Adaptation Study of the Ecological Literacy Scale for Middle School Students

*Kevser Arslan ⓘ, **Aslı Görgülü Arı ⓘ

Abstract. The aim of this study is to adapt the Ecological Literacy Scale developed by Ha, Huang, Zhang, and Dong (2021) into Turkish and conduct validity and reliability analyses. During the Turkish adaptation phase, both Turkish translation and English back-translation of the scale were performed by language experts to ensure linguistic equivalence. Language equivalences of the scale to be adapted were tested, adjustments were made based on expert opinions, and linguistic and stylistic controls were ensured. The scale, after a pilot application, was administered to 515 middle school students from different grade levels who were identified as the study group. The study data were analyzed using statistical software. Exploratory factor analyses were conducted on the data collected for the Ecological Literacy Scale. Following the analyses, a structure consisting of five subscales and 30 items was obtained. It was revealed that the factor loadings of the scale were at a very high level. The 5-factor structure of the scale was confirmed, and it was found that the fit indices were acceptable and showed excellent fit. The Cronbach's alpha internal consistency coefficient for the entire scale was calculated and determined to be 0.834. As a result of the study, a 5-point likert type "Ecological Literacy Scale" consisting of 5 factors and 30 items was adapted into Turkish. The adapted Ecological Literacy Scale was found to be a valid and reliable tool suitable for middle school students. A measurement tool that researchers and educators can benefit from has been added to the literature.

Keywords: Environmental education, ecological literacy, validity, reliability, adaptation.

*(**Responsible Author**) Dr., Yıldız Technical University, Faculty of Education, Istanbul, Türkiye

e-mail: arslankevser96@gmail.com

** Prof. Dr., Yıldız Technical University, Faculty of Education, Istanbul, Türkiye

e-mail: agorgulu@yildiz.edu.tr

All living beings, including humans, engage in direct or indirect interactions with the environmental system throughout their lifetimes. Within the environmental system, humans utilize environmental resources for various life activities (Kayan, 2018). The unsustainable and unconscious use of natural resources by individuals has resulted in irreversible damage to both underground and surface resources, leading to resource depletion. As a result, industrial production, irregular urbanization, and consumption habits have increased the pressure on the environment, paving the way for environmental problems (Akyüz, 2015).

With the harm caused to environmental elements, adverse global repercussions have started to manifest themselves significantly. The process leading to environmental problems becoming one of the world's fundamental issues has become inevitable. When considering the development of environmental issues, it is evident that human behavior is the most critical factor (Çakır Arıca & Kağar, 2018; Gülersoy, Dülger, Dursun, Ay & Duyal, 2020). With the increasing ecological problems due to the rise in environmental issues, it has become imperative for humans to live in harmony with other living beings and the environment, thus enhancing the importance of the science of ecology (Demir, 2022). Ecology, as a part of the environmental system, is based on the study of interactions between living beings and their environment. Furthermore, ecology can be described as a scientific field that explores how vital activities within the triangle of living organisms, inanimate elements, and the environment can mutually influence each other to ensure sustainability (Demir, 2021).

The science of ecology plays a significant role in offering valuable solutions to environmental problems and promoting a positive attitude toward nature (Hammarsten et al., 2019; Lewinsohn et al., 2015). It can be stated that humans also play an important role in maintaining the ecological balance within the environmental system. Ecological balance is achieved when individuals and their physical environments have healthy and mutually beneficial relationships (Erkal, Şafak &Yertutan, 2011). Pitman et al. (2018) indicate that the integrity of the relationship between humans and nature is fundamental for the survival of all living beings. The knowledge and understanding of individuals about the world's life form the central point of ecological literacy, which is proposed to be essential for the continuity of sustainable living.

In recent years, ecological literacy, arising from the growing ecological issues, focuses on a scientific perspective that is considered as a component of environmental literacy and necessitates having knowledge in the process of making effective decisions related to the environment (Okyay,

Demir, Sayın & Özdemir, 2021). Ecological literacy is concerned with understanding how individuals interact within the ecosystem and how they can ensure sustainability (Hammarsten et al., 2019). Ha, Huang, Zhang & Dong (2021) explain ecological literacy as the intersection of ecology with various disciplines, proposing it as a solution to the frequent occurrence of ecological problems. It is also mentioned that it plays a significant role in achieving harmony between humans and nature, and consequently, in sustainable development.

Similarly, Lees (2017) defines the process of an individual adapting to the ecological environment they live in as ecological literacy. Ha, Huang, Zhang & Dong (2021) propose five dimensions within the framework of ecological literacy: ecological knowledge, ecological awareness, ecological ethics, ecological emotions, and ecological behavior. Within these dimensions, the emphasis is on actions such as being ecologically knowledgeable, disseminating knowledge, increasing ecological conservation awareness, and guiding the sustainable development of ecological behavior.

The cultivation of students with ecological literacy skills and environmentally sensitive behaviors forms a robust foundation in the process of sustainable development (Demir, 2022). This is because individuals with ecological literacy will act by recognizing the changing natural balances and the importance of the ecosystem, causing less harm to the environment (Dündar & Kızık, 2022). An ecologically literate individual understands environmental truths, is aware of environmental issues, and demonstrates the ability to develop solutions for these problems (McBride et al., 2013). Such an individual can establish a relationship with nature, internalize it, make daily choices with consideration for their impact on the environment, and take action for sustainable living (Çabuk, 2019). Moreover, they can contribute to improving the environment, aim to reduce negative activities, and generate solutions (Khanal, Pandey, Khan, Mishra & Kunwar, 2020).

The acquisition of ecological literacy by individuals and their education accordingly is one of the most important steps to address ecological problems and leave a habitable world for future generations (Çakır Arıca & Kağar, 2018). Ecological literacy shifts the focus from short-term solutions to embracing sustainable steps, thereby presenting an alternative (Ferreira, Cruz &Pitarra, 2016; Okyay et al., 2021). Educating ecologically literate individuals, considered as the key to solving ecological crises, is most effectively done through schools (Ikhsan et al., 2019; Wallace, 2019; Wooltorton, 2006; Yıldırım & Hablemitoğlu, 2013).

Ecological literacy education is expected to promote the acquisition of knowledge about climate change, environmental pollution, lifestyle, production and consumption issues, as well as fostering responsibility in solving these problems (Levinshon et al., 2015). Furthermore, it can be regarded as a process of developing attitudes, values, knowledge, and skills related to nature, and exploring ways to live in harmony with the environment (Aydın, Dündar, & Korkut, 2016).

