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Original article

Climate Change Literacy Assessment Instrument for Fourth-Grade Primary School Students: A Validity and Reliability Study

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Abstract

Climate change literacy is an important area of competence that enables individuals to understand climate change and develop their knowledge, emotions, and behaviors related to this issue. This study aimed to develop a valid and reliable assessment instrument for evaluating different components of climate change literacy among fourth-grade primary school students. For this purpose, the Climate Change Literacy Assessment Instrument for Fourth-Grade Primary School Students was developed. The instrument has four sections: Willingness to Take Action Against Climate Change, Emotions Toward Climate Change, Behaviors to Address Climate Change, and the Climate Change Knowledge Test. The study included fourth-grade students in schools in the Eyüpsultan district of Istanbul during the 2024–2025 academic year. A total of 151 students participated in the pilot study, and 552 students participated in the main study. To examine validity evidence, exploratory and confirmatory factor analyses were conducted for the first three Likert-type sections, while item analyses were performed for the Knowledge Test. To assess reliability, we calculated Cronbach's alpha and McDonald's omega coefficients for the first three sections and the KR-20 internal consistency coefficient for the Knowledge Test. The analyses indicated that the first section consisted of eight items with a two-factor structure, the second section consisted of 10 items with a single-factor structure, and the third section consisted of 14 items with a single-factor structure. The Knowledge Test consisted of 20 items. The findings provided evidence supporting the construct validity, item discrimination, and internal consistency of the instrument's sections. In conclusion, the developed assessment instrument can be used to separately evaluate fourth-grade primary school students' knowledge, emotions, willingness to take action, and behaviors related to climate change literacy.

Keywords: Climate Change Literacy, Climate Change Education, Sustainable Development, Scale Development, Environmental Literacy

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INTRODUCTION

Sustainable development is defined as an approach based on meeting present needs without compromising the ability of future generations to meet their own needs (WCED, 1987). Climate change is a global challenge closely linked to the environmental, social, and economic dimensions of sustainable development because it affects natural and human systems (IPCC, 2023). The United Nations Sustainable Development Goals address climate action as a distinct goal, with particular emphasis on strengthening education, awareness, and societal capacity (United Nations, 2015). Accordingly, how children understand climate change and their orientations toward this challenge are important considerations in climate change education.

Addressing climate change education from childhood onward supports students' understanding of climate change in developmentally appropriate ways (Nepraš et al., 2022). In their systematic review of climate change education research at the primary and lower secondary levels, Nepraš, Strejčková, and Kroufek (2022) found that studies focused not only on knowledge acquisition but also on domains such as behavior, action, attitudes, anxiety, hope, motivation, and willingness to act. Indeed, recent research involving children aged 10–11 indicates that they encounter climate change through school, the media, family life, and public discussions, while their conceptual understanding, emotional responses, and action-related orientations continue to develop (Vermund et al., 2026).

Climate change literacy is particularly relevant when assessing how children understand climate change and how they orient themselves toward this issue. Climate change literacy is associated not only with knowledge and understanding of the causes and consequences of climate change, its mitigation, and adaptation to changing climatic conditions, but also with characteristics such as attitudes, motivation, behavior, and skills (Vermund et al., 2026). From this perspective, climate change literacy is conceptualised as a multidimensional construct that encompasses more than knowledge alone, including individuals' orientations toward the issue and their action-related characteristics.

Because the components of climate change literacy are interrelated, it is especially important to distinguish knowledge from action-related characteristics. Although knowledge about climate change is a fundamental component of climate change literacy, knowledge alone does not necessarily predict whether an individual will engage in behaviors intended to address climate change (Lubej et al., 2025; Skamp et al., 2013). Skamp, Boyes, and Stanisstreet (2013) found differences between students' beliefs about the effectiveness of specific actions to reduce global warming and their willingness to take those actions. Similarly, Christensen and Knezek (2015) distinguished climate change beliefs from behavioral intentions to bring about positive environmental change, treating behavioral intentions as antecedents of action rather than as actions themselves. These findings support assessing separately what children know about climate change, what they wish to do to address it, and what behaviors they actually perform.

For children, learning about and making sense of climate change can involve emotional as well as cognitive responses (Ojala, 2012b). In a study of 12-year-old children, Ojala (2012a) found that different coping approaches to climate change were associated with environmental engagement and psychological well-being in different ways. Likewise, in a climate change education study involving children aged 10–12, Trott (2022) found that negative emotional responses, including fear, worry, anger, and sadness, formed part of children's experiences of climate change and noted that assessments focused solely on knowledge acquisition may overlook the affective effects of education. These findings support assessing emotional responses to climate change separately alongside knowledge and action-related characteristics when evaluating children's climate change literacy.

The measurement literature has previously used approaches that assess children's different environmental characteristics as separate components. The Children's Environmental Attitude and Knowledge Scale (CHEAKS), developed by Leeming, Dwyer, and Bracken (1995), assesses environmental knowledge separately from attitudes; within its attitude component, children's willingness to protect the environment (verbal commitment), behaviors (actual commitment), and emotional responses (affect) are treated as distinct subdimensions. This CHEAKS structure shows how instruments for children can distinguish knowledge, willingness to act, behavior, and emotional responses.

