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A DEVELOPMENT OF THE SCALE FOR PROBLEM SOLVING IN ENVIRONMENTAL EDUCATION: THE STUDY OF VALIDITY AND RELIABILITY

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Abstract:
This study aims to develop a valid and reliable instrument to assess the problem solving skills of five-year-old children receiving environmental education. The study included 156 children selected from the study population using the simple random sampling method. The literature was reviewed for Turkish and foreign studies on environmental education for children, improvement of problem solving skills, environmental education and problem solving skills to develop the Scale for Problem Solving in Environmental Education (SPSEE). Specialists' opinions were obtained, exploratory factor analysis was performed, and total item correlation, bottom and top group mean difference, Cronbach's Alpha internal consistency coefficient and test-retest correlation coefficients were calculated. The data were analysed using the SPSS 22 package. The exploratory factor analysis showed that the scale has 14 questions and two factors. Questions were prepared for each activity and the answers for these questions were formed in a three-point Likert-type scale. One of the researchers applied this scale to each child. The researchers prepared a guidebook, activities, a CD including these activities and a booklet including pictures to apply the scale. The pictures in the booklet were obtained from various activity books used in preschool education. The first researcher applied the scale by asking the questions in the booklet. The items of the SPSEE were found to sufficiently discriminate the individuals according to the scale's factor loads and total item correlation, and the study sample was determined to be appropriate and sufficient for factor analysis. The significant difference ($p<0.01$) between the mean scores of the bottom 27% and top 27% groups was used to determine how the SPSEE subscales discriminated the individuals who have the characteristic to be assessed at a higher and lower level. Test-retest correlation and the Cronbach's

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Alpha coefficient were used for the reliability analyses of the SPSEE. The Cronbach's Alpha coefficient was found to be 0.77 for the scale. During the test-retest analysis, a high correlation was observed between the scores of the two tests performed at a 20-day interval concerning the subscale and total scores. The validity and reliability analyses indicated that the Scale for Problem Solving in Environmental Education (SPSEE) is valid and reliable for five-year-old children.

Keywords: environmental education, problem solving, scale development, validity and reliability

1. Instruction

The first years of life are extremely important for children's development. During this period, children both try to understand the world in which they live and acquire basic information, skills and habits. Their environmental consciousness reaches its maximum level during the preschool period, when they try to understand the reasons and results of the situations they encounter by asking questions (Abbeduto and Beth, 2002; Küçükturan, 2005). The education that children receive in preschool both buildson their knowledge and guides their curiosity and search in the right direction (Solomon, 2005). Being in different learning environments to see the world from a scientific perspective will not only raise children's natural and environmental awareness but also contribute to their problem solving skills in regards to the environment and nature around them (Tuğrul, 2011; Stylianidou, 2012; Yayan ve Çelebioğlu, 2016).

While the recent industrial and technological developments have significantly facilitated life, they have caused a negative impact on the environment. This requires us to provide environmental education in each educational stage. Environmental education, defined as an interdisciplinary field of study, is based on raising a certain awareness of natural or artificial environments. The aim is that children acquire environmental literacy and awareness along with gaining accurate information, attitudes and skills about the environment (Gülay and Öznacar, 2010). The experience and education about nature and the environment during childhood lead to environmental awareness in later years (Shume, 2016). The environmental education provided during early childhood coupled with the support of family and society is important for children (Chepesiuk, 2007). Environmental education focuses on the denaturalization of the environment and the resulting reduction in the quality of life (Gough, 2002). Environmental education can be addressed under three categories: education of natural environments, education about the environment and education for

the environment (Barraza and Walford, 2002; Kesicioğlu and Alisinanoğlu, 2009). Ramsey and Hungerford (2002) defined the first stage of environmental education as the stage of environmental problem solving, including the information and skills to be focused on during environmental problem solving.