Individuals should be educated to become ecologically literate individuals who are knowledgeable about ecological issues, actively seek solutions, and uphold ecological ethical values. Ensuring that individuals become ecologically literate will play a significant role in shaping the future of the world positively and addressing global environmental problems. One of the forefront alternative solutions that can be proposed to leave a sustainable world for future generations is to make individuals ecologically literate. Therefore, it has been emphasized that individuals need to receive effective ecological education, and this education should be especially provided at the elementary and middle school levels (Gülersoy et al., 2020; Yıldırım & Hablemitoğlu, 2013). Additionally, there is a need to assess individuals' knowledge levels, awareness, ethical values, emotional, and behavioral aspects.

The development of an assessment tool that can determine the readiness of students in terms of ecological literacy skills and evaluate their ecological literacy levels would be valuable. Therefore, the introduction of an assessment tool that can measure middle school students' ecological literacy would be a significant step. It is expected that the measurement tool will be useful for researchers and educators. In this study, the aim is to adapt the "Ecological Literacy Scale" developed by Ha, Huang, Zhang & Dong (2021) into Turkish and to conduct validity and reliability analyses, addressing the following research questions:

1. Does the "Ecological Literacy Scale" adapted into Turkish for middle school students yield valid results?

2. Does the "Ecological Literacy Scale" adapted into Turkish for middle school students yield reliable results?

Method

Research Model

The study was conducted within the framework of an exploratory sequential design design from mixed research methods. It is the process of starting with the qualitative stage and then moving on to the quantitative stage. After the qualitative data are collected and analyzed, the data

are tested and quantitative methods are diagnosed. The exploratory sequential design design can be used in the development of a measurement tool (Creswell & Creswell, 2021).

Study Group

The participants of the study consist of middle school students from different grade levels in a public middle school located in Istanbul, during the 2022-2023 academic year. A total of 515 middle school students, from each grade level (5th, 6th, 7th, and 8th), are included. The research participants were determined using a purposive sampling method through a convenient sampling approach. In convenient sampling, the goal is to reach the study group in a practical manner, eliminating time constraints during the research process (Patton, 2014; Yıldırım & Şimşek, 2018). The characteristics of the students who participated in the research are presented in Table 1.

Table 1.

Qualifications of the Students Participating in the Research

Demographic features	Exploratory Factor Analysis	Confirmatory Factor Analysis	Total
Gender			
Girl	172	110	**282**
Boy	143	90	**233**
Total	**315**	**200**	**515**
Grade			
5.	77	55	**132**
6.	78	42	**120**
7.	79	48	**127**
8	81	55	**136**
Total	**315**	**200**	**515**

When examining Table 1, the characteristics of the middle school students who participated in the research, as well as the sample distributions for exploratory factor analysis and confirmatory factor analysis, can be observed. The study participants consist of 282 female students and 233 male students. Additionally, there are 132 students from the fifth grade, 120 from the sixth grade, 127

from the seventh grade, and 136 from the eighth grade. In this context, it can be said that the research group is distributed approximately evenly across each grade level.

Out of the 500 participants in the research, 300 constitute the data set for exploratory factor analysis, while 200 are included for confirmatory factor analysis. Literature in the field suggests working with a sample size of approximately 3 to 5 times the number of items in the scale (Bryman & Cramer, 2001; Sönmez & Alacapınar, 2016). In confirmatory factor analysis, a sample size of 150 or more is expected to be appropriate (Muthen & Muthen, 2002). Therefore, it can be understood that including 315 students in the exploratory factor analysis process and 200 students in the confirmatory factor analysis process is appropriate in the current scale development study.

Adaptation Process and Planning of the Measurement Tool

The shaping and planning of the research process were influenced by adaptation studies of measurement tools conducted in the literature. Within the framework of the literature in the field (Alexandre &Coluci, 2011; Bayık & Gürbüz, 2016; Çapık, Gözüm &Aksayan, 2018; Gelen et al., 2019; Heggestad et al., 2019; Korkmaz, Çakır & Erdoğmuş, 2021; Seçer, 2018; Şeker &Gençdoğan, 2014; Stover et al., 2012), the stages of the current study are presented in Figure 1.
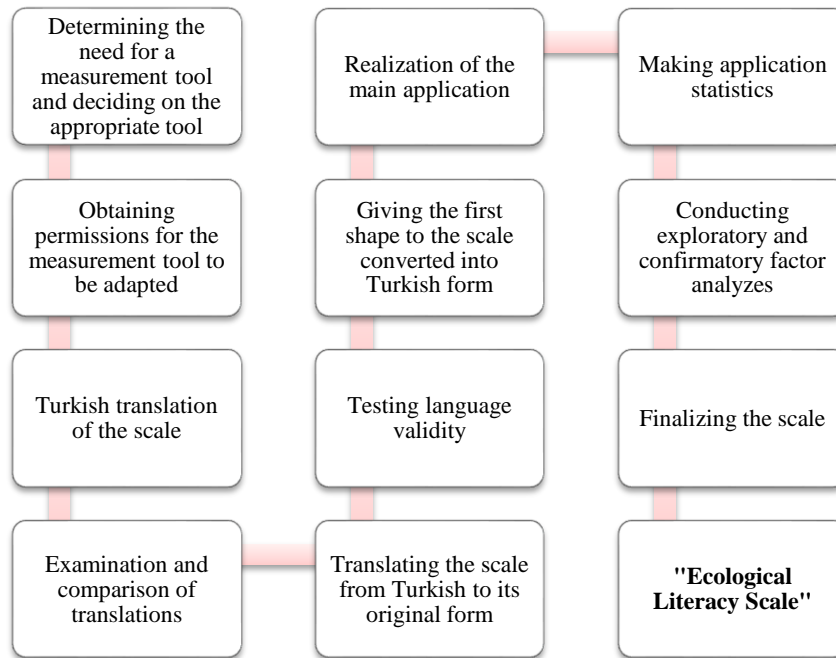

Figure 1. Adaptation Process and Planning Stages of the Ecology Literacy Measurement Tool.

When examining Figure 1, the stages of the adaptation and planning process for the ecological literacy measurement tool can be observed. In the first stage, an extensive literature review was

conducted, and due to the absence of a measurement tool with appropriate psychometric properties, the need for an ecological literacy scale was identified. Following the literature review, it was decided to adapt an ecological literacy scale with suitable content and characteristics.