Researchers have developed instruments targeting different age groups and constructs to assess climate change-related characteristics. Studies involving middle and high school students have assessed such characteristics as climate change awareness, beliefs, and intentions to act (Christensen & Knezek, 2015; Gönen et al., 2023; Albayrak et al., 2025; Satmaz et al., 2025). Researchers have also conducted measurement studies with primary-school-aged children. In an instrument developed to assess climate change competence among children aged 10–12, Ortega-Quevedo et al. (2024) identified three main dimensions: knowledge, skills, and attitudes. The knowledge dimension covers basic climate change processes, causes, consequences, and mitigation; the skills dimension addresses behaviors related to consumption, transport, and energy conservation; and the attitudes dimension encompasses worry, hope, and interest. Vermund et al. (2026), meanwhile, developed the Climate Change Literacy Questionnaire (CCLQ) for children aged 10–11 to assess perceived knowledge about climate change, behaviors, motivation to learn and act, and orientations toward its social and collective dimensions.

These studies show that researchers have examined children's climate change-related characteristics using different conceptual frameworks and measurement approaches. Some instruments assess knowledge through objective questions, while others assess it through children's self-reported knowledge; emotional and action-related characteristics are also conceptualised differently. In the present study, we adopted a measurement approach that assesses fourth-grade primary school students' objective knowledge of climate change, emotional responses, willingness to take action against climate change, and behaviors in separate sections.

Accordingly, this study aimed to develop an assessment instrument to evaluate climate change literacy among fourth-grade primary school students and to examine evidence of the instrument's validity and reliability.

METHOD

This study developed the Climate Change Literacy Assessment Instrument for Fourth-Grade Primary School Students and examined evidence of its validity and reliability. During the development of the four-section instrument, we conducted two administrations (a pilot study and a main study) and performed validity and reliability analyses separately for each section. The study obtained ethics committee approval and research and implementation permissions from the Ministry of National Education.

Participants

The study group was selected through convenience sampling, based on schools accessible to the researcher. The pilot study included 151 fourth-grade students (84 boys and 67 girls; mean age = 9.29 years) from different primary schools in Istanbul's Eyüpsultan district during the 2024–2025 academic year. The main study included 552 fourth-grade students (277 boys and 275 girls; mean age = 9.77 years) attending different primary schools in the same district. Both administrations were conducted face-to-face at the students' schools.

Development of the Climate Change Literacy Assessment Instrument for Fourth-Grade Primary School Students

The instrument development process began with a literature review of assessment instruments on climate change literacy, climate change education, and environmental education for children. Based on the literature review and the study's conceptual framework, the instrument was designed to assess students' willingness to take action against climate change, emotions toward climate change, behaviors to address climate change, and knowledge about climate change, each in a separate section. The first three sections consisted of Likert-type items, whereas the knowledge section consisted of true–false items.

We developed a separate item pool for each section. When drafting the items, we ensured coverage of the causes and effects of climate change, climate change mitigation, and adaptation to changing climatic conditions. We prepared an expert evaluation form to assess the content coverage and age appropriateness of the draft instrument developed from these item pools. Eight experts reviewed the draft: three in science education, two in primary education, two in curriculum and instruction, and one in measurement and evaluation. Experts were asked to rate each item as “Appropriate,” “Inappropriate,” or “Needs Revision” and to provide comments in the “Suggestions/Explanations” section where necessary. Based on their feedback, we reviewed the items for content, wording, and suitability for students' age level and made necessary revisions.

Following expert review, the draft instrument consisted of 23 items in Section 1 (Willingness to Take Action Against Climate Change), 30 items in Section 2 (Emotions Toward Climate Change), 28 items in Section 3 (Behaviors to Address Climate Change), and 38 items in Section 4 (Climate Change Knowledge Test). The first and third sections used four response categories: "Never," "Sometimes," "Most of the Time," and "Always." The second section used "Not at All Applicable," "Slightly Applicable," "Applicable," and "Highly Applicable." Items in the Climate Change Knowledge Test offered "True," "False," and "I Don't Know" response options. For example, the statement "Vehicle exhaust emissions contribute to climate change" is a true item, whereas "Saving energy is not an effective way to address climate change" is a false item. The "I Don't Know" option was included to reduce guessing on items students did not know. For the first three Likert-type sections, responses were scored from 1 to 4, with higher scores indicating higher levels of the characteristic assessed by each section. The Climate Change Knowledge Test was scored by assigning 1 point to each correct response and 0 points to incorrect and "I Don't Know" responses. The team also reviewed the draft form with primary school students to assess item comprehensibility and age appropriateness; they identified and revised expressions that were difficult to understand as needed.

Data Collection

We conducted the administrations face-to-face at the schools attended by the students. Because of the draft form's length, the pilot administration was conducted in two consecutive sessions to reduce response-related fatigue. After finalising the instrument following the pilot study, the main administration was completed in a single session. Each session lasted approximately 40 minutes.

Data Analysis

We conducted exploratory factor analysis (EFA) on the pilot data to assess construct validity for the first three Likert-type sections of the instrument. We evaluated the data's suitability for factor analysis using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity. Direct Oblimin oblique rotation was used based on the assumption that the factors might be correlated. Factors with eigenvalues greater than 1 were considered when determining the factor structure, and items with factor loadings below .30 or identified as loading on more than one factor were removed.

