiences that preschool children have in their social environment in particular are closely related to science (Akman, 2003; Holt, 1977; Howe & Jones, 1998). Many situations, events and concepts, encountered by the child in his/her environment, such as the characteristics and motions of ordinary observable objects, life cycles of living beings, astronomical objects visible in the sky, slow or fast-paced changes in world, and technological advances are all subjects of science (Aktaş-Arnas, 2002). The National Science Education Standards, which describe the standards, extent, and content of preschool science education, were also created with this fact in mind. According to the National Science Education Standards, preschool science education can be grouped under eight categories. These are unifying scientific concepts and processes, scientific inquiry, physical science, life science, earth and space science, science and technology, science as seen from individual and social perspectives, and the nature and history of science (National Research Council [NRC], 1996; NRC, 2000). As captured by these categories, children start exploring the world of science, asking questions and searching for answers, solving problems and gathering awareness from the moment of their birth through both the formal and informal experiences they have. As they grow older, children become more adept at using their sensory faculties and start to utilize the essential skills involved in scientific processes (Pianta, 2012; Samarapungavan, Mantzicopoulos& Patrick, 2008; Saracho & Spodek, 2007). In this regard, a planned approach to preschool science education is essential to ensure that children acquire basic knowledge and skills related to science, are able to comprehend the objects and events they encounter, and become acquainted with scientific concepts (Akman, Üstün & Güler, 2003; Dubosarsky, 2011; Duschl, Scweingruber & Shouse, 2006; Erden & Sönmez, 2011; French, 2004).

Eshach & Fried (2005) explain the significance of preschool science education in a study on this subject. A well-planned science education program enables children to think about the concepts and events they are curious about and would like to know more about, and helps them develop a positive orientation towards their experiences concerning science. At the same time, such a program is instrumental in supporting the acquisition of scientific literacy, a scientifically meaningful grasp of cause-effect relationships, and the ability to use scientific reasoning skills more effectively (Akman, Üstün & Güler, 2003; Platz, 2004). According to Akman (2010), an effective preschool science education supports the development of children's grasp of scientific concepts and skills and the growth of their scientific knowledge. Science education helps raising children's scientific awareness regarding the experiences they have, improves the skills instrumental for discovery and generally reinforces the skills that are needed to conduct a basic scientific investigation. Akman (2010) also emphasizes the key role of science education in keeping alive the children's sense of wonder and inquisitiveness and in helping them adopt a realistic, objective, and critical attitude towards the concepts and events they encounter in their environment. The children whose developments are supported with a science education that takes the said facts into account tend to develop a positive orientation towards science, and their positive orientation manifests itself in their scientific behavior.

In a study that aims to determine preschool children's motivational beliefs concerning science education, Samarapungavan, Mantzicopoulos & Patrick (2008) also argue that science education from a very early age has remarkable significance regarding the longevity of their interests in science throughout their future careers and their future scientific success. Moreover, the results of the study reveal that the duration of exposure to scientific education and their motivational beliefs related to science (interest in science, scientific self-confidence, scientific curiosity, scientific literacy and scientific competence) are positively correlated. Similarly, Barton (2010) reports that inclusion of science education into early childhood programs would pose a major advantage for the children exposed to it. As inclusion and healthy application of science education in a curriculum lead to improvements in children's skills in numerous areas such as communication, reading-writing, and critical thinking, these also result in detectable positive changes in their scientific tendencies. In another study, where Samarapungavan, Patrick & Mantzicopoulos (2011) compared the scientific motivation of children enrolled in an effective science program (based on critical thinking) with a control group, they found significant differentiation in favor of the experiment group. Nevertheless, Brooks (2012) concludes in a study that children are able to use their visual and manual skills more effectively within the framework of basic process skills, to retain scientific information more effectively, and to give answers that are more sophisticated to the questions asked to them, by means of a science education program.

In related literature, there are a number of scales about science competence or motivation. Science Motivation Scale (Çetin-Dindar & Geban, 2015), Academic Motivation Scale Toward Learning Biology (Aydın, Yerdelen, Yalmancı & Göksu, 2014), Continuing Motivation for Science Learning Scale (Erdoğan, Çakır, Gürel, & Şeker, 2015) and Questionnaire for Motivation toward Science Learning (Dede & Yaman, 2008) can be shown as examples for these scales. However, when all adapted and developed scales are investigated, it is seen that they are suitable for children at primary school, secondary school, and high school levels. Any scale about motivation, attitude, or competence toward science could not be found for children at the early childhood level. It is very crucial to support children by exploring their competencies, attitudes, or motivations toward science in early childhood years.