The scale considered for adaptation was approved by the original authors, and permission for adaptation was obtained via email. The original form of the scale was translated into Turkish by six language and translation experts, independently of each other. The translated forms were brought together, and a review and comparison process of the translations was conducted. The translation forms were checked for semantic, theoretical, and cultural appropriateness. They were also reviewed for linguistic suitability and clarity in Turkish. Adjustments were made to improve comprehensibility in some of the scale items. For example, the sentence "*I am very disgusted by the destruction of the ecological environment.*" was modified to "*I don't like the destruction of the ecological environment.*" Several items given in question form were transformed into plain sentences. For example, the item "*How much do you know about rubbish classification?*" was modified to "*I have knowledge about garbage classification.*" Different rating scales used in a few questions were standardized to the same format with all other items. Some inverted sentence structures in the Turkish version were corrected. Minor changes were made to the scale items. Unnecessary and inappropriate words in the scale items were removed, and words used incorrectly were replaced, necessitating necessary adjustments.

The measurement tool that underwent translation into Turkish was retranslated into the original language by two language experts. Subsequently, a comparison process between the Turkish form and the original form revealed no significant differences. Following the translation processes, it was indicated that the adaptation of the scale to the Turkish version was completed.

To establish linguistic equivalence, the form was administered to 35 middle school students who represent the target audience. Turkish and original language forms were administered to the students at two-week intervals. The correlation values of the data obtained from the applications were examined. Form 1 was evaluated by a total of 8 experts, including a social studies educator, 2 environmental scientists, 2 measurement and evaluation specialists, 2 science educators, and 1 science teacher. A pilot application was conducted with a middle school group consisting of 45 participants, and subsequently, the scale took its final form. After this final version, the main implementation of the scale was carried out.

Following the main application, the data obtained were subjected to exploratory factor analysis. As a result of the exploratory analyses, it was deemed appropriate to remove 10 items. The structure of the remaining 30-item scale was confirmed by confirmatory factor analysis. Given that the adapted scale was originally of the 5-point likert type, the form was prepared in a 5-point likert format. The rating system was structured as follows: "1: strongly disagree," "2: disagree," "3: neutral," "4: agree" and "5: strongly agree." Additionally, a brief and concise instruction explaining the purpose and instructions for the scale was added to the draft form. As a result, the adapted "Ecological Literacy Scale" with established validity and reliability was presented.

Data Collection Tool and Data Collection Process

Within the framework of the study, data was obtained through ecological literacy measurement, which was intended to be adapted. The psychometric properties of the original form of the scale are given in Table 2 (Ha et al., 2021).

Table 2.

Psychometric Properties of the Ecological Literacy Measurement Tool

Sub-Dimensions	Number of Items
Ecological Information	8
Ecological Awareness	8
Ecological Ethics	8
Ecological Feeling	8
Ecological Behavior	8
Total	40
Cronbach Alpha: 0.888	
Rated on a 5-point Likert Type	

Table 2 presents information about the psychometric properties of the ecological literacy measurement tool. The original version of the measurement tool intended for adaptation consists of 5 different sub-dimensions. The dimensions of the scale include environmental science-related knowledge, ecological awareness, ecological ethics, ecological emotions, and ecological behavior. Each sub-factor of the scale contains 8 items, resulting in a total of 40 items. The scale employs a 5-point Likert scale for rating. In the ecological knowledge dimension, the rating scale consists of "Very familiar," "Familiar," "Undecided," "Not Familiar," and "Not Familiar at All." In the ecological behavior dimension, the rating scale comprises "Always," "Frequently," "Sometimes,"

"Rarely," and "Never." For the other dimensions, the rating scale includes "Strongly Disagree," "Disagree," "Undecided," "Agree," and "Strongly Agree."

The internal consistency of the scale, as measured by Cronbach's alpha reliability coefficient, is 0.888. The original form of the Ecological Literacy Scale to be adapted is provided in (Appendix 1). Prior to proceeding with the administration of the form, the necessary explanations and instructions for filling out the form were provided to the students. Data collection was carried out during the second semester of the 2022-2023 academic year. No interventions were made with the students until the data collection process was completed. The process of obtaining data for the study was conducted face-to-face with the participating middle school students in a classroom setting.

Data Analysis

The research data were analyzed using quantitative analysis methods. The data were evaluated through the SPSS and LISREL statistical software programs. Initially, data obtained from student participants were checked, and forms with missing information were separated from the data set. The remaining forms were transferred to the SPSS program, where missing data were identified and the data set was prepared for analysis.

The data obtained from the application of the adapted scale form in its original and Turkish versions at two-week intervals were analyzed through the calculation of Pearson product-moment correlation coefficients at the item level and related paired t-test results. The data obtained from the main application were examined to determine whether they exhibited a normal distribution. Factor analysis was conducted to ensure the construct validity of the scale and to decide on the items that should be included in the scale. Prior to proceeding to the factor analysis stage, the Kaiser-Meyer-Olkin (KMO) and Bartlett tests were conducted to assess the suitability of the data for factor analysis. Subsequently, exploratory factor analysis was performed. In this analysis, items with factor loadings above 0.40 were accepted. Moreover, items with a minimum difference of 0,10 in factor loadings among multiple factors were removed after the rotation process.

As a result of the analysis, it was deemed appropriate to remove a total of 10 items from the scale. After completing the exploratory factor analysis, confirmatory factor analysis was conducted to confirm the factor loadings and sub-dimensions. The data set obtained from the second sample group was transferred to the LISREL program to perform the confirmatory factor analysis. In this analysis, factor loadings and fit indices of the scale items were confirmed, and the reliability of the entire scale and its sub-dimensions was assessed by calculating the Cronbach's alpha internal

consistency coefficient. The Cronbach's alpha internal consistency coefficient for reliability was calculated in a different sample (n=120). An independent t-test analysis was conducted to identify differences between item scores. Mean, standard deviation, and item-total correlation values for the items were determined. Furthermore, correlation values between the factors were calculated to determine the relationships between the factors (Acar Güvendir & Özerk Özkan, 2022; Büyüköztürk, 2019; Seçer, 2017; Şeker & Gençdoğan, 2014; Tabachnick & Fidell, 2019).