We used item analysis techniques to examine the Climate Change Knowledge Test items and calculated item difficulty and discrimination indices (Özçelik, 2011). For scoring the knowledge test, correct responses were coded as 1, whereas incorrect and "I Don't Know" responses were coded as 0. In addition, lower and upper 27% groups were formed based on the total scores for each section of the instrument. We compared item scores and section total scores between these groups using independent-samples t tests.

To assess reliability, Cronbach's alpha and McDonald's omega internal consistency coefficients were calculated for the first three Likert-type sections. For the Climate Change Knowledge Test, we

used the Kuder–Richardson Formula 20 (KR-20) coefficient to estimate internal consistency based on dichotomously scored items (Şencan, 2005).

Confirmatory factor analysis (CFA) was performed on the main-study data to examine the factor structures of the first three Likert-type sections. Analyses were conducted in AMOS 24 using maximum likelihood estimation. Model fit was evaluated using the chi-square/degrees-of-freedom ratio (χ^2/df), root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), and Tucker–Lewis index (TLI).

Using the main-study data, we repeated item difficulty and discrimination analyses and the KR-20 reliability analysis for the Climate Change Knowledge Test, while we repeated Cronbach's alpha and McDonald's omega internal consistency analyses for the Likert-type sections. Item analyses for the knowledge test were performed using the Test Analysis Program (TAP, version 19.1.4); the other analyses were conducted in SPSS 25, and CFA was conducted in AMOS 24.

RESULTS

EFA was conducted on the pilot data for the first three Likert-type sections of the instrument. Items with factor loadings below .30 or identified as loading on multiple factors were removed. As a result, the number of items decreased from 23 to 8 in the Willingness to Take Action Against Climate Change section, from 30 to 10 in the Emotions Toward Climate Change section, and from 28 to 14 in the Behaviors to Address Climate Change section. Following item analyses for the Climate Change Knowledge Test, we removed items with discrimination indices below .30, reducing the number of items in that section from 38 to 20. After item removal, EFA was repeated for the Likert-type sections, and item difficulty and discrimination analyses were repeated for the knowledge test. The validity and reliability findings from the pilot and main studies are presented below by instrument section.

Section 1: Willingness to Take Action Against Climate Change

Analyses of the pilot data yielded a KMO value of .829, and Bartlett's test of sphericity was statistically significant ($\chi^2 = 303.371$, $p < .001$), indicating that the data were suitable for factor analysis. EFA identified two factors with eigenvalues greater than 1. The first factor had an eigenvalue of 3.274 and the second 1.150; together, they explained 55.303% of the total variance. Table 1 presents the rotated factor loadings, item–scale correlations, and independent-samples t-test results comparing the lower and upper 27% groups.

Table 1. Section 1: Item Factor Loadings, Item–Scale Correlations, and Independent-Samples t-Test Results

Item	Draft item	Factor 1	Factor 2	Item–scale r	t
1	12	.720	.117	.463	9.944*
2	13	.815	.167	.575	10.069*
3	15	.700	.219	.521	10.206*
4	16	.672	.243	.517	10.527*
5	17	.219	.727	.519	9.539*
6	19	.322	.523	.452	8.425*
7	21	.163	.737	.479	7.734*
8	23	.094	.788	.467	8.571*
Eigenvalue		3.274	1.150		
% of variance explained		40.931	14.373		

*p <.05

As shown in Table 1, Section 1 exhibited a two-factor structure, with four items in each factor. Items in the first factor addressed willingness to conduct research, share information, and raise awareness as part of efforts to address climate change, whereas items in the second factor concerned willingness to participate in recycling practices. The factors were therefore named Willingness to Raise Awareness and Willingness to Recycle, respectively. For example, the item "I would like to conduct research on the importance of green spaces and their protection and share my findings with my friends" reflects willingness to raise awareness, whereas "I would like to put used batteries in a recycling bin" reflects willingness to recycle. Item factor loadings ranged from .523 to .815, and item–scale correlations ranged from .452 to .575. An item–total correlation of .30 or higher is regarded as a criterion indicating sufficient discrimination between individuals on the measured characteristic (Büyüköztürk, 2007). Accordingly, we considered the item–scale correlations acceptable. Moreover, the independent-samples t tests comparing item scores between the lower and upper 27% groups showed statistically significant differences for all items (p <.05).

Table 2. Correlations Between the Dimensions of Section 1 and Internal Consistency Reliability Coefficients

Subdimension	Willingness to Raise Awareness	Willingness to Recycle	Cronbach's α	McDonald's ω
Willingness to Raise Awareness			.74	.76
Willingness to Recycle	.52*		.69	.69
Section 1	.88*	.86*	.79	.80

*p <.01

Examination of the relationships between the subdimensions of the Willingness to Take Action Against Climate Change section revealed a statistically significant correlation. The correlation coefficient between the two subdimensions was .52. According to the literature, correlations between dimensions exceeding .60 may indicate a high degree of interdependence and suggest that the dimensions represent the same conceptual construct (Şencan, 2005). Because the correlation obtained in this study was below this threshold, the findings suggest that the subdimensions are related but distinguishable constructs.