Objective

The objective of this study is to create an adaptation of Puppet Interview Scales of Competence in and Enjoyment of Science for preschoolers by Samarapungavan, Mantzicopoulos & Patrick (2008) to the Turkish culture.

Method

Overview

This scale was developed originally in English for pre-literacy children who are very young to have linguistic competence and knowledge base to express their different beliefs and opinions in areas such as science. The scale has 63 items comprising four subscales: General Scientific Competence, Specific Scientific Knowledge and Ability, Love of Science, and Ease of Scientific Learning. The scale includes criteria for both a positive and a negative evaluation of each item. Each positive response adds 1 point to the child's score, while negative responses are considered 0 points, which makes the possible range of a total score from 0 to 63. In every item of the scale, a sentence is read to the child. In each item, there are two different images. Whereas one of the images displays the read sentence in a negative way, the other image displays the sentence in a positive way. At this point, the child is required to choose the image that is closer to him/her by internalizing the images. Before applying the scale, the children involve in an array of activities containing scientific films and books, and thus acquire some familiarity with the subjects and situations mentioned in the items of the scale. Higher total scores indicate that the child's attitude and orientation towards science are positive whereas lower scores indicate the opposite.

Study Group

Researchers used the Turkish adaptation of the scale on 1158 six year-olds enrolled in the public and private preschool education institutions in the provinces of Aksaray, Ankara, Aydın, Balıkesir, Gaziantep, İstanbul, İzmir, Karaman, Kırşehir, Konya, Mersin, Rize, Tokat, Şanlıurfa, and Uşak. Demographic information of the children who involved in the study is provided in Table 1.

Table 1. Demographic information of the sample

Demographic	Characteristic	n	%
Gender	Girl	595	51.38
	Boy	563	48.62
	Total	1158	100
Type of School	Public School	511	44.13
	Private School	647	55.87
	Total	1158	100
City	Aksaray	55	4.75
	Ankara	145	12.52
	Aydın	79	6.82
	Balıkesir	43	3.71
	Gaziantep	64	5.53
	İstanbul	105	9.07
	İzmir	99	8.55
	Karaman	88	7.60
	Kırşehir	38	3.28
	Konya	134	11.57
	Mersin	39	3.37
	Rize	43	3.71
	Şanlıurfa	74	6.39
	Tokat	97	8.38
	Uşak	55	4.75
	Total	1158	100

In the study, it was found that the average age of the children in the study is 62.78 months. During the data collection procedure, the public and private schools, for which necessary permissions were received, were visited by the researchers. The data was collected by each researcher by working with children one by one while applying the scale. This process took about 18-25 minutes for every child.

Findings

The Validity of the Scale

Linguistic Validity

In order to assess and ensure the linguistic validity of the scale, three language specialists were hired to translate independently the Puppet Interview Scales of Competence in and Enjoyment of Science from English, its original language, to Turkish. Then, the three translations were combined together, keeping the parts agreed in all three translations. The specialists who did the translation were consulted regarding the parts where their translations differed, and a consensus was reached concerning a uniform wording. The names of the subscales of the scale were also simplified by taking into account the feedback received from the specialists. The resulting scale text was re-translated back to English by three new language specialists. Finally, three new specialists were asked to compare the English re-translation with the original English version, and they unanimously determined that there was not any significant difference between the re-translation and the original. - A field expert was asked for opinion in order to collect sufficient proofs for the Turkish version, and it was found as a result of the field expert opinion that the translation was highly consistent. In this line, language validity of the translation was ensured.

Structural Validity

Factor analysis was utilized in order to determine structural validity. Since it would have been inappropriate to conduct both exploratory and confirmatory factor analyses on a single data set, the data was divided into two equal parts in an unbiased manner. Then exploratory factor analysis was conducted on the first part and confirmatory factor analysis on the second part. In order to determine the number of factors under which the items examined by the factor analysis were accumulated, eigenvalues and the explored percentages of variance were prioritized. The items with factor weights greater than .35 were evaluated and items with eigenvalues greater than 1 were determined to be significant. Factor loadings of items were examined and items with a factor loading less than 0.35 were excluded. As a result, 22 items were excluded from the original scale because of low factor loadings, and the analysis continued with 41 items. The results of the factor analysis are provided in Table 2.