Ethical Process of Research

Regarding the ethical process of the research, participants were informed that the research would be used for scientific purposes, and that the confidentiality of their data would be maintained. Informed consent forms were obtained from the middle school students who voluntarily participated in the study. The purpose of the study, the reason for its conduct, and the intended use of the responses were clearly explained to the students. Additionally, student names and surnames were kept confidential and a coding method was employed. Within the framework of the conducted research, the necessary legal permissions were obtained from the university's academic ethics committee and the Ministry of National Education.

Results

Validity and reliability analyses of the adaptation of the Ecological Literacy Scale to Turkish have been presented in the results section. In order to determine the linguistic equivalence of the Turkish version of the Ecological Literacy Scale, a test-retest method was used, and it was administered to 35 participants. Following the administration, the Pearson product-moment correlation coefficients and related paired t-test results were calculated for both the original and Turkish forms, as presented in Table 3.

Table 3.

Related Group T-Test Results of Linguistic Equivalence

		Original Form	Turkish Form
Original Form	Pearson Correlation (r)	1	.906**
	P (Significance)		.000
	N	35	35
Turkish Form	Pearson Correlation (r)	.906**	1
	P (Significance)	.000	
	N	35	35

When examining Table 3, Pearson product-moment correlation coefficients and related paired t-test results for items from the original and Turkish forms of the Ecological Literacy Scale, pertaining to linguistic equivalence, are observed. Upon reviewing the correlation results for linguistic equivalence examination, it is evident that there is a high level of relationship between the original form and the Turkish form of the scale (r=0.906; p<0.01).

In order to ensure the normality distribution assumption of the data set before starting the factor analysis process of the adaptation phase, the normality distribution test results of the data set of the scale are given in Table 4.

Table 4.

Normality Test Results

	Kolmogorov-Smirnov			**Shapiro-Wilk**		
Total	Statistics	Degrees of Freedom (df)	P Significance (sig)	Statistics	Degrees of Freedom(df)	P Significanc (sig)
	.038	315	.200*	.996	315	.660

When examining Table 4, the results of the normality distribution test for the dataset of the adapted Ecological Literacy Scale are observed. Upon inspecting the normality test results for the adapted scale, it was determined that there was no significant difference according to the normality tests, and the data exhibited a normal distribution (p>0.05). Furthermore, the skewness and kurtosis values for the dataset are within the range of -1.96 to +1.96 (skewness: -0.053; kurtosis: -0.154), while the mode, median, and mean values are close to each other (3.70; 3.73), as reported by Can (2022). The results of the Kaiser-Meyer-Olkin (KMO) and Bartlett tests, presented in Table 5, demonstrate that the sample size is sufficient and that the data is suitable for factor analysis prior to conducting the exploratory factor analysis.

Table 5.

KMO and Bartlett Test Results

KMO		**0.816**
Barlett	Chi-square Value	2717.179
Test	Degrees of Freedom	435
Results	Significance	.000

When examining Table 5, the results of the Kaiser-Meyer-Olkin (KMO) and Bartlett tests for the dataset of the adapted Ecological Literacy Scale are presented. Upon reviewing the KMO and Bartlett's test results, the Kaiser-Meyer-Olkin value for the scale was found to be 0.816. The Bartlett test yielded a chi-square value of 2717.179 with 435 degrees of freedom (p<0.01).

Following the rotation process conducted during the exploratory factor analysis, the explained variance ratios based on eigenvalue statistics obtained from the rotated component matrix are presented in Table 6.

Table 6.

Eigenvalues of the Scale

Factors	Total	Explained Variance	Cumulative (%)
1	3.418	11.395	11.395
2	2.942	9.806	21.200
3	2.703	9.010	30.210
4	2.649	8.830	39.041
5	2.311	7.703	46.744

When examining Table 6, the explained variance ratios based on eigenvalue statistics obtained from the rotated component matrix of the adapted Ecological Literacy Scale are observed. It is understood that the items in the measurement instrument are grouped under 5 sub-factors and each factor explains a total of 46.744% of the variance.

As a result of the exploratory factor analysis, the factor distributions of each item remaining in the scale and the values related to the loadings of the items in the factors are given in Table 7.

Table 7.

Factor Load Values of Scale Items and Factors

Item No.	Factor-1	Factor-2	Factor-3	Factor-4	Factor-5
I1	0.768				
I2	0.707				
I3	0.685				
I4	0.648				
I5	0.639				
I6	0.601				
I7	0.480				

I8	0.693			
I9	0.639			
I10	0.613			
I11	0.562			
I12	0.557			
I13	0.513			
I14	0.454			
I15		0.687		
I16		0.659		
I17		0.627		
I18		0.586		
I19		0.554		
I20		0.538		
I21			0.611	
I22			0.606	
I23			0.569	
I24			0.518	
I25			0.494	
I26				0.704
I27				0.591
I28				0.580
I29				0.526
I30				0.480

When examining Table 7, values related to the factor distributions of each remaining item in the adapted Ecological Literacy Scale and the factor loadings of items within the factors obtained from the rotated component matrix of the factor analysis are observed. The factor loadings for the scale range from 0.454 to 0.768. The factor loadings for the first factor of the scale range between 0.480 and 0.768, while those for the second factor vary from 0.454 to 0.693. The factor loadings for the third factor of the scale range between 0.538 and 0.687, the fourth factor ranges from 0.494 to 0.611, and the fifth factor has factor loadings between 0.480 and 0.704.

The results related to the common factor variances for the remaining items in the scale following the rotation process conducted during the exploratory factor analysis are presented in Table 8.

Table 8.

Common Factor Variance Values of Scale Items after Rotation

Item No	Starting Values	Factor Variance	Item No	Starting Values	Factor Variance
I1	1.000	0.635	**I16**	1.000	0.576
I2	1.000	0.551	**I17**	1.000	0.431
I3	1.000	0.539	**I18**	1.000	0.410
I4	1.000	0.463	**I19**	1.000	0.477
I5	1.000	0.513	**I20**	1.000	0.362
I6	1.000	0.452	**I21**	1.000	0.527
I7	1.000	0.501	**I22**	1.000	0.466
I8	1.000	0.555	**I23**	1.000	0.412
I9	1.000	0.509	**I24**	1.000	0.385
I10	1.000	0.498	**I25**	1.000	0.408
I11	1.000	0.426	**M26**	1.000	0.581
I12	1.000	0.467	**M27**	1.000	0.414
I13	1.000	0.389	**M28**	1.000	0.367
I14	1.000	0.342	**M39**	1.000	0.387
I15	1.000	0.543	**M30**	1.000	0.436

When examining Table 8, values related to the common factor variances for the remaining items in the adapted scale following the rotation process conducted during the exploratory factor analysis are observed. Upon reviewing the values, it is understood that the common factor variance values for the items fall within the range of 0.342 to 0.635. It has been determined that all common factor variance values are above 0.30.