Cronbach's alpha and McDonald's omega coefficients were calculated to assess the internal consistency reliability of the subdimensions and the overall section. As shown in Table 2, Cronbach's alpha coefficients were .74 for Willingness to Raise Awareness, .69 for Willingness to Recycle, and .79 for the overall Willingness to Take Action Against Climate Change section. McDonald's omega coefficients were .76 for Willingness to Raise Awareness, .69 for Willingness to Recycle, and .80 for the overall Willingness to Take Action Against Climate Change section.

The two-factor structure of the Willingness to Take Action Against Climate Change section was tested by CFA using data from the second administration. The results yielded a chi-square value of 37.920 (df = 19, p = .006) and a χ^2/df ratio of 1.996. The model fit indices were RMSEA = .043, AGFI = .967, CFI = .978, GFI = .983, and NNFI =.968. According to the literature, a χ^2/df ratio below 3, an RMSEA below .05, and other fit indices above accepted thresholds indicate a high degree of fit between the model and the data (Kline, 2011). These findings support the two-factor structure of Section 1 and indicate adequate model fit.

Figure 1 presents the standardised factor loadings estimated in CFA. Standardized coefficients for the item–factor relationships ranged from .51 to .71, and all freely estimated paths were statistically significant (C.R. = 9.33- 9.78, p <.001).

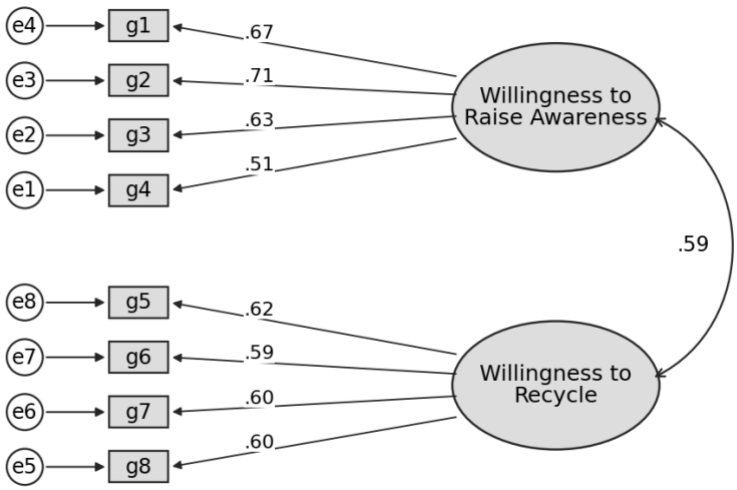

Figure 1. Path Diagram for Section 1

Reliability analyses for the Willingness to Take Action Against Climate Change section were repeated using the main-study data. Cronbach's alpha coefficients were .72 for Willingness to Raise Awareness, .69 for Willingness to Recycle, and .76 for the section as a whole. McDonald's omega coefficients were .72 for Willingness to Raise Awareness, .70 for Willingness to Recycle, and .77 for the section as a whole.

Section 2: Emotions Toward Climate Change

The pilot data in the Emotions Toward Climate Change section were suitable for factor analysis, as indicated by the KMO value (.823) and Bartlett's test of sphericity ($\chi^2 = 372.151$, $p < .001$). EFA showed that the items loaded on a single factor with an eigenvalue of 3.741, explaining 37.409% of the total variance. Table 3 presents the factor loadings, item–total correlations, and item discrimination results.

Table 3. Section 2: Item Factor Loadings, Item-Scale Correlations, and Independent-Samples t-Test Results

Item	Draft item	Factor 1	Item–scale r	t
1	1	.604	.483	8.434*
2	4	.518	.404	6.680*
3	6	.620	.503	9.501*
4	13	.629	.500	9.646*
5	17	.636	.517	10.243*
6	21	.713	.603	9.587*
7	22	.601	.480	9.989*
8	25	.464	.353	5.925*
9	29	.610	.477	8.891*
10	30	.683	.568	10.340*
Eigenvalue		3.741		
% of variance explained		37.409		

*p <.05

As shown in Table 3, the section comprised 10 items with a single-factor structure. These items assessed students' emotional responses to climate change and related environmental problems. For example, the statements “Climate change scares me” and “Thinking that we are harming nature makes me sad” reflect emotional responses such as fear and sadness. Factor loadings for the items ranged from .464 to .713.

Item–scale correlation coefficients ranged from .353 to .603, indicating that the items were discriminating. To provide additional evidence of item discrimination, we compared item scores in the

lower and upper groups using independent-samples t tests; we found statistically significant differences between the groups' mean item scores. The Emotions Toward Climate Change section yielded a Cronbach's alpha coefficient of .81 and a McDonald's omega coefficient of .81.