Children are born with a sense of wonder. Providing children with settings where they can become aware of their curiosity and gain experience is important for children to solve the problems they encounter and develop scientific thoughts (Tu, 2006). Being a good problem solver depends on children's motivation, interest and self-confidence. It has been reported that children's active participation in problem solving processes increases both their success level and their motivation (Akınoğlu and Akbaş, 2011). Dewey identified the steps of problem solving to be encountering a situation of difficulty, finding the problem in this situation, determining possible solutions and developing hypotheses, considering the results, and suspending, changing or correcting the hypotheses according to the results (Kıray and İlik, 2011).

Problem solving is the process of deciding and selecting the appropriate method to put forward effective solutions (D'Zurilla and Goldfried, 1971). It has cognitive and behavioral aspects. Problem solving skillsmean the knowledge of searching, analysing and determining alternative situations (Mac Nair and Elliot, 1992). It is also the ability to understand and control the environment (Güldal, Şahin and Çağlar, 2001). Previous studies show that children have problem solving skills from early ages, and they can improve upon these skills when they are provided with the appropriate environments (Helm and Gronlund, 2000; Faulkner-Schneider, 2005, Gallenstein, 2005; Ünal and Aral, 2014).

Children's solution of environmental problems is closely related to receiving environmental education and encountering environmental problems from early ages. Robertson (2008) analysed the effect of environmental education on children aged between 3 and 5 and found that the environmental awareness of these children continued significantly when they reached the age of 10 to 12 and that environmental education provided to children in preschool affected their attitudes in the future. Various studies also indicated the effectiveness of environmental education provided at early ages (Wilson, 1996; Musser and Diamond, 1999; Chepesiuk, 2007; Shume, 2016). The problem solving scales developed for children generally concern interpersonal relationships. Although the literature has various studies on problem solving and environmental education, none of them addressed problem solving within the context of environmental education. This scale is therefore expected to contribute to determining children's ability to solve the problems they encounter in environmental education and supporting them on this subject. This study aims to develop a valid and

reliable instrument to assess the problem solving skills of five-year-old children in environmental education.

Method

A Study Population and Sampling

The study population consisted of 5-year-old children going to the independent preschools affiliated with the Ministry of National Education in the Malatya city center in the spring semester of the 2015–2016 school year. During sampling, the list of these preschools was obtained from Malatya Provincial Directorate for National Education. From this list, two preschools which were located in similar neighbourhoods and had similar socioeconomic and sociocultural status were determined to be included in this study. The list of all children going to these two preschools was obtained and a total of 156 children were selected for the study using the simple random sampling method. Homogeneous groups were tried to be formed by selecting an equal number of children from each class in order to eliminate the effect of teachers.

Data Collection Tools

Preparation of the Scale Form: The literature was reviewed for Turkish and foreign studies on environmental education for children, improvement of problem solving skills, environmental education and problem solving skills to develop the Scale for Problem Solving in Environmental Education (SPSEE). The researchers determined after the literature review that problem solving skills in environmental education consisted of two substages. Literature review outcomes and specialists' opinions were used to create a pool for this study. First, a 64-item pool of problems was created for the SPSEE. The problems in the scale were formed based on the problems encountered in the environmental education for 5-year-old children. The number of problems was reduced to 28 due to various reasons such as some problems were inappropriate for environmental education, above or below the children's developmental level, exceeded the children's attention span, about different issues, expecting high-level skills from children and were not encountered by children within their immediate environment.

The scale consisted of 28 activities of environmental education regarding the problems encountered in environmental education. Questions were prepared for each activity and the answers for these questions were formed in a three-point Likert-type scale. One of the researchers applied this scale to each child. The researchers prepared a guidebook, activities, a CD including these activities and a booklet including pictures to apply the scale. The pictures in the booklet were obtained from various activity books

used in preschool education. The first researcher applied the scale by asking the questions in the booklet.

The Procedure

The exerciser opens the scale booklet, places it in sight of the child, and asks the child to look at the picture in the booklet. He or she applies the instructions of the scale by asking the questions on his or her side of the booklet. He or she ensures that the child answers the questions respectively. The child's answers are scored as 2 if they are correct, 1 if they are partially correct, and 0 if they are incorrect according to the answers in the booklet. The following instructions are given to the child to apply the scale.