Table 2. The eigenvalues and explored percentages

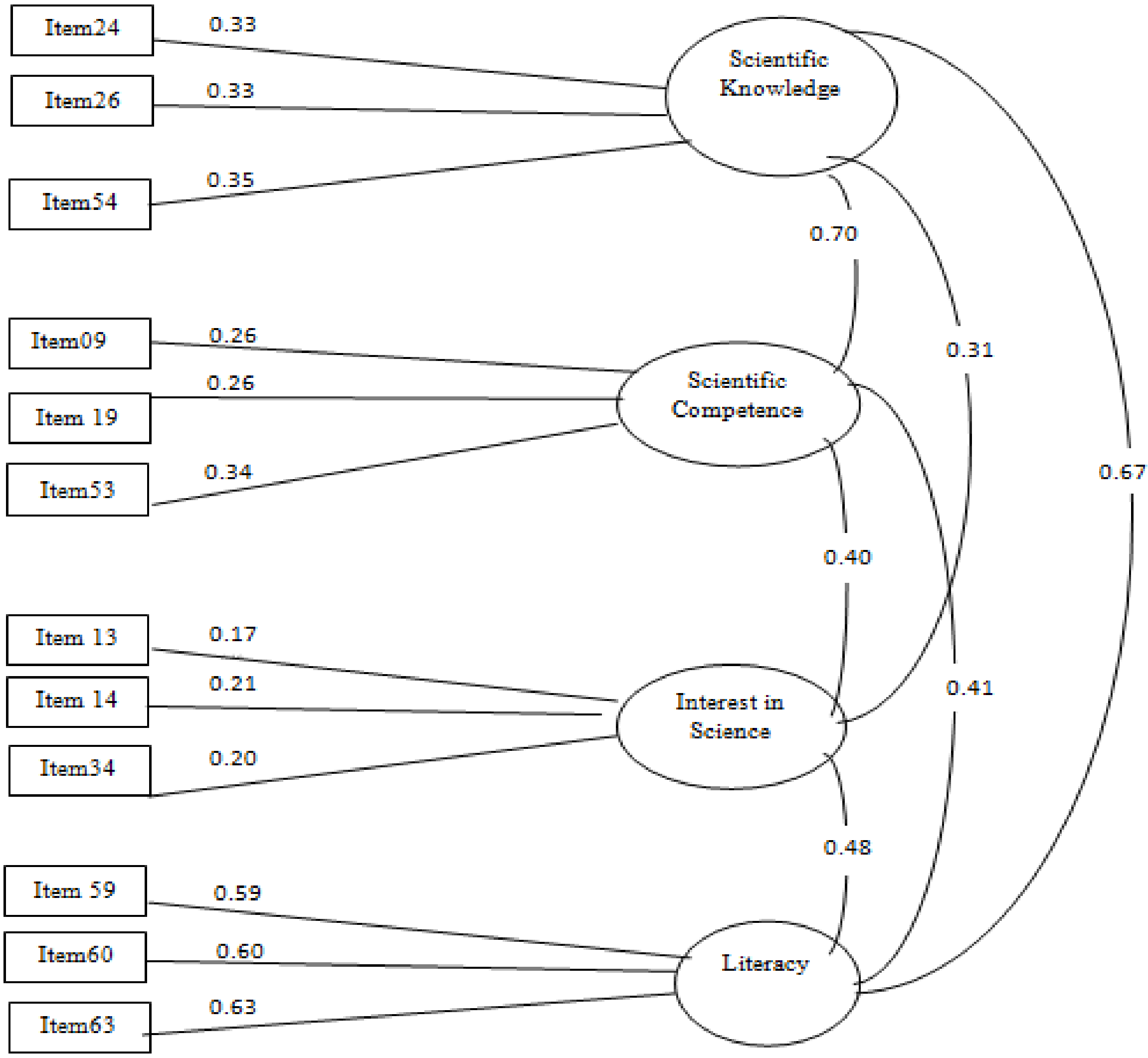
Components	Eigenvalues	Explored Var. %
1	19.861	31.525
2	5.881	9.335
3	3.478	5.521
4	1.983	3.147

*Extraction Method: Principal Component Analysis

In Table 2, it is observed that there are four components with eigenvalues over 1.00. Therefore, the scale has a four-factor structure. Nevertheless, as it is depicted in Table 2, the variability of individual factors are respectively 31.525%, 9.335%, 5.521%, and 3.147%. The combined variability of the four factors is 49.525%. Table 3 lists the factor weights and item-total score correlations for each item relative to the magnitude of the factor weight. As a result of the factor analysis, the items of the scale fall under 4 subscales.