We tested the unidimensional structure of the Emotions Toward Climate Change section using CFA with data from the second administration. The analysis yielded $\chi^2 = 54.086$ (df = 33, p = .012) and $\chi^2/df = 1.639$. Other model fit indices were RMSEA = .034, AGFI = .967, CFI = .928, GFI = .980, and NNFI =.902. In evaluating model fit, a χ^2/df ratio between 0 and 2, an RMSEA below .05, and a GFI above .95 indicate excellent fit. CFI and NNFI values above .90 also indicate acceptable fit (Hu & Bentler, 1999; Kline, 2011). These findings support the section's unidimensional structure. Figure 2 presents the standardised factor loadings estimated in CFA. They ranged from .47 to .74, and all freely estimated paths were statistically significant (C.R. = 9.74–16.44, p <.001).

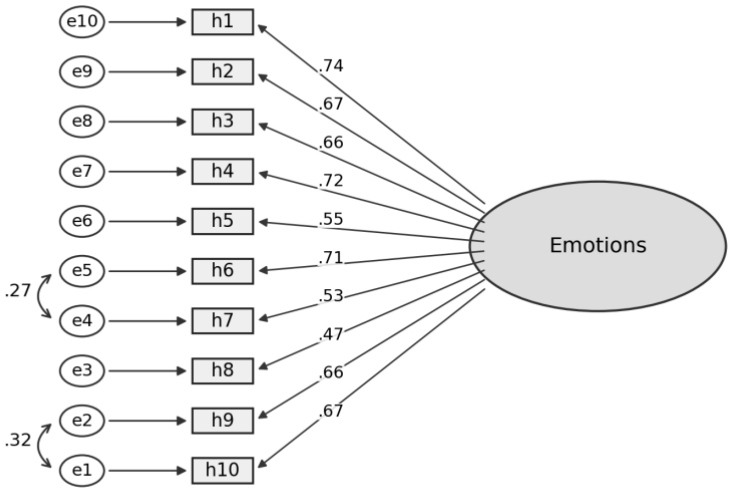

Figure 2. Path Diagram for Section 2

The internal consistency of the Emotions Toward Climate Change section was reassessed using data from the main-study group. Cronbach's alpha was .87, and McDonald's omega was .87.

Section 3: Behaviors to Address Climate Change

For the Behaviors to Address Climate Change section, the KMO value obtained from the pilot data was .830, and Bartlett's test was statistically significant ($\chi^2 = 563.142$, p <.001), supporting the suitability of the dataset for factor analysis. EFA indicated that the items loaded on a single factor. This factor had an eigenvalue of 4.624 and accounted for 33.027% of the total variance. The item factor loadings, item-scale correlations, and discrimination results obtained from EFA are reported in Table 4.

Table 4. Section 3: Item Factor Loadings, Item-Scale Correlations, and Independent-Samples t-Test Results

Item	Draft item	Factor 1	Item–scale r	t
1	2	.48	.38	6.205*
2	3	.56	.47	4.876*
3	4	.63	.53	7.778*
4	5	.54	.45	5.641*
5	6	.72	.63	10.661*
6	7	.55	.45	10.056*
7	8	.66	.59	9.059*
8	11	.62	.51	8.116*
9	12	.45	.36	8.310*
10	13	.63	.57	9.127*
11	14	.55	.45	5.063*
12	17	.55	.45	9.373*
13	20	.63	.46	10.111*
14	21	.34	.32	4.321*
Eigenvalue		4.624		
% of variance explained		33.027		

*p <.05

As shown in Table 4, Section 3 consisted of 14 items with a single-factor structure. The items were designed to assess behaviors that students perform in their daily lives to address climate change. For example, the statement "I turn off unnecessary lights" reflects an energy-saving behavior. Other items cover behaviors related to water conservation, recycling, and environmental protection. Factor loadings ranged from .34 to .72.

Item–scale correlation coefficients ranged from .32 to .63, indicating that the items discriminated between individuals on the measured characteristic. Supporting this finding, independent-samples t tests comparing item scores between the lower and upper 27% groups also demonstrated item discrimination. Cronbach's alpha and McDonald's omega coefficients calculated from the pilot data were .85 and .84, respectively, providing evidence of the internal consistency reliability of the Behaviors to Address Climate Change section.

The unidimensional structure identified for the Behaviors to Address Climate Change section was tested by CFA using data from the second administration. The results yielded $\chi^2 = 169.815$ (df = 75, p <.001) and a χ^2/df ratio of 2.264. The fit indices (RMSEA = .048, AGFI = .938, CFI = .952, GFI = .956,

and NNFI = .942) indicated that the single-factor model for the Behaviors to Address Climate Change section fit the data.

Figure 3 presents the standardised factor loadings estimated in CFA. They ranged from .45 to .65, and all freely estimated paths were statistically significant (C.R. = 9.18–12.69, p <.001).