> "*Now we are going to watch a CD with you. I ask you to look at the pictures in the CD carefully and answer the questions that I will ask. You can say that you don't know if you can't answer the question. We can start if you are ready*."

The child watches the CD after giving the instructions, and the exerciser tells the child the environmental activities in the pictures. An example of these activities is given below.

Microbes

Gains and Indicators

Cognitive Domain

Gain 1: They pay attention to the object/situation/event.

Indicators

They focus on the object/situation/event that draw their attention.

Additional Gains

1. They become aware of how to protect themselves from microbes.
2. They distinguish clean and dirty conditions.

Materials: A deep container, water, a bar of soap and black pepper.

Application: The container is half-filled with water. Some black pepper is put in the water. The bar of soap is straightly submerged into the water. The black pepper is observed to move away from the soap.

Evaluation Questions

1. Where and when do we use soap?
2. What should we do to protect ourselves from microbes? (Önder and Özkan, 2013:200)

The exerciser asks the questions in the scale to the child after he or she performs the activity. For example, the child's answers to the questions such as "*Where and when do we use soap?*" or "*What should we do to protect ourselves from microbes?*" are scored as 0 if the child cannot answer or the answer is incorrect, 1 if the answer is partially correct, and 2 if the answer is correct according to the answers in the booklet. The sum of the score of each problem yields the respective scores of two subscales (protection and regaining/improving); and the sum of the scores of these two subscales yields the score of the Scale for Problem Solving in Environmental Education.

Findings

Validity

Validity is defined as the extent to which the instrument assesses the concept to be assessed. The validity of an instrument is calculated using various methods: content validity, predictive validity and construct validity. The validity of an instrument is accepted to be ideal when the instrument has a high validity on all these methods. However, validity on any of these methods is accepted since this obligation is usually impossible to meet (Hovardaoğlu, 2007). Content and construct validity are analyzed in this study. Content validity determines whether the items of the scale represent the field to be assessed. Two processes which transform qualitative studies based on specialists' opinions into quantitative studies are used for content validity analysis: The Lawshe Technique and the Dawis Technique (Yurdugül, 2005). The Lawshe Technique is the most frequently used technique to determine the content validity rates. This technique calculates the content validity rates and indices of the scale. It consists of six steps: a) Formation of a group of specialists, b) Preparation of candidate scale forms, c) Obtaining the specialists' opinions, d) Obtaining the content validity indices of the items, e) Obtaining the content validity indices of the scale and f) Finalization of the scale form according to the content validity rates/indices. Opinions of a minimum of 5 and a maximum of 40 specialists who have sufficient knowledge on the study subject, understand the importance of the study and have adequate time for the study can be obtained (Tavşancıl, 2002).

The content validity rates of the SPSEE were determined using the Lawshe Technique and shown in Table 1.

Table 1: The Content Validity Rates of the Scale for Problem Solving in Environmental Education

The Scale for Problem Solving in Environmental Education	**Appropriate**	**Partially Appropriate**	**Inappropriate**	**Content Validity Rates (CVR)**	**Item Compliance Level (%)**
Item 1	9	2	0	0.63	63
Item 2	10	1	0	0.81	81
Item 3	9	2	0	0.63	63
Item 4	9	1	1	0.63	63
Item 5	10	0	1	0.81	81
Item 6	9	2	0	0.63	63
Item 7	11	0	0	1	100
Item 8	9	1	1	0.63	63
Item 9	10	1	0	0.81	81
Item 10	10	0	1	0.81	81
Item 11	9	2	0	0.63	63
Item 12	10	1	0	0.81	81
Item 13	11	0	0	1	100
Item 14	9	2	0	0.63	63
Number of Specialists					**11**
Content Validity Criteria					**0.59**
Content Validity Index					**0.74**

*The items included in the study according to the factor analysis were shown in the table.

