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The Climate Literacy Levels of Secondary School Students and Their Opinions on Climate Change

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Abstract

Turkey is among the countries which is highly sensitive to climate change on a global scale and under risk. It is predicted that the annual temperature across the country will have increased by 2100. In certain regions, the temperature increase may reach up to 60 °C. Against this risk there, however, are opportunities to improve climate literacy, particularly in schools, on climate change, its impacts and solutions. In this framework, this study intends to scrutinize the climate literacy levels of secondary school students in terms of certain variables and to disclose their opinions on climate change. As a result of the analysis of the data collected in the study in which the survey design was implemented, it was found that the climate literacy levels of the students were not at the desired level, particularly in the climate awareness dimension. This dimension includes items related to minimizing the effects of climate change and taking precautions. Nevertheless, another important result is that some students lead to environmentally unfriendly behaviours and actions to mitigate climate change on the back burner owing to economic concerns and financial problems lime unemployment. The most important solution for ecological sustainability and climate action is to legislate and create national educational solutions Via government incentives and support. Considering the result that school and family are insufficient in climate literacy education, it is of importance to carry out relevant studies.

Keywords: climate, climate literacy, climate change, sustainability, ecology, geography, geography education.

Ortaöğretim Öğrencilerinin İklim Okuryazarlık Düzeyleri ve İklim Değişikliğine İlişkin Görüşleri

Öz

Türkiye, küresel ölçekte iklim değişikliğine karşı son derece duyarlı ve risk altında olan ülkeler arasında yer almaktadır. Ülke genelindeki yıllık sıcaklığın 2100 yılına kadar artış göstereceği tahmin edilmektedir. Bazı bölgelerde sıcaklık artışı 60 °C'ye kadar çıkabilir. Bu riskin karşısında, iklim değişikliği, etkileri ve çözümleri konusunda özellikle okullarda iklim okuryazarlığını geliştirmek için fırsatlar bulunmaktadır. Bu çerçevede çalışmada, ortaöğretim öğrencilerinin iklim okuryazarlık düzeylerini belirli değişkenler açısından incelemek ve iklim değişikliği konusundaki görüşlerini ortaya çıkarmak amaçlamaktadır. Tarama desenin uygulandığı çalışmada, toplanan verilerin analizi sonucunda, öğrencilerin iklim okuryazarlık düzeylerinin özellikle iklim farkındalığı boyutunda istenilen seviyede olmadığı ortaya çıkmıştır. Bu boyut, iklim değişikliğinin etkilerini azaltma ve önlem alma ile ilgili maddeleri içermektedir. Bununla birlikte, başka önemli bir sonuç da bazı öğrencilerin, ekonomik endişeler ve işsizlik gibi maddi sorunlar nedeniyle çevre dostu olmayan davranışları ve iklim değişikliğini azaltmaya yönelik eylemleri ikinci plana attığıdır. Ekolojik sürdürülebilirlik ve iklim eylemi için en önemli çözüm, yasal düzenlemeler yapmak ve hükümet teşvikleri ve destekleriyle ulusal eğitim çözümleri üretmektir. Okul ve ailenin iklim okuryazarlığı eğitimde yetersiz kalması sonucu dikkate alındığında, buna yönelik çalışmaların yapılması önem arz etmektedir.

Anahtar Sözcükler: iklim, iklim okuryazarlığı, iklim değişikliği, sürdürülebilirlik, ekoloji, coğrafya, coğrafya eğitimi.

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INTRODUCTION

The climate is an essential factor influencing human life. Generally, the average of the measurements made for many years as to the weather and weather events we have been exposed to every day is expressed as the climate. (Kurnaz, 2019). Today, climate change is one of the most critical global issues (IPCC, 2007; Doğan & Tüzer, 2011; El-Zein et al., 2021; WEF, 2021). Climate change is characterized mainly by a rise in average temperatures, an increase in seasonal anomalies, and an increase in the temperature and severity of extreme weather events (Bernstein et al., 2008). Climate change is the situation in which irregularities and changes are experienced in the climate in the long term as a result of natural processes and human activities disrupting the atmospheric order (UN, 1972; Türkeş, 2008) as well as long-term changes in the average condition and/or variability of the climate regardless of the reason (MGM, 2022).

Nevertheless, it is evident that climate change, unlike natural changes, is also defined as a deterioration in the atmospheric composition due to human activities (Talu, 2015; UN, 2020; MGM, 2020). Normally, nature has a mechanism to ensure its internal balance. Still, due to this bad influence and pressure, nature has become unable to solve the disturbed balance in its internal mechanism (Elverdi, 2017).