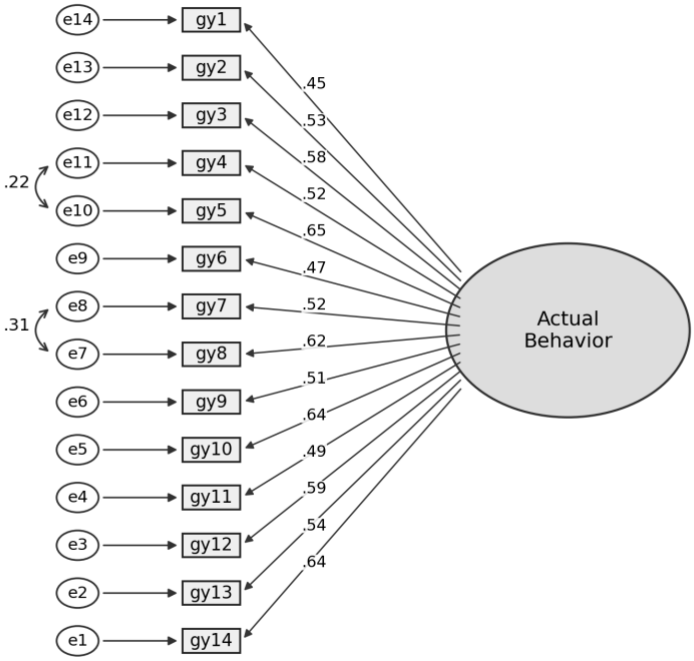

Figure 3. Path Diagram for Section 3

The internal consistency of the Behaviors to Address Climate Change section was reassessed using data from the main study. Cronbach's alpha and McDonald's omega coefficients were both .86. These findings provide evidence of internal consistency reliability in both the pilot and main-study administrations.

Climate Change Knowledge Test

Using data from the pilot and main administrations of the draft Climate Change Knowledge Test prepared following expert review, the item discrimination indices, item difficulty values, independent-samples t-test results, and KR-20 reliability coefficients calculated in the initial examination of the test's validity and reliability characteristics are presented in Table 5.

Table 5. Item Analysis and Reliability Results for the Climate Change Knowledge Test

Pilot study				**Main study**			
Draft item	**Discrimination**	**Item difficulty**	**t**	**Item**	**Discrimination**	**Item difficulty**	**t**
1	.48	.68	6.219*	1	.42	.71	7.797*
3	.50	.50	5.726*	2	.56	.55	12.915*
7	.62	.68	7.466*	3	.55	.65	12.156*
8	.58	.62	7.305*	4	.49	.72	10.763*
10	.44	.47	5.736*	5	.45	.65	9.978*
11	.64	.62	8.186*	6	.50	.73	10.783*
12	.47	.71	5.840*	7	.32	.79	6.869*
14	.43	.28	5.588*	8	.46	.39	10.383*
15	.61	.45	7.096*	9	.62	.56	13.510*
17	.55	.74	7.979*	10	.34	.86	7.761*
18	.45	.39	6.470*	11	.57	.50	13.695*
24	.63	.54	6.650*	12	.59	.59	13.987*
25	.58	.64	6.729*	13	.49	.67	11.021*
26	.59	.36	8.394*	14	.63	.49	15.228*
27	.67	.57	11.669*	15	.58	.66	13.527*
29	.55	.68	7.979*	16	.42	.77	9.955*
34	.61	.44	8.235*	17	.48	.52	9.962*
35	.49	.52	5.357*	18	.47	.62	9.901*
36	.53	.46	5.760*	19	.56	.61	13.413*
37	.71	.60	10.684*	20	.65	.63	15.269*
Mean item difficulty		.55				.63	
KR-20		.84				.80	

*p <.05

Table 5 reports the item discrimination indices, item difficulty indices, independent-samples t-test results, and KR-20 reliability coefficients obtained for the knowledge test in the pilot and main studies. In the pilot study, item discrimination indices ranged from .43 to .71, indicating that the items were highly effective at discriminating among students with different knowledge levels. In the main study, discrimination indices ranged from .32 to .65. Because values of .30 or above are considered acceptable in the literature, all items show adequate discrimination.

The mean item difficulty index was .55 in the pilot study and .63 in the main study. These results suggest that the test items were generally of moderate difficulty and could assess students' achievement levels in a balanced manner. Some items were easier (e.g., Item 10 in the main study, with a difficulty index of .86), whereas others were relatively more difficult. This variation can be considered beneficial for assessing students with different knowledge levels.

The finding that all t tests comparing mean knowledge-test item scores between the upper and lower groups were statistically significant ($p < .05$) provides statistical support for the items' discriminating properties. In addition, KR-20 coefficients for the knowledge test were .84 in the pilot study and .80 in the main study. KR-20 values of .80 or higher indicate that the knowledge test is a reliable assessment instrument.

Table 6. Correlation Coefficients Between the Sections of the Assessment Instrument

	Pilot study			**Main study**		
Section	**I**	**II**	**III**	**I**	**II**	**III**
I						
II	.66*			.558*		
III	.46*	.47*		.584*	.490*	
Knowledge Test	.29*	.33*	.32*	.299*	.319*	.294*

*$p < .05$

Table 6 presents the correlations between the instrument's sections for both the pilot and main studies. Positive, statistically significant relationships were observed between all sections ($p < .05$). In the pilot study, a moderate positive correlation was found between Willingness to Take Action Against Climate Change and Emotions Toward Climate Change ($r = .66$). Behaviors to Address Climate Change was also positively correlated with both willingness ($r = .46$) and emotions ($r = .47$). Correlations between the Knowledge Test and the other sections ranged from .29 to .33.