The scale was submitted to 11 specialists for their opinions on its content validity. The specialists were academic members from different universities and were paid attention to be working or have worked on environmental education and problem solving. The specialists were asked to assess the items on the three-points rating scale as "inappropriate," "partially appropriate" and "appropriate" in terms of fitness for the purpose and comprehensiveness of the item and give recommendations to improve the items. The content validity rates are obtained by collecting the specialists' opinions on any of the items. Content Validity Rates (CVR) is obtained by subtracting 1 from the proportion of the number of specialists giving the opinion of "appropriate" for any item to the total number of specialists giving their opinion on that item. The items with the CVR values including negative values or zero are eliminated first. The items with positive CVR values are tested for statistical criteria and significance. The Lawshe content validity rate formula yields a percent value between -1 and +1 for each item

(Yurdugül, 2005; Şencan, 2005). The minimum content validity rates are determined at the significant level of α=0.05 in order to test the significance level of the content validity rates obtained. To facilitate calculation, Veneziano and Hooper (1997) tabulated the minimum CVR values at the significance level of p=0.05, and the minimum content validity rate was determined to be 0.59 for 11 specialists (Yurdugül, 2005). A content validity rate lower than 0.59 requires that the item be excluded from the data collection tool. Since none of the items of the Scale for Problem Solving in Environmental Problem Solving were found to have a content validity rate lower than 0.59, no items were excluded from the scale. Of the items, 22 remained the same since they had a compliance level between 90% and 100% and 6 were kept in the scale after making corrections to them and their pictures since they had a compliance level between 70% and 80%. Since none of the items were found to have a compliance level of 60% or lower, no items were completely excluded from the scale (Büyüköztürk, 2011). The Scale for Problem Solving in Environmental Education was made ready for the pilot application with 28 problems. The scale was applied to 30 children, and no changes were made on its content after this pilot application. Then the first researcher individually applied the scale to 156 children. The researcher showed the pictures and told the problems to the children and then gave them opportunity to answer. The scale was applied in classrooms and took 15 to 20 minutes for each child.

Construct validity is the theoretical analysis of whether the items formed to assess a variable actually assesses that variable or how this item is related to that variable. Factor analysis and internal consistency analysis are used to provide evidence for construct validity of instruments. In this study, the Kaiser-Meyer-Olkin (KMO) coefficient and the Bartlett's Sphericity Test were used to determine the appropriateness of the data obtained from the children for factor analysis. Then the exploratory factor analysis, total item correlations and bottom and top group mean difference were calculated to determine the scale's validity. The KMO coefficient should be higher than 0.5 and the Bartlett Sphericity Test result should be significant (Büyüköztürk, 2011). Hair et al. (1995) state that the Bartlett's test gives the statistical probability of significant relationships between some variables. The KMO value was assessed before analysing the factor structure and was found to be 0.89. Kaiser-Meyer indicated that a KMO value between 0.5 and 0.7 is acceptable, between 0.7 and 0.8 is good, between 0.8 and 0.9 is great and higher than 0.9 is perfect (Transferred by Field, 2013). The results of the validity analyses (KMO=0.89, Bartlett Küresellik Testi=0.00, p=0.00) showed that the data were appropriate for factor analysis. The test of normality was used to determine whether the data showed a normal distribution. Items 3 and 12 were excluded from the scale since they showed an abnormal distribution; and items 4, 7, 10, 15, 18, 21 and 26

were excluded from the study since they had a low factor load. The remaining 19 items were subjected to factor analysis again, and items 1, 5, 9 and 16 were excluded from the scale as they had a very low factor load. In addition, item 25 was excluded from the scale as it represented both factors. The remaining 14 items were then categorized under two factors and the Scale for Problem Solving in Environmental Education was finalized with two subscales. Table 2 shows the factor loads and total item correlation.