Table 3. Item-total score correlations of the factor weights after the application of varimax rotation

Scientific Knowledge			Scientific Competence			Interest in Science			Literacy		
Item	Factor	$r_{(jx)}$	Item	Factor	$r_{(jx)}$	Item	Factor	$r_{(jx)}$	Item	Factor	$r_{(jx)}$
BGY35	.813	.747	BGY09	.695	.754	BGY13	.450	.550	BGY59	.592	.549
BGY48	.798	.742	BGY19	.632	.682	BGY14	.587	.470	BGY60	.677	.737
BGY42	.795	.787	BGY20	.683	.652	BGY15	.459	.429	BGY61	.797	.835
BGY44	.791	.781	BGY43	.567	.729	BGY21	.537	.672	BGY62	.730	.778
BGY29	.791	.738	BGY50	.752	.614	BGY22	.579	.709	BGY63	.745	.798
BGY47	.782	.732	BGY51	.782	.754	BGY25	.571	.592			
BGY31	.780	.811	BGY52	.735	.742	BGY27	.462	.453			
BGY49	.768	.699	BGY53	.744	.706	BGY34	.501	.604			
BGY37	.757	.767									
BGY40	.756	.777									
BGY45	.752	.633									
BGY38	.748	.755									
BGY33	.743	.812									
BGY24	.732	.817									
BGY26	.731	.778									
BGY32	.728	.727									
BGY46	.710	.804									
BGY36	.683	.815									
BGY54	.661	.788									
BGY39	.624	.692									
N of items	20			8			8			5	
Reliability	.967			.907			.803			.877	



Chi-Square: 2629,12 df: 773 p = 0,000 RMSEA= 0,071

Figure 1. Confirmatory factor analysis diagram for items

The varimax rotation technique was used to facilitate the exploration of important factors. The items in the factors, which seem to be important due to their post-rotation factor weights, were also listed in Table 3. From the view that the sub-dimensions can be renamed, these four factor dimensions were named as "Scientific Knowledge", "Scientific Competence", "Interest in Science", and "Literacy", based on the contents of these factors and in accordance with the opinion of the expert of the field. In addition to exploratory factor analysis, confirmatory factor analysis was also conducted on the scale, the results of which are provided in Figure 1.

The most frequently computed statistics on the model-data fit in confirmatory factor analysis are Chi-square (x^2), x^2/sd, Root Mean Square Error of Approximation (RMSEA), Root Mean Square Residual (RMR), Goodness-of-Fit-Index (GFI), and Adjusted Goodness-of-Fit-Index (AGFI). Model-data fit is indicated by a computed x^2/df (3.401) ratio lower than 5, GFI and AGFI values greater than .90, and RMR and RMSEA values smaller than .05. However, ~~a~~ GFI greater than .85, AGFI greater than .8, and RMR and RMSEA smaller than .10 could also be taken as reasonable lower-bounds for model-data fit (Anderson & Gerbing, 1984: Reported by Duyan & Gelbal, 2008). Perfect model fit and acceptable model fit ranges for goodness of fit statistics were given in Table 4 below (Hair, Black, Babin & Anderson, 2010; Hu & Bentler, 1999; Kline, 2011; Tabachnick & Fidel, 2013; West, Taylor & Wu, 2012). Additionally, statistics concerning the model-data fit revealed by the confirmatory factor analysis conducted on the Puppet Interview Scales of Competence in and Enjoyment of Science were provided in the same table.

Table 4. Model-data fit values

	Perfect Model Fit	Acceptable Model Fit	Goodness-of-Fit
Chi-square	-	-	2629.12
df	-	-	773
p-value			.000
χ^2/df	χ^2/df <3	3<χ^2/df < 5	3.401
CFI	CFI > 0.95	0.90 < CFI <0.95	0.97
NFI	NFI > 0.95	0.90 < NFI <0.95	0.96
GFI	GFI > 0.95	0.90 < GFI <0.95	0.80
IFI	IFI > 0.95	0.90 < IFI <0.95	0.97
RMR	RMR < 0.05	0.05 < RMR < 0.08	0.011
SRMR	SRMR < 0.05	0.05 < SRMR < 0.08	0.054
RMSEA	RMSEA < 0.05	0.05 < RMSEA < 0.08	0.071

The statistics concerning the model-data fit revealed by the confirmatory factor analysis conducted on the Puppet Interview Scales of Competence in and Enjoyment of Science are provided in Table 5.