The main-study results likewise revealed positive, statistically significant relationships between the instrument's sections. Willingness to Take Action Against Climate Change and Emotions Toward Climate Change were moderately positively correlated ($r = .558$). Behaviors to Address Climate Change was significantly related to both willingness ($r = .584$) and emotions ($r = .490$). The correlations between the Knowledge Test and the other sections ranged from low to moderate ($r = .294$–$.319$). These results indicate that the sections are related but distinct constructs, supporting the instrument's structural coherence.

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

This study developed a four-section assessment instrument to evaluate different components of climate change literacy among fourth-grade primary school students. The instrument assesses four components separately: willingness to take action against climate change, emotions toward climate

change, behaviors to address climate change, and climate change knowledge. The findings provided evidence regarding the validity and reliability of these sections.

The instrument's structure broadly aligns with previous research indicating that environmental and climate change literacy cannot be limited to knowledge alone. In CHEAKS, Leeming et al. (1995) assessed environmental knowledge, willingness to protect the environment, behaviors, and emotional responses as separate components. Similarly, Ortega-Quevedo et al. (2024) structured their instrument for children aged 10–12 around knowledge, skills, and attitudes. By assessing knowledge, willingness to take action against climate change, emotions, and behaviors in separate sections, the instrument developed in the present study allows examination of multiple aspects of climate change literacy within a single assessment.

Recent studies with similar age groups also highlight the importance of assessing climate change literacy through multiple components. In the Climate Change Literacy Questionnaire developed for children aged 10–11, Vermund et al. (2026) jointly examined perceived knowledge, motivation, behavior, and systemic and collective orientations. These domains represent related but distinct aspects of climate change literacy. Although the present study likewise adopts a multicomponent approach, it assesses knowledge using a test with “True,” “False,” and “I Don't Know” response options rather than relying on students' perceptions of their knowledge. In this respect, the instrument enables separate examination of students' knowledge of climate change, emotions, willingness to take action, and behaviors.

The EFA results for the first three sections indicated a two-factor structure for Willingness to Take Action Against Climate Change and single-factor structures for Emotions Toward Climate Change and Behaviors to Address Climate Change. The CFA results from the main-study data also supported the fit of the identified factor structures. Cronbach's alpha and McDonald’s omega coefficients from both the pilot and main studies supported the internal consistency of the Likert-type sections. In the Climate Change Knowledge Test, item discrimination indices exceeded .30 in both administrations, and KR-20 coefficients were .84 and .80, respectively. Taken together, these findings provide various forms of evidence supporting the construct validity, item discrimination, and internal consistency of the instrument's sections.

Treating emotions as a separate section is important because it avoids assessing children's relationship with climate change solely through cognitive and behavioural indicators. Items in this section focus on emotional responses such as fear, worry, and sadness. Research on climate change education involving children also emphasizes the need to consider emotional experiences alongside knowledge acquisition. Trott (2022) noted that children may experience negative emotions such as fear, worry, anger, and sadness in relation to climate change, and that climate change education should not overlook its affective dimension. Ojala's (2012a, 2012b) studies likewise show that worry about climate

change is an important emotional component of how children and young people relate to environmental issues, and that these emotions' relationships with hope and action warrant attention. Accordingly, assessing emotions in a separate section of the present instrument allows examination of the affective aspects of climate change literacy.

Correlations between the sections also yielded noteworthy findings for evaluating the structure of the instrument. Although all sections showed positive, statistically significant relationships in both the pilot and main studies, their magnitudes differed. Relationships among willingness, emotions, and behaviors were relatively stronger, whereas the Knowledge Test showed weaker relationships with the other three sections. This pattern suggests that students' climate change knowledge, emotions, willingness to act, and behaviors are related but do not represent the same construct. It also highlights the importance of assessing components of climate change literacy beyond knowledge separately.

This pattern of correlations helps clarify the conceptual and psychometric status of the instrument's four sections. In this study, we did not treat knowledge, emotions, willingness, and behaviors as indicators of a single factor; instead, we assessed them as distinct but interrelated components of climate change literacy. This approach resembles both CHEAKS's treatment of knowledge and attitudes as separate constructs and more recent climate change literacy instruments' separate assessment of distinct domains. Therefore, rather than reducing the findings to a single total score, it appears more appropriate to interpret scores from each section in relation to the component it measures.

The findings provided validity and reliability evidence supporting the use of the developed instrument to assess different components of climate change literacy among fourth-grade primary school students. The instrument may be used in climate change and environmental education research to examine how educational practices affect students' knowledge, emotions, willingness to take action, and behaviors.

Nevertheless, when evaluating the generalizability of the findings, consider the use of convenience sampling and the restriction of both the pilot and main studies to fourth-grade students in the Eyüpsultan district of Istanbul. Future research should therefore administer the instrument in different regions and student populations and reassess its psychometric properties. This would allow researchers to determine the extent to which the validity and reliability evidence from the present study is replicated in different samples.

If the instrument is to be used at other grade levels, researchers should first reassess the items in relation to the target group's developmental characteristics. In particular, reviewers should review items in the Climate Change Knowledge Test with reference to the relevant grade level and curriculum, and repeat validity and reliability studies with the intended student population. The instrument may also be used in intervention studies on climate change education to examine changes in students' knowledge,

emotions, willingness to act, and behaviors separately. Future studies investigating additional sources of validity and reliability evidence could contribute to a more comprehensive evaluation of the instrument's psychometric properties.