The line graph of the factors obtained after the exploratory factor analysis is shown in Figure 2.
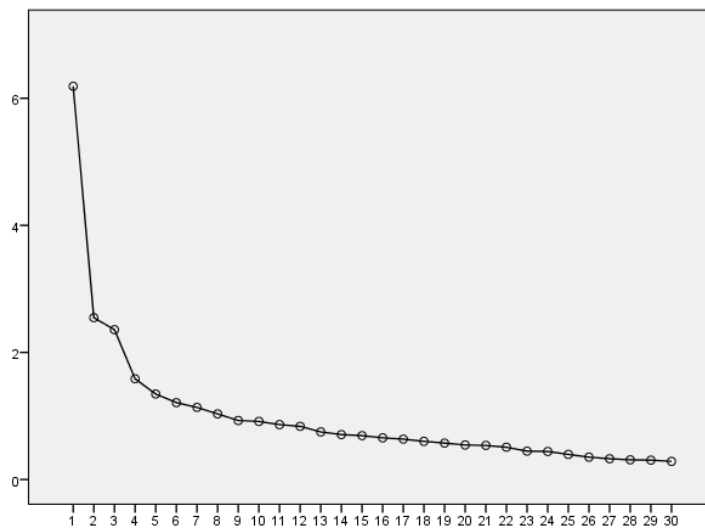

Figure 2. Line graph of exploratory factor analysis result.

When examining Figure 2, it is evident that there is a distinct breaking point in the eigenvalue scree plot of the adapted scale, and from this point onwards, the curve becomes horizontal. This indicates that the scale conforms to a 5-factor structure. To confirm the scale that was validated through exploratory factor analysis, confirmatory factor analyses were conducted, and the obtained t-values are presented in Figure 3.
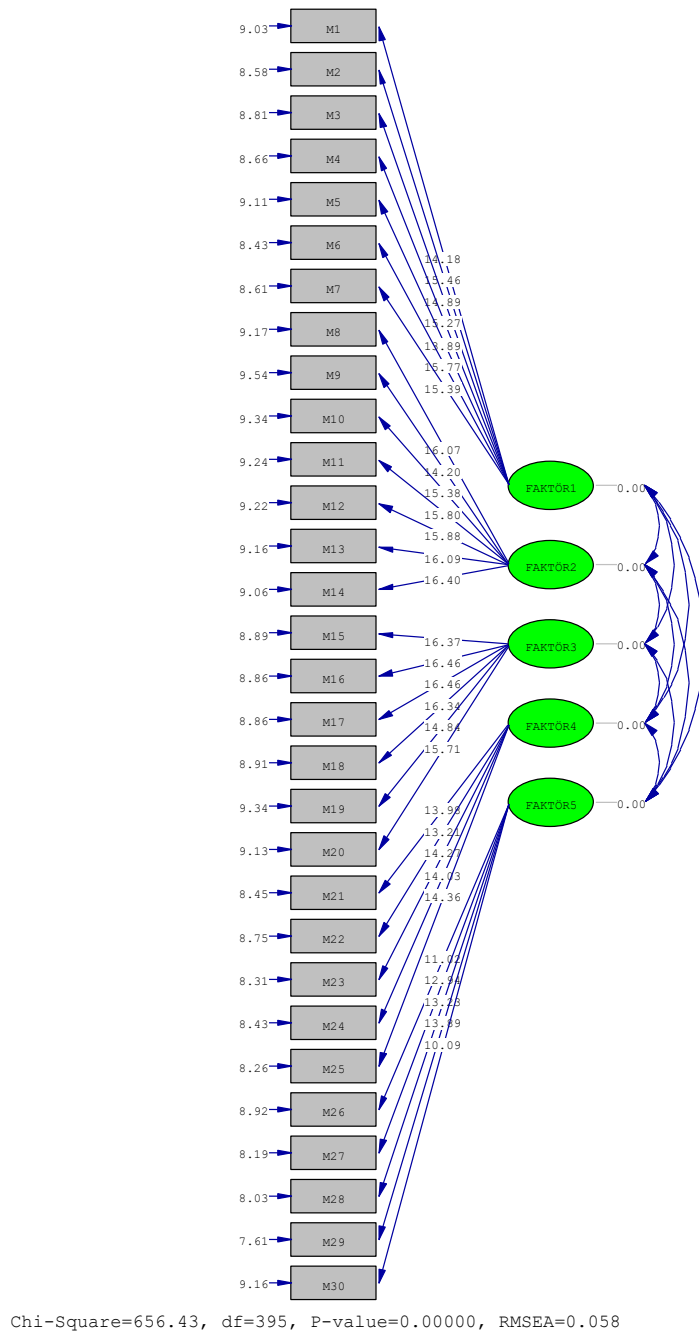

Chi-Square=656.43, df=395, P-value=0.00000, RMSEA=0.058

Figure 3. Confirmatory Factor Analysis t-Values Roadmap.

In Figure 3, t-values for the confirmatory factor analysis conducted to confirm the 5-factor structure as established by exploratory factor analysis are displayed. There are no red arrow indicators on the figure. It is observed that the t-values for the entire scale range between 10.05 and 16.46. The t-values for the first factor range from 13.89 to 15.77, the second factor's t-values range from 14.20 to 16.40, the third factor's t-values range from 14.84 to 16.46, the fourth factor's t-values range from 13.21 to 14.36, and the t-values for the fifth factor range from 10.09 to 13.89.