Table 5. Goodness-of-fit indicate values

Chi-square	df	p-value	CFI	NFI	GFI	IFI	RMR	SRM	RMSEA	90%C.I RMSEA
2629.12	773	p<.05	.97	.96	80	.97	.011	.054	.071	.068-.074

Figure 1 depicts the model constructed to express the theoretical structure of the Puppet Interview Scales of Competence in and Enjoyment of Science. According to the results of the confirmatory factor analysis conducted to investigate the fit of this model to data, the fit between the model and data is high. The fact that CFI and NFI values, both of which are indicators of model-data fit, are higher than .90 indicates that model-data fit is high. Moreover, it can also be argued that the model-data fit is high because the IFI value, which yields the value of the SRMR probability independently of sampling, is .97. It is also possible to interpret that SRMR value is smaller than .08 as an indication of a good fit, as SRMR reveals the model-data fit with regards to the model's standardized error (Hu & Bentler, 1999).

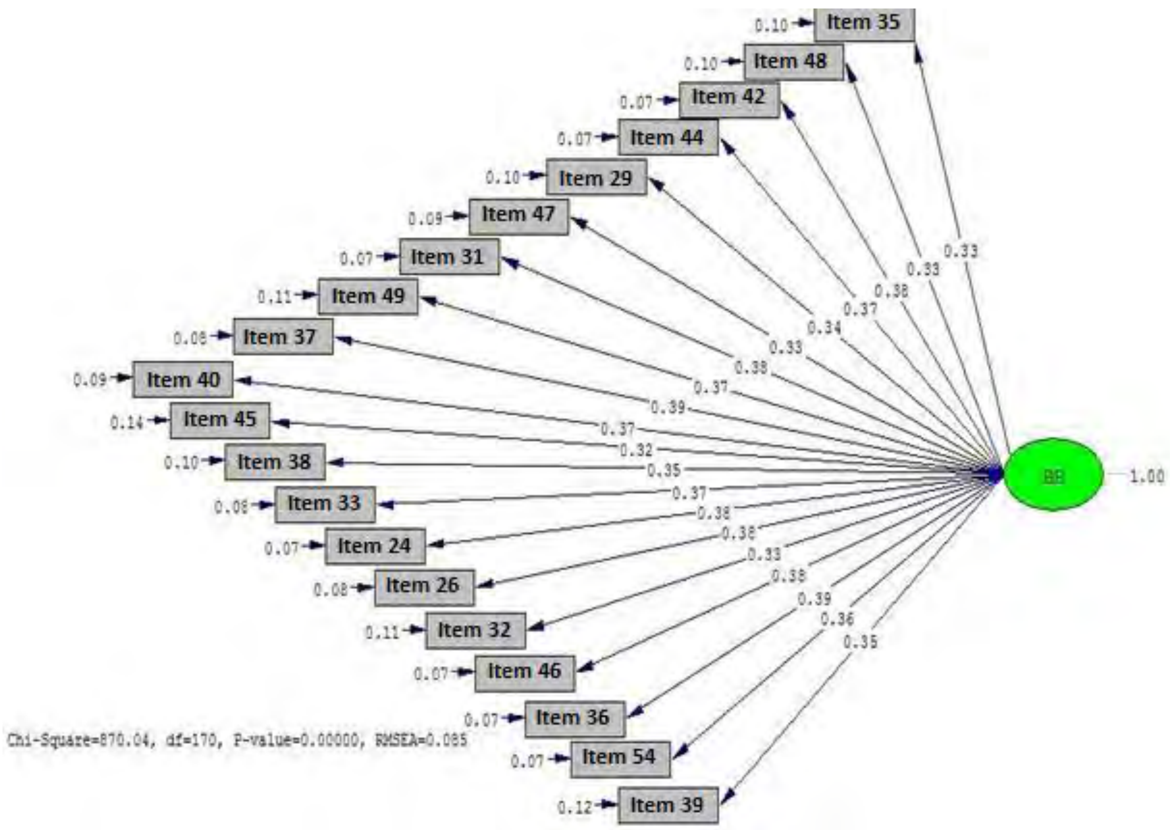


Figure 2. Confirmatory factor analysis results for questions in the subscale of scientific knowledge

A holistic evaluation of the values that track model-data fit reveals the finding that the model exhibits good fit to data, and that the scale has structural validity. In this regard, it can be concluded that the items comprising the scale can actually measure the otherwise-hidden variable of competence and enjoyment of science. Confirmatory factor analysis (CFA) was also conducted for the scale since it was stated by the developer that the scale is flexible and since subscales were created taking the items that work for the Turkish culture. The results presented in Figure 2, Figure 3 and Figure 4.