Table 2: The Factor Loads of the Scale for Problem Solving in Environmental Education and Total Item Correlations

Items	**Factors**		
	Problems Regarding Environmental Protection	**Problems Regarding Regaining/Improving the Environment**	
	Factor Load	**Factor Load**	**Total Item Correlation Coefficients**
Item 11	0.57		0.362
Item 17	0.77		0.348
Item 24	0.62		0.607
Item 2	0.54		0.542
Item 23	0.82		0.448
Item 14	0.76		0.464
Item 6	0.44		0.598
Item 28	0.75		0.381
Item 20		0.63	0.370
Item 22		0.46	0.562
Item 13		0.75	0.622
Item 8		0.64	0.345
Item 27		0.43	0.558
Item 19		0.53	0.349
Explained Varience (%)	25.22	18.68	
KMO	0.89		
Barlett's Test	0.00		
Df	140		
Approx Chi-Square	346.124		

Table 2 shows the factor loads of the SPSEE and total item correlation. The factor structure of the scale was analysed using the principal components analysis. The analyses were based on the Varimax rotation. In line with the specialists' opinions, the items under the first factor were included in the Problems Regarding Environmental

Protection subscale as they focused on environmental protection. The items under the second factor were included in the Problems Regarding Regaining/Improving the Environment subscale as they focused on recycling and regaining the environment. The factor loads of the first subscale ranged between 0.44 and 0.82. The factor loads of the second subscale ranged between 0.43 and 0.75. Items were analysed to calculate total item correlations. The item discrimination levels ranged between 0.348 and 0.607 for the first subscale and between 0.345 and 0.622 for the second subscale. This showed that the items sufficiently discriminate the individuals. A total item correlation value of 0.30 or higher shows that the items sufficiently discriminate the individuals, between 0.20 and 0.30 shows that the items can be included in the scale if needed or should be corrected and lower than 0.20 shows that the items should not be included in the scale (Büyüköztürk, 2011). As seen in the table, the results of Kaiser-Meyer-Olkin (KMO) and Barlett' test were found to be 0.89 and 0.00, respectively, both of which were significant at $p<0.01$ significance level. The KMO and Barlett's test indicated that the sample to which the SPSEE was applied was appropriate and sufficient for factor analysis.

Table 3: The Mann-Whitney U Test Results Regarding the Mean Item Scores of the Bottom 27% and Top 27% Groups Formed according to the Subscale and Total Scores of the Scale for Problem Solving in Environmental Education

The Scale for Problem Solving in Environmental Education		$\overline{X}$	n	Min.	Max.	Sd	Mean Rank	U	p
Problems Regarding Environmental Protection	Bottom 27%	1.03	36	1.13	0.80	0.98	13	65	0.00*
	Top 27%	1.53	36	2.06	1.08	0.03	59		
Problems Regarding Regaining/Improving the Environment	Bottom 27%	1.35	36	0.69	1.00	0.12	13	44	0.00*
	Top 27%	1.66	36	2.76	2.13	0.82	59		
Total	Bottom 27%	1.24	36	0.29	1.09	0.66	13	59	0.00*
	Top 27%	1.60	36	2.08	2.57	0.74	59		

*p<0.01

Item analyses were used to determine how the SPSEE subscales discriminated the individuals who have the characteristic to be assessed at a higher and lower level. A total of 72 participants were identified: 36 for the bottom 27% group and 36 for the top 27% group by ranking the scores obtained from the SPSEE. The subscales were tested using the Mann-Whitney U test for whether they discriminate these two groups. The significant difference ($p<0.01$) between the mean subscale and total scores of the bottom

27% and top 27% groups indicated that the items discriminated the children's problem solving skills in environmental education.

Reliability

Reliability is the ability of an instrument to measure the same characteristics every time it is applied (Yılmaz and Sünbül, 2003). Test-retest correlation and the Cronbach's Alpha coefficient were used for the reliability analyses of the SPSEE. The following tables show the results of the reliability analyses of the scale.

Table 4: The Cronbach's Alpha Reliability Coefficients of the Scale for Problem Solving in Environmental Education

	Factors		
	Problems Regarding Environmental Protection	**Problems Regarding Regaining/Improving the Environment**	**The Scale for Problem Solving in Environmental Education**
Cronbach's Alpha	0.69	0.70	0.77

Test-retest reliability was calculated to determine the level of the scale in order to make consistent measurements (stability). The Cronbach's Alpha coefficient was analyzed as an indicator of the internal consistency and homogeneity of the SPSEE and was found to be 0.77.