The loading values of the items obtained as a result of the confirmatory factor analyzes are shown in Figure 4.
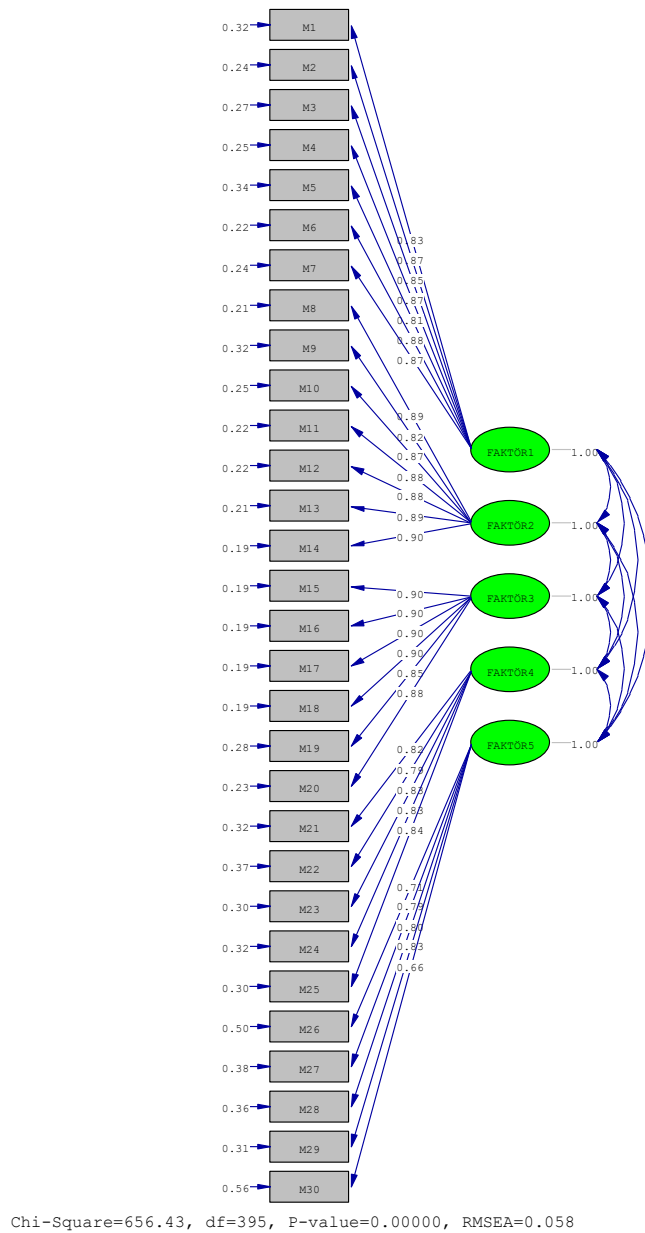

Chi-Square=656.43, df=395, P-value=0.00000, RMSEA=0.058

Figure 4. Confirmatory Factor Analysis Item Loading Road Map.

When examining Figure 4, the factor loading values for the scale items obtained from the confirmatory factor analysis are displayed. The item loading values for the items in the scale range from 0.66 to 0.90. The item loading values for the first factor range from 0.81 to 0.87, for the second factor they range from 0.82 to 0.90, for the third factor they range from 0.85 to 0.90, for the fourth factor they range from 0.80 to 0.84, and for the fifth factor, they range from 0.66 to 0.83.

After the analysis, the goodness-of-fit indices for the CFA model (Seçer, 2018) were examined, and the results are presented in Table 9.

Table 9.

Goodness-of-Fit Indices for the DFA Model Obtained from the Scale

Fit Index	Result	Comment
χ^2 /df	1.66	Perfect Fit
NNFI	0.95	Perfect Fit
IFI	0.96	Perfect Fit
CFI	0.96	Perfect Fit
GFI	0.82 (0.85)	Acceptable Fit
NFI	0.90	Acceptable Fit
AGFI	0.80	Acceptable Fit
PNFI	0.82	Acceptable Fit
PGFI	0.70	Acceptable Fit
SRMR	0.037	Perfect Fit
RMSEA	0.058 (0.050)	Perfect Fit
RMR	0.084	Acceptable Fit
RFI	0.90	Acceptable Fit

When examining Table 9, the goodness-of-fit indices obtained from the confirmatory factor analysis of the adapted scale are observed. The fit indices indicate that the scale items exhibit excellent or acceptable fit. Values for χ^2/df, NNFI, IFI, CFI, AGFI, PNFI, PGFI, RFI, SRMR, RMSEA, and RMR point to good and excellent fit, confirming that the model fit of the scale structure has been achieved.

Cronbach's alpha internal consistency coefficients were calculated to assess the reliability of the adapted scale as a whole and for the scale factors, and the obtained values are presented in Table 10.

Table 10.

Reliability Coefficients for Factors and the Entire Scale

Factor Name	Number of Items	Cronbach Alpha
Ecological Information	7	0.762
Ecological Awareness	7	0.781
Ecological Ethics	6	0.786
Ecological Feeling	5	0.730
Ecological Behavior	5	0.733
Total	**30**	**0.834**

When examining Table 10, the reliability coefficient values calculated for the adapted scale and for each factor of the scale are observed. It is understood that the Cronbach's alpha reliability coefficient for the entire scale is 0.834. The reliability coefficient for the first sub-factor, which is the ecological knowledge dimension, is 0.762, for the second sub-factor, the ecological awareness dimension, it is 0.781, for the third sub-factor, the ecological ethics dimension, it is 0.786, for the fourth sub-factor, the ecological emotion dimension, it is 0.730, and for the fifth sub-factor, the ecological behavior dimension, it is 0.733.

In order to examine the measurement status of the items in the adapted scale for the intended construct, item-total correlation values were calculated for each item. Furthermore, the values of t-tests indicating the differences between item scores in the parent and subgroups of the scale exceeding 27% were determined. The results of item analysis, including item means, standard deviations, item-total correlations, and t-values for the items, are presented in Table 11.

Table 11.

Item Analysis Results of the Scale

Item	Group	Mean	Standard Deviation	Item Total Correlation	t- Value	Significance (p)
I1	Parent	3.6512	1.41228	0.326	11.645	.000
	Sub	1.7093	.62996			
I2	Parent	3.9651	1.13187	0.369	8.964	.000
	Sub	2.4884	1.02606			
I3	Parent	3.6395	1.41349	0.389	10.178	.000
	Sub	1.8256	.85669			
I4	Parent	3.9767	1.20759	0.433	8.489	.000