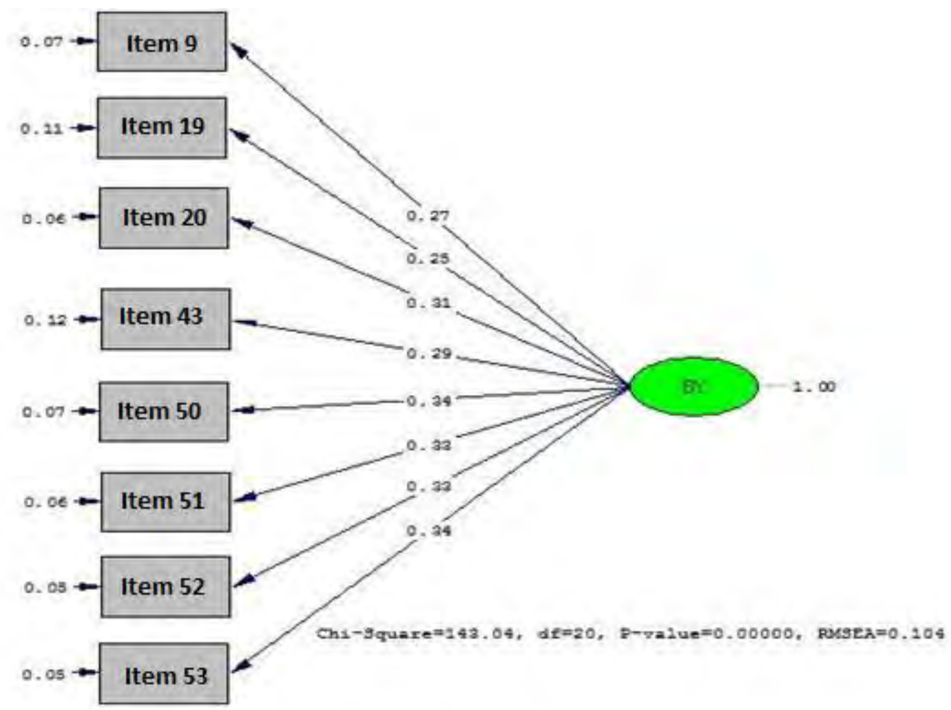


Figure 3. Confirmatory factor analysis results for questions in the subscale of scientific

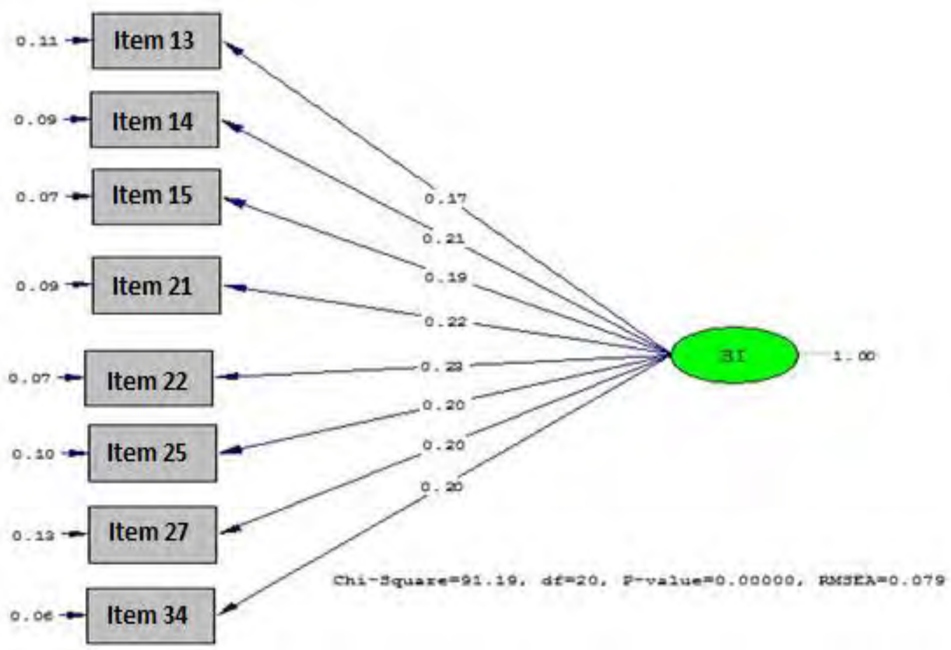


Figure 4. Confirmatory factor analysis results for questions in the subscale of interest