Table 5: Test-Retest Correlation Results of the Subscale and Total Scores of the Scale for Problem Solving in Environmental Education

The Scale for Problem Solving in Environmental Education		**Problems Regarding Environmental Protection**	**Problems Regarding Regaining/Improving the Environment**	**Total**
Problems Regarding Environmental Protection	r	0.958		
	p	0.00*		
	n	58		
Problems Regarding Regaining/Improving the Environment	r		0.934	
	p		0.00*	
	n		58	
Total	r			0.926
	p			0.00*
	n			58

*p<0.01

Table 5 shows the test-retest results of the subscale and total scores of the SPSEE. A high correlation was observed between the scores of the two tests performed at a 20-day interval concerning the subscale and total scores. The correlation coefficient was found to be 0.958 for the problems regarding environmental protection subscale, 0.934 for the problems regarding regaining/improving the environment subscale, and 0.926 for the total score. A significant relationship was found between the scores of these two tests ($p<0.01$).

Discussion*

This study aims to develop a valid and reliable instrument to assess the problem solving skills of five-year-old children receiving environmental education. The analyses showed the Cronbach's Alpha coefficient to be 0.77 for the scale. The reliability coefficient should be at least 0.70 for the scale tobe accepted as reliable (Tavşancıl, 2005; Büyüköztürk, 2008; Büyüköztürk et al., 2009). Ünal and Aral (2014) found the Cronbach's Alpha reliability coefficient to be 0.75 in their study titled Development of the Problem Solving Scale in Science Education. Serin et al. (2010), on the other hand, found the Cronbach's Alpha coefficient to be 0.80 in their study titled Development of the Problem Solving Inventory for Elementary School Students. In addition, this coefficient was found to be 0.87 for the Interpersonal Problem Solving Inventory for Preschool Children (Kesicioğlu, 2015). Finally, Smith-Donald et al. (2007) found the Cronbach's Alpha coefficient to be 0.89 and 0.87, respectively for each subscale of the Preschool Self-Regulation Assessment. In the present study, the correlation coefficient was found to be 0.958 for the problems regarding environmental protection subscale, 0.934 for the problems regarding regaining/improving the environment subscale, and 0.926 for the total score. A significant relationship was found between the scores of these two tests ($p<0.01$). The test-retest correlation was found to be 0.96 in the study titled Development of the Problem Solving Scale in Science Education and 0.85 in the study titled Development of the Problem Solving Inventory for Elementary School Students (Serin et al., 2010; Ünal and Aral, 2014). It was found to be 0.86 in the study titled Preschool Self-Regulation Assessment (PSRA): Adaptation Study for Turkey (Tanrıbuyurdu and Yıldız, 2014). When compared to the literature, the results of the analyses carried out in the present study indicate that the Scale for Problem Solving in Environmental Education makes a valid and reliable measurement.

Conclusion and Suggestions*

This study aimed to develop the Scale for Problem Solving in Environmental Education for 5-year-old children and to determine the validity and reliability of this scale. The items of the SPSEE were found to sufficiently discriminate the individuals according to the scale's factor loads and total item correlation, and the study sample was determined to be appropriate and sufficient for factor analysis. The significant difference ($p<0.01$) between the mean scores of the bottom 27% and top 27% groups was used to determine how the SPSEE subscales discriminated the individuals who have the characteristic to be assessed at a higher and lower level. Test-retest correlation and the Cronbach's Alpha coefficient were used for the reliability analyses of the SPSEE. The Cronbach's Alpha coefficient was found to be 0.77 for the scale. During the test-retest analysis, a high correlation was observed between the scores of the two tests performed at a 20-day interval concerning the subscale and total scores. The results of the present study indicate that the scale can be used for 5-year-old children. Applying the scale to larger samples and various age groups will positively affect the validity and reliability level of the scale.

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