	Sub	2.3140	1.35700			
I5	Parent	4.4419	.91529	0.536	8.695	.000
	Sub	2.8140	1.47538			
I6	Parent	4.4471	.91944	0.464	8.675	.000
	Sub	2.8140	1.47538			
I7	Parent	4.1977	.99196	0.408	9.253	.000
	Sub	2.7558	1.05089			
I8	Parent	4.4070	.75736	0.493	6.760	.000
	Sub	3.5116	.96704			
I9	Parent	4.5698	.72826	0.427	7.182	.000
	Sub	3.5465	1.10248			
I10	Parent	4.3837	.78469	0.456	7.827	.000
	Sub	3.2093	1.14908			
I11	Parent	4.5465	.73014	0.411	7.293	.000
	Sub	3.4651	1.16516			
I12	Parent	4.5698	.72826	0.412	7.613	.000
	Sub	3.3837	1,24776			
I13	Parent	4.1279	1.06048	0.336	9.009	.000
	Sub	2.5698	1.20334			
I14	Parent	4.1860	.98830	0.464	7.167	.000
	Sub	2.8953	1.34627			
I15	Parent	4.0581	1.08849	0.376	9.659	.000
	Sub	2.5000	1.02613			
I16	Parent	4.2209	.96285	0.358	9.527	.000
	Sub	2.7674	1.03667			
I17	Parent	4.0000	1.11672	0.316	9.633	.000
	Sub	2.3256	1.16257			
I18	Parent	4.3721	1.08516	0.313	8.792	.000
	Sub	2.5698	1.56085			
I19	Parent	3.7791	1.35821	0.326	7.976	.000
	Sub	2.2442	1.15744			
I20	Parent	4.4535	.91596	0.319	8.076	.000
	Sub	3.0233	1.36319			
I21	Parent	4.6512	.62811	0.430	8.911	.000
	Sub	3.3605	1.18731			

I22	Parent	4.3721	.79774	0.397	7.105	.000
	Sub	3.2558	1.21932			
I23	Parent	4.7907	.53394	0.326	7.244	.000
	Sub	3.8605	1.06454			
I24	Parent	4.4302	.72826	0.367	8.026	.000
	Sub	3.2791	1.11304			
I25	Parent	4.5698	.72826		7.805	.000
	Sub	3.3372	1.27058	0.320		
I26	Parent	4.4535	.91596	0.353	7.841	.000
	Sub	3.1279	1.27230			
I27	Parent	4.0233	1.04010		8.164	.000
	Sub	2.8605	.81404	0.325		
I28	Parent	4.1047	1.07407	0.320	9.193	.000
	Sub	2.6047	1.06582			
I29	Parent	4.2326	.95393		8.074	.000
	Sub	2.7674	1.38627	0.458		
I30	Parent	3.3256	1.18264		10.738	.000
	Sub	1.6163	.88342	0.337		

When examining Table 11, item-total correlation values for each item in the scale, t-values indicating the differences between item scores in the parent and subgroups exceeding 27%, item means, and standard deviation values for the items are observed. The item-total correlation values for the items in the scale are above 0.30, ranging between 0.305 and 0.533. Additionally, it is worth noting that there is a significant difference between the means of parent and subgroups for each item in the scale (p: 0.000 < 0.05).

Following the factor analysis and exploratory analyses conducted for the intended adaptation of the measurement instrument, information about the items removed from the original form of the scale and the remaining items is presented in Table 13.

Table 13.

Items Included After Analysis from the Original Form of the Measurement Tool

Factor	Items Removed from the Original Scale	Items Remaining on the Scale
Ecological Information	1 Item	7 Items
Ecological Awareness	1 Item	7 Items
Ecological Ethics	2 Items	6 Items
Ecological Feeling	3 Items	5 Items
Ecological Behavior	3 Items	5 Items
Total	**10 Items**	**30 Items**

When examining Table 13, information about the items removed from the original form of the scale and the remaining items after the analyses conducted for the adapted measurement instrument is presented. A total of 10 items have been removed from the original form of the scale. One item was removed from the first factor, one from the second factor, two from the third factor, and three each from the fourth and fifth factors. In summary, the Ecological Literacy Scale, comprising 30 items with a 5-factor structure, has been obtained. The final version of the adapted scale in Turkish is provided (Appendix 2).

The Pearson correlation coefficient values representing the relationship between the factors in the scale are presented in Table 14.

Table 14.

Correlation Values Between Sub-Factors in the Measurement Tool

		Factor-1	Factor-2	Factor-3	Factor-4	Factor-5
Factor-1	r	1	.388**	.209**	.247**	.343**
	p		.000	.000	.000	.000
Factor-2	r	.388**	1	.285**	.538**	.361**
	p	.000		.000	.000	.000
Factor-3	r	.209**	.285**	1	.267**	.365**
	p	.000	.000		.000	.000
Factor-4	r	.247**	.538**	.267**	1	.305**
	p	.000	.000	.000		.000
Factor-5	r	.343**	.361**	.365**	.305**	1
	p	.000	.000	.000	.000	
**P<0.01, R= Pearson Correlation Coefficient						

When examining Table 14, Pearson correlation coefficient values representing the relationship between the sub-factors in the scale are observed. A positive and significant relationship is observed between the first factor and the second factor ($r=0.388$; $p<0.01$), between the first factor and the third factor ($r=0.209$; $p<0.01$), between the first factor and the fourth factor ($r=0.247$; $p<0.01$), and between the first factor and the fifth factor ($r=0.343$; $p<0.01$). Additionally, a positive and significant relationship is observed between the second factor and the fourth factor ($r=0.538$; $p<0.01$), between the second factor and the third factor ($r=0.285$; $p<0.01$), and between the second factor and the fifth factor ($r=0.361$; $p<0.01$). There is also a positive and significant relationship between the third factor and the fourth factor ($r=0.267$; $p<0.01$) and between the third factor and the fifth factor ($r=0.365$; $p<0.01$).

Discussion and Conclusion

The research aimed to adapt the Ecological Literacy Scale developed by Ha, Huang, Zhang & Dong (2021) into Turkish and conduct validity and reliability analyses. The goal was to create a valid and reliable measurement tool for middle school students. Ensuring the cultural appropriateness and comprehensibility of the adapted scale enhances the validity and reliability results of the measurement tool and prevents the acquisition of erroneous data (Johnson & Christensen, 2014). Thus, the adaptation process of the measurement tool, including item translations, scale administration, factor analyses, and finalizing the scale, was carried out with great care.