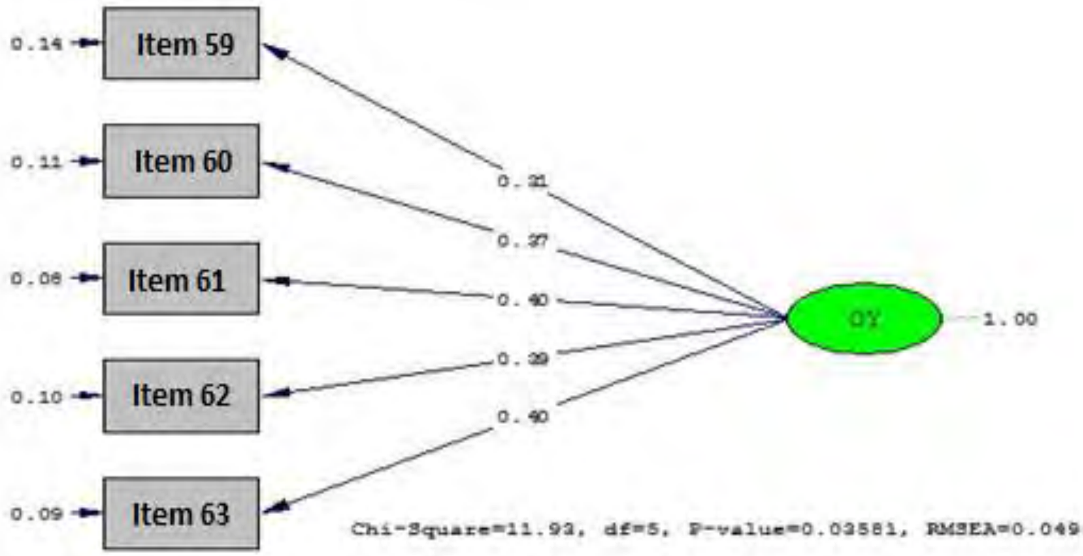


Figure 5. Confirmatory factor analysis results for questions in the subscale of literacy

Reliability of the Scale

Firstly, an itemized analysis of the scale was conducted and the characteristic response pattern was determined for each item. The correlations between the total score (X) and individual items (r(jx) item indicative strength level) were computed and listed in the final column (r(jx)) of Table 3. For each respective subscale, the item-total score correlations fluctuate between .58 and .81, .47 and .78, .61 and .76, .59 and .76. As the item indicative strength is .30 for each item (Özçelik, 2010), which means a good measurement, the correlations between the subscales and total score demonstrate the adequate indicative strength of individual items. KR-20 (Kuder Richardson), which is a special case of Cronbach alpha coefficient that yields the internal consistency of a collection of items scored 1-0, was used to estimate the reliability of the scale. The internal consistency coefficient of the items for respective subscales was found to be .96, .81, .90 and .87. As these values were sufficiently high, it was concluded that the Puppet Interview Scales of Competence in and Enjoyment of Science is reliable.

Conclusion and Suggestions

In this study, exploratory and confirmatory factor analyses were conducted in order to examine the factor structure of the Puppet Interview Scales of Competence in and Enjoyment of Science, and mutually congruent findings that support each other were reached. The results of the study indicate that the Turkish language adaptation of the scale exhibits the same four-factored structure as the one the original scale has. The fact that some of the items were found to have low factor values by the analyses and therefore had to be taken out from the scale can be explained by an appeal to cultural differences. In particular, the virtual total absence of reading and writing education in Turkey's preschools is a significant cultural difference. This is why; the Turkish adaptation of the scale contains pictures so as to facilitate effective application of the scale on illiterate preschool children. The facts that the items comprising the Puppet Interview Scales of Competence in and Enjoyment of Science have desirable qualities and that the degree of reliability and validity of the scale is high and comparable to that of the original indicate that the adapted scale can be used to determine the levels of competence in and enjoyment of science among preschoolers in Turkey.

Scientific Ethics Declaration

The author(s) declare that the scientific ethical and legal responsibility of this article published in JESEH journal belongs to the author(s).

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Appendix 1. English version of Puppet Interview Scales of Competence in and Enjoyment of Science