According to the Intergovernmental Panel on Climate Change (IPCC) assessment reports (IPCC, 2014), the Earth atmosphere is, on average, 1^0C warmer today than before the industrial revolution, equivalent to an increase of 0.2^0C per decade. According to the same report, global warming is estimated to reach 1.5^0C between 2030 and 2052. Studies also reveal that the most important impacts of global climate change will manifest themselves in the form of temperature increase and decrease in water resources (Varol et al., 2021) and will increase climate-related natural disasters and ecological degradation, such as forest fires, drought, floods, and flood events, desertification, and erosion (Talu et al., 2010; Leaning & Guha-Sapir, 2013; UNCCS, 2019; Chugunkova & Pyzhev, 2020).

In its report published in 2021, the World Meteorological Organization (WMO) specified that the impacts of weather, climate, and water-related hazards continue to negatively affect health, economic status, and social development worldwide, with weather, climate, or water-related disaster occurring on every day for the last 50 years. According to the report (WMO, 2021), over the past 50 years, these events have caused the death of 115 people per day and a daily economic loss of US $ 202 million. According to the data of the Internal Disaster Monitoring Center (IDMC) on disaster-related migration worldwide between 2008 and 2020, floods and storms are the disasters that cause people to relocate the most (IDMC, 2021). In 2021, while large forest fires occurred in countries in the Mediterranean Basin (Turkey, Greece, Italy, Spain, France, Portugal, Spain, France, Portugal) where extreme temperatures have been effective (Gallagher Re, 2023), the same year was also a year with a high number of meteorological disasters (MGM, 2021). A total of 1024 natural disasters with meteorological character were reported in Turkey in 2021, and this was recorded as the highest value in the 1940-2021 period (MGM, 2021).

Studies on the effects of climate change on national and international security have increased as of the 2000s (Brauch, 2002; Barnett & Adler, 2007; Sindico, 2007; Scott, 2012; Baysal & Karakaş, 2017). Studies focusing on human vulnerabilities caused by climate change, especially food insecurity, health problems, and poverty, are considered environmental safety problems (Detraz, 2011; IPCC, 2014). The limited livelihoods and migration movements due to climate change (IPCC, 2021), increase in food prices, water scarcity, economic contraction, and unemployment (El-Zein et al., 2021), community and mental health problems (Myers & Patz, 2009; Costello et al., 2009; Luber & Prudent, 2009; Stanley et al., 2021, WHO, 2021) have started to come out more. It is stated that the impacts of climate change, or in other words, the climate crisis, can be solved via effective and comprehensive policies and actions to be implemented at global, national, and local levels and that efforts should be developed on two axes: mitigation and adaptation (Balaban, 2017). While prevention activities aim to prevent global warming and fix temperature increases to a certain level (Balaban, 2017), adaptation to climate change is related to risk reduction and management before and after disasters (Lewis, 2020).

In Turkey, among the countries that are highly vulnerable and at risk of global climate change, it is predicted in the climate projection studies that the annual temperature will increase throughout the country until 2100, and temperature increases in some regions may reach up to 6^0C (Dalfes et al., 2007; IPCC, 2007; IPCC, 2014; Kovats et al., 2014; Demircan et al., 2017; Varol et al., 2021). Climate events in Turkey in recent years have supported this prediction (OECD, 2019), the areas with extreme precipitation have expanded since 2000, and flood risk areas have increased (Çelik et al., 2017), while drought and desertification have become widespread in some regions (Türkeş, 2012). Bartın Province, located in the Western Black Sea region of Turkey, which was selected as the study area of this research, is one of the provinces with the highest level of vulnerability to floods and overflows

because of excessive rainfall (Sılaydın Aydın & Kahraman, 2022). Especially in the Black Sea Region, where Bartın province is located, it is predicted that it will be under the influence of a more humid and warmer climate in the future compared to today's conditions; there will be an increase in rainfall in the form of torrential rains, and floods, floods and landslides will increase accordingly (Atalay, 2011; Turoğlu, 2014; Demircan et al. l., 2017; Bolat et al. l., 2018). A projection study conducted for the Bartın Stream Basin estimated that there would be an adverse change in the land, natural areas would decrease, and construction and land fragmentation would increase by 2050 (Kalaycı Kadak, 2021). All this indicates that Bartın Province is a place that will be very much affected by climate change.

Although many studies have been conducted on the global, national, and local dimensions of climate change (UNCCS, 2019; Chugunkova & Pyzhev, 2020; El-Zein et al., 2021; IPCC, 2021; MGM, 2021; WEF, 2021; WMO, 2021); there is an increase in studies such as climate change awareness (Dal et al., 2014), risk perception (Spence et al., 2010; Tvinnereim & Austgulen, 2014; Tam, 2020), adaptation and mitigation perception (Meehan et all., 2018), individual factors affecting change (Brügger et al., 2015; Capstick et al., 2015; Shi et al., 2016). Education and schools are important stakeholders in understanding climate and climate change and its impacts, as well as in prevention and adaptation efforts to be carried out under the guidance of scientific studies (Coertjens, 2010).

Opportunities to develop climate literacy related to climate, climate change, its effects, and solutions exist in formal educational institutions, such as schools, non-formal educational environments including the media, and the field of informal education (UNESCO, 2010). Studies on climate literacy and climate change, have increased today (Lee et al., 2015; Görgülü Ari & Arslan. 2020; Eckstein et al., 2021). Nonetheless it has become more important to develop climate literacy under the guidance of scientific studies to fulfill the commitments of the Paris Climate Agreement and to achieve the United Nations Sustainable Development Goal "SDG 13: Climate Action" to take urgent action to combat climate change and its impacts (UN, 2023). In Turkey, one of the signatory countries to the Paris Agreement, the "Environmental Education and Climate Change" course was introduced as an elective course in secondary schools in 2021 (Ministry of National Education, 2022), but the subject of climate and climate change at the secondary level is limited to topics in geography courses only. Today, it has emerged that students must make informed decisions and become "climate literate citizens" (Arndt & LaDue, 2008). The purpose of the research conducted in this context is to discuss the climate literacy levels of students studying in secondary education in terms of some variables and to reveal their opinions on climate change. Accordingly, the following questions were sought to be answered in the study.

1. What is the level of students' climate literacy?

2. Is there a significant difference in students' climate literacy levels according to variables (gender, school type, school location, class, mother's education level, father's education level, participation in environmental activities, resources that contribute to understanding climate and climate change, following climate change developments, the degree of climate change exposure, the effects of climate change in the place where you live)?

3. Is there a relationship between students' climate literacy levels and gender, grade, participation in environmental activities following the developments in climate change, and the degree of being affected by climate change?

4. What are the students' opinions on climate change?

METHOD

Research Design

The aim of this study is investigating the climate literacy levels of secondary school students according to some variables and defining the current phenomenon to reveal their opinions on climate change. Hence, the survey design was preferred in this study. Survey researches are studies conducted to express the opinions, interests, attitudes, concerns, etc., of a specific and large group of people on a particular subject (Fraenkel et al., 2011; Büyüköztürk et al., 2011). Cross-sectional survey research (Fraenkel et al., 2011) was preferred since it provides a significant advantage in this study by providing the opportunity to make comparisons as well as collecting data from the target group at a time / in a short time, especially compared to time-consuming research types.

Participants & Study Group

In determining the secondary school students in the study group, the purposive sampling technique was used because it allows for selection among more easily accessible participants from the population and participation in the study is voluntary (Teddlie & Yu, 2007). In this direction, secondary school students studying in Bartın Province of Turkey, one of the critical places affected by climate change due to floods and flood events,

excessive and irregular rainfall occurring every year, were reached. The main reason for determining secondary school students as participants is the assumption that they have acquired basic climate concepts and knowledge at this educational level in schools through educational programs. However as stated in the United Nations World Youth Report (2010), young people, who are an important group affected by climate change, also constitute an essential segment that should take an active role in measures to reduce the impacts of climate change.

Of the 542 secondary school students in the study group, 332 (61.3%) were woman, and 210 (38.7%) were man. 68 (12.5%) of these students study in the village (students coming from the village to the city through transport education), whereas 27 (5%) study in the district center, and 447 (82.5%) study in the provincial center. 348 (64.2%) of the students study in general high schools, 79 (14.6%) study in science high schools, 115 study (21.2%) in vocational high schools; 137 (25.3%) study in 9th grade, 202 (37.3%) study in 10th grade, 84 (15.5%) study in 11th grade and 119 (22%) study in 12th grade. The distribution of students according to their mother and father's education level is indicated in Figure 1.

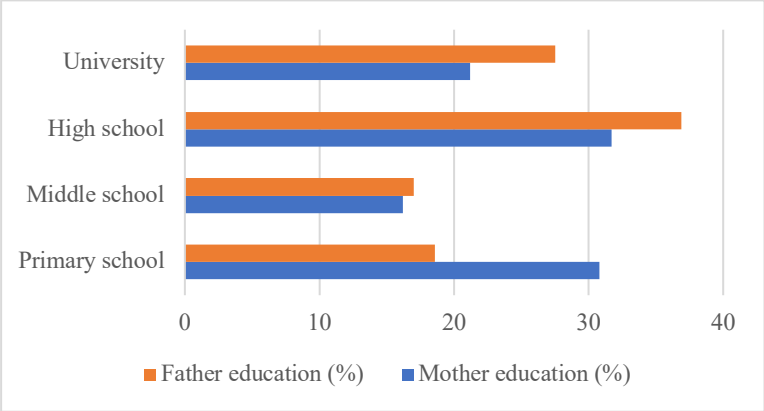

Figure 1. *Mother and father's education level*

As indicated in Figure 1, although the mother's education level is lower than the father's, the highest proportion (31.7% - 36.9%) of both mother and father's education levels is at the high school level.

Data Collection Tools and Implementation

Personal information form, Climate Literacy Scale, and Case Text Form were used to collect data in line with the purpose of the research. Expert (measurement and evaluation faculty member, geography education faculty member, geography teacher, linguist) opinions were obtained for all data collection tools, and they were piloted with ten secondary school students who were not in the study group for comprehensibility and suitability. In the personal information form prepared by the researcher, the following questions were included: Gender of the participants, school type, location of the school, grade, mother, and father education level, participation in environmental activities, resources that contribute to understanding climate and climate change, the status of following the developments in climate change, the degree of being affected by climate change and the effects of climate change occurring in the place where they live.

The Climate Literacy Scale was developed by Görgülü Arı and Arslan (2020). The scale has three dimensions: Climate concept, climate awareness, climate consciousness, and 24 items. The scale categories are scored as “strongly disagree=1”, “partially disagree=2”, “undecided=3”, “partially agree=4”, and “absolutely agree=5” and obtained by collecting the subscales. When the data obtained from the confirmatory factor analysis results of the scale and the fit indices are compared, the model has significant, good, acceptable values (χ^2/sd = 1.76; RMSEA= 0.054; CFI = .95; NFI = .88; IFI = .95; GFI = .88; SRMR = .050) and it was concluded that the reliability value was Croncbachs' Alpha=0.89 (Görgülü Arı & Arslan, 2020). The Cronbachs’ Alpha coefficient regarding the reliability of the Climate Literacy Scale was calculated again within the scope of the research. The total reliability of the scale was found to be 0.93. In addition to the good validity and reliability values of this scale, it was preferred to use it because the items consist of statements about the students' climate concept, climate awareness, climate-human interaction, and climate change awareness.

The Case Text Form was applied by taking the expert opinion of the researcher and making corrections after the pilot application. In the form, a single case text about the effect of climate change without a conclusion was given, and students were asked to complete the conclusion of the text and present their justifications for the conclusion. The text focuses on students' climate change sensitivity and the behaviour they will show in a dilemma situation to take a role in measures to reduce the effects of climate change. In the dilemma text presented in the

context of the construction of a mineral processing plant and a thermal power plant in a forested village and the protection of the forested area and olive groves, the issue of climate change was brought to the fore. The researcher applied research data collection tools to voluntary secondary education students in classrooms during one lesson hour after obtaining the ethics committee's permission as well as the that of the institution.

Data Analysis

The SPSS 21.0 program was used to analyse the quantitative data obtained by the data collection tools of the research, and the Excel program was used in drawing the graphs. As a result of the Kolmogorov-Smirrov test conducted on the assumption of normality of the research data, it was found out that the data did not show a normal distribution (Kolmogorov-Smirnov Sig. 0.000). In scale analyses that did not show normal distribution; Mann Whitney-U test, a non-parametric test, was used for independent variables with two categories, Kruskal Wallis H-Test and Spearman Rank Difference correlation test were used for those with three or more categories. If there is a significant difference after the comparisons, the source of the difference was determined using the Mann-Whitney U-Test and Bonferroni correction. In addition, frequencies, percentages, and means were calculated, and the Chi squared test was used to examine the relationship between qualitative variable categories.

In addition to statistical significance, effect size was also calculated in comparisons. To determine the effect size, eta squared (η^2), and r values are calculated. In Kruskal Wallis H-Test, eta squared (η^2) values were calculated to determine the effect of independent variables on each dependent variable. When interpreting the eta squared values it was reported that $\eta^2 = 0.01$ was for small effect size, $\eta^2 = 0.06$ was for medium effect size, and $\eta^2 = 0.14$ was for high effect size (Green & Salkind, 2005). The correlation coefficients (r) effect sizes were determined for the Mann-Whitney U test