Additional Declaration

Author Contributions

Both authors have contributed equally to the article.

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Responsible Artificial Intelligence Statement

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Conflicts of Interest

The authors declare that there are no conflicts of interest related to the publication of this study.

Ethics Approval

The study was reviewed by the Scientific Research and Publication Ethics Committee and found to comply with its ethical principles, subject to obtaining and submitting the required permissions (Decision No. 14/42, dated October 3, 2024; Project No. 2024-YÖNP-5187). All procedures followed scientific and ethical principles, and all referenced studies are appropriately cited.

REFERENCES

Albayrak, H., Polat, R., & Kenan, A. (2025). Ortaokul öğrencilerine yönelik iklim değişikliği farkındalık ölçeğinin geliştirilmesi [Development of a climate change awareness scale for middle school students]. *Buca Eğitim Fakültesi Dergisi, 65,* 3252–3271. https://doi.org/10.53444/deubefd.1621576

Büyüköztürk, Ş. (2007). Sosyal bilimler için veri analizi el kitabı [Handbook of data analysis for the social sciences] (7th ed.). Pegem Akademi.

Christensen, R., & Knezek, G. (2015). The climate change attitude survey: Measuring middle school student beliefs and intentions to enact positive environmental change. International Journal of Environmental and Science Education, 10(5), 773–788. https://eric.ed.gov/?id=EJ1081857

Gönen, Ç., Deveci, E. Ü., & Aydede, M. N. (2023). Development and validation of climate change awareness scale for high school students. Environment, Development and Sustainability, 25, 4525–4537. https://doi.org/10.1007/s10668-022-02213-w

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling, 6(1), 1–55. https://doi.org/10.1080/10705519909540118

Intergovernmental Panel on Climate Change. (2023). Climate change 2023: Synthesis report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (Core Writing Team, H. Lee & J. Romero, Eds.). IPCC. https://www.ipcc.ch/report/ar6/syr/

Kline, R. B. (2011). Principles and practice of structural equation modeling (3rd ed.). Guilford Press.

Leeming, F. C., Dwyer, W. O., & Bracken, B. A. (1995). Children's Environmental Attitude and Knowledge Scale: Construction and validation. The Journal of Environmental Education, 26(3), 22–31. https://doi.org/10.1080/00958964.1995.9941442

Lubej, M., Petraš, Ž., & Kirbiš, A. (2025). Measuring climate knowledge: A systematic review of quantitative studies. iScience, 28(2), 111888. https://doi.org/10.1016/j.isci.2025.111888

Nepraš, K., Strejčková, T., & Kroufek, R. (2022). Climate change education in primary and lower secondary education: Systematic review results. Sustainability, 14(22), 14913. https://doi.org/10.3390/su142214913

Ojala, M. (2012a). How do children cope with global climate change? Coping strategies, engagement, and well-being. Journal of Environmental Psychology, 32(3), 225–233. https://doi.org/10.1016/j.jenvp.2012.02.004

Ojala, M. (2012b). Regulating worry, promoting hope: How do children, adolescents, and young adults cope with climate change? International Journal of Environmental and Science Education, 7(4), 537–561.

Ortega-Quevedo, V., López-Luengo, M. A., Ferrari, E., & Ruiz, C. (2024). Evaluating climate change competence in pre-teens: Instrument development and validation. Journal of Environmental Psychology, 96, 102329. https://doi.org/10.1016/j.jenvp.2024.102329

Özçelik, D. A. (2011). Ölçme ve değerlendirme [Measurement and evaluation] (4th ed.). Pegem Akademi.

Satmaz, İ., Girgin, D., Ayverdi, L., & Önder, E. Y. (2025). Ortaokul öğrencilerine yönelik küresel iklim değişikliği farkındalık ölçeği: Geçerlik ve güvenirlik çalışması [Global climate change awareness scale for middle school students: A validity and reliability study]. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi, 73,* 59–88. https://doi.org/10.21764/maeuefd.1449542

Skamp, K., Boyes, E., & Stanisstreet, M. (2013). Beliefs and willingness to act about global warming: Where to focus science pedagogy? Science Education, 97(2), 191–217. https://doi.org/10.1002/sce.21050

Şencan, H. (2005). Sosyal ve davranışsal ölçümlerde güvenilirlik ve geçerlilik [Reliability and validity in social and behavioral measurement]. Seçkin Yayıncılık.

Trott, C. D. (2022). Climate change education for transformation: Exploring the affective and attitudinal dimensions of children's learning and action. Environmental Education Research, 28(7), 1023–1042. https://doi.org/10.1080/13504622.2021.2007223

United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development. https://sdgs.un.org/2030agenda

Vermund, M. C., Nielsen, G., Stage, A., Müllertz, A. L. O., & Elsborg, P. (2026). Development and validation of the Climate Change Literacy Questionnaire (CCLQ) for children aged 10 to 11 in Denmark. Environmental Education Research. https://doi.org/10.1080/13504622.2026.2730576

World Commission on Environment and Development. (1987). Our common future. Oxford University Press.