Sub-dimensions	Original item numbers	New item numbers	Scale items (score 1)
Scientific Knowledge	24	1	I know a lot about insects.
	26	2	I know why living things camouflage.
	29	3	I know how many legs insects have.
	31	4	I know a lot about different kinds of living things.
	32	5	I know how to measure things like a scientist.
	33	6	I know a caterpillar seen.
	35	7	I know what different living things need to stay alive.
	36	8	I can remember what my (science) books are about.
	37	9	I know how to use a science notebook.
	38	10	I am good at telling what is an insect.
	39	11	I know how fish breathe.
	40	12	I know a lot yet about animals that live in the ocean.
	42	13	I know how a hermit crab camouflages.
	44	14	I know how to make a prediction.
	45	15	I know how to make an observation.
	46	16	I know what tools to use to measure how heavy a book is.
	47	17	I am good at telling what makes things move.
	48	18	I know how a force makes things move.
	49	19	I know how to make a ball go fast on a ramp.
	54	20	I know lots of new science words.
Scientific Competence	9	21	I have fun learning science.
	19	22	I like reading scientific books.
	20	23	Science is beneficial.
	43	24	I know how to ask questions like a scientist.
	50	25	I like learning about how things move.
	51	26	I want to know more about living things.
	52	27	I have fun yet learning about animals that live in the ocean.
	53	28	I want to learn more about how things move.
Interest in Science	13	29	I like using different science tools
	14	30	I know how to do science.
	15	31	I learn science well.
	21	32	Learning about living things is easy.
	22	33	I am good at making an observation.
	25	34	I know how to use different tools to learn about science
	27	35	I can remember new science words
	34	36	I am good at making predictions.
Literacy	59	37	I know how to read different words
	60	39	I can read on my own.
	61	39	I can read stories with many words in them.
	62	40	I don’t need help with reading.
	63	41	I am good at reading new words.

Appendix 2. Turkish Version of Puppet Interview Scales of Competence in and Enjoyment of Science

Alt boyutlar	Orjinal madde numarası	Yeni madde numarası	Ölçek maddeleri (1 puan)
Bilimsel Bilgi	24	1	Böcekler hakkında çok şey biliyorum
	26	2	Canlıların neden gizlendiklerini biliyorum.
	29	3	Böceklerin kaç bacağı olduğunu bilirim.
	31	4	Farklı türde canlılar hakkında çok şey biliyorum.
	32	5	Bir bilim adamı gibi nasıl ölçüm yapacağımı biliyorum.
	33	6	Tırtılın nasıl göründüğünü biliyorum.
	35	7	Farklı canlıların hayatta kalmaları için ihtiyaç duyduğu şeyleri biliyorum.
	36	8	Bilimsel kitaplarımın hangi konularda olduğunu hatırlayabilirim.
	37	9	Bilim defterini nasıl kullanacağımı biliyorum.
	38	10	Böceğin ne olduğunu anlatmada iyiyim.
	39	11	Balıkların suda nasıl nefes aldıklarını biliyorum.
	40	12	Okyanusta yaşayan hayvanlar hakkında çok şey biliyorum.
	42	13	Bir yengecin nasıl gizlendiğini biliyorum.
	44	14	Nasıl tahminde bulunacağımı biliyorum.
	45	15	Nasıl gözlem yapacağımı biliyorum.
	46	16	Bir kitabın ağırlığını ölçmek için hangi aleti kullanacağımı biliyorum.
	47	17	Maddelerin nasıl hareket ettiğini anlatmada iyiyimdir.
	48	18	Bir kuvvetin nesneleri nasıl hareket ettirdiğini biliyorum.
	49	19	Bir topun yokuşta nasıl hareket ettiğini biliyorum.
	54	20	Bir çok bilimsel kelime bilirim.
Bilimsel Yeterlik	9	21	Bilim hakkında daha fazla şey öğrenmek isterim.
	19	22	Bilimsel kitapları okumayı severim.
	20	23	Bilim faydalıdır.
	43	24	Bir bilim insanı gibi nasıl soru soracağımı biliyorum.
	50	25	Nesnelerin nasıl hareket ettiğini öğrenmeyi seviyorum.
	51	26	Canlılar hakkında daha çok şey öğrenmek istiyorum.
	52	27	Okyanusta yaşayan canlılar hakkında bilgi sahibi olmaktan keyif alıyorum.
	53	28	Nesnelerin nasıl hareket ettiği konusunda daha çok şey öğrenmek istiyorum.
Bilimsel İlgi	13	29	Farklı bilim aletlerini kullanmayı severim.
	14	30	Bilimin nasıl yapıldığını biliyorum.
	15	31	Bilimi iyi öğrenirim.
	21	32	Canlılar hakkında bilgi sahibi olmak kolaydır.
	22	33	Gözlem yapmada iyiyim.
	25	34	Bilimi öğrenmek için farklı aletleri nasıl kullanacağımı biliyorum.
	27	35	Yeni bilimsel kelimeleri hatırlayabiliyorum.
	34	36	Tahmin yapmada iyiyim.
Okuma Yazma	59	37	Farklı harfleri nasıl okuyacağımı biliyorum.
	60	39	Tek başıma okuyabiliyorum.
	61	39	Çok sözcük içeren hikayeleri okuyabiliyorum.
	62	40	Okurken yardıma ihtiyaç duymam.
	63	41	Yeni kelimeleri okumada iyiyim.