Following the language validation analyses of the measurement tool's original and Turkish forms, it was determined that language equivalence was established (Seçer, 2018; Şeker & Gençdoğan, 2014). The scale items with established language validity were presented to expert opinions. According to the Lawshe (1975) technique, expert opinions were evaluated, and it was decided to conduct a pilot application without removing any items from the scale to meet the minimum content validity ratio, which is 0.750 for 8 experts (KGO). In the pilot application phase, the most suitable sampling method was generally purposive sampling due to matching the characteristics of the target audience (Erkuş, 2012). Therefore, 20 students who met the qualifications of the target group were selected for the pilot application. In the main implementation phase, the study was conducted with 315 students, with an average of 7-8 participants per item (315/40). In scale studies, it is recommended to work with approximately 3 to 5 times the number of items in the scale (Bryman & Cramer, 2001; Seçer, 2018; Sönmez & Alacapınar, 2016). It can be inferred that the sample size is appropriate in this regard. In many studies examining scale studies,

the sample group generally consists of 300 or more participants (Akbaş et al., 2019; Akçay et al., 2018; Gül & Sözbilir, 2015; Şahin & Boztunç Öztürk, 2018). However, the relatively higher number of participants per item, around 5-9, supports our study (Akbaş et al., 2019). Tabachnick & Fidell (2019) suggest that having at least 300 participants may be beneficial for conducting factor analysis.

In the process of extracting a factor from items that come together because they measure similar attributes through exploratory factor analysis, items with a relationship to one factor but low loadings on other factors are attempted to be grouped together (Can, 2022). Similarly, Şeker & Gençdoğan (2014) suggest that during exploratory factor analysis, items in a measurement tool are expected to be grouped into specific sub-dimensions. The varimax rotation, one of the most common orthogonal rotation methods, is typically used during the rotation process in exploratory factor analysis. The varimax rotation attempts to minimize the number of variables with high loadings on each factor (Pallant, 2020). Therefore, it was considered appropriate to use varimax rotation in the exploratory factor analysis in this study. The KMO value of the study's dataset was obtained as 0.816. A KMO value of 0.60 or higher is expected, along with a significant result in the Barlett test, to confirm the suitability of the data for exploratory factor analysis (Büyüköztürk, 2019; Pallant, 2020; Tabachnick & Fidell, 2019). Therefore, it can be said that the study's data is suitable for factor analysis. In the context of the study, the variance explaining the 5-dimensional structure ranging between 40% and 60% indicates that the variance ratios are sufficient (Tavşancıl, 2014). Additionally, since the eigen values for the 5 sub-dimensions are greater than 1, it was considered appropriate to treat them as factors (Howards, 2016). Following the rotation process, all factor loading values in the factors are above 0.40, indicating that all items have relatively good values (Costello & Osborne, 2005; Field, 2013; Howard, 2016; Seçer, 2017).

Confirmatory factor analysis, as a method used to confirm a predetermined model during the adaptation process (Şeker & Gençdoğan, 2014; Yaşlıoğlu, 2017), similarly yielded factor loadings above 0.40. The fit indices for the confirmatory factor analysis were between 0.90 and 0.96, signifying acceptable and excellent fit (DeVellis & Thorpe, 2021; Erkorkmaz et al., 2013; Howard, 2016; Seçer, 2018; Sürücü, Şeşen & Maslakçı, 2021; Şeker & Gençdoğan, 2014; Can, 2022; Tabachnick & Fidell, 2019).

The reliability of measurement instruments is of paramount importance. Reliability of a scale is associated with its internal consistency, indicating how well the items comprising the scale are in

agreement and measure the same construct. Cronbach's alpha coefficient is widely used in studies for assessing reliability (Pallant, 2020). A calculated coefficient should ideally be at least 0.70 (DeVellis & Thorpe, 2021; Karakoç & Dönmez, 2014). As Can (2022) similarly states, a reliability coefficient between 0.90 and 1 in measurements indicates a very high level of reliability. In this study, the internal consistency coefficient of the adapted scale was calculated as 0.834. Therefore, it is demonstrated that the value of the adapted scale is highly reliable. Akçay et al. (2018) indicated in their synthesis studies that internal consistency coefficients are commonly calculated in adaptation studies, especially with Likert-type scales. Consistent with other scale studies, it was reported in this study that Cronbach's α coefficient is used for assessing reliability (Acar Güvendir & Özer Özkan, 2015; Delice & Ergene, 2015; Gül & Sözbilir, 2015; Şahin & Boztunç Öztürk, 2018). The item analysis, including the item-total correlation coefficients of the scale's items and the independent sample t-test values between sub and parent groups, is of considerable importance. In this context, it is important that the item-total correlation coefficient values obtained in this study are above 0.30, suggesting that the items are appropriate to be retained in the scale (Büyüköztürk, 2019). Furthermore, a measurement instrument should be compared using the independent sample t-test to distinguish between individuals who exhibit the behavior to be measured and those who do not. This process can indicate that there is a significant difference in mean scores, implying that the measurement instrument distinguishes students who exhibit the intended target behavior from those who do not (Can, 2022). The significant differences found between the means of sub and parent groups for each item in this study ($p < 0.05$) underscore the discriminatory power of the items.

Recommendations

The ecology literacy scale adapted into Turkish has been tested for its appropriateness for middle school students, validity, and reliability. This scale can be used in various studies involving middle school students. By determining individuals' levels of ecological literacy, appropriate educational plans and strategies can be developed to enhance their ecological literacy skills. Furthermore, the impact of ecological literacy scores on different variables can be examined. For qualitative studies, interviews with participants can provide insights into factors that support ecological literacy scores. Comparisons can also be made between ecological literacy scores of middle school students at different levels. The adapted scale into Turkish is expected to serve as an alternative measurement tool for researchers and educators working in the fields of the environment and ecology.

About Authors

First Author: Kevser Arslan completed her PhD in science education at Yıldız Technical University. Her studies are in the fields of Environment, Science Education and Disaster.

Second Author: Aslı Görgülü Arı is a lecturer at Yıldız Technical University. She works in the Department of Mathematics and Science Education at the Faculty of Education. She completed her PhD at Eskişehir Osmangazi University. Fields of study are Science Education, Biology Education, Environmental Education, Life Sciences, Biochemistry, Biotechnology, Environmental Biology.

Conflict of Interest

It has been reported by the authors that there is no conflict of interest.

Funding

Ethical Standards

Indicate if there is ethics committee approval. Otherwise, by stating that you have carried out the research within the Ethics committee approval was obtained for the study.

ORCID

Respectively write the ORCIDs of the authors, as in the example below.

Kevser Arslan https://orcid.org/0000-0003-0658-7175

Aslı Görügülü Arı http://orcid.org/0000-0002-6034-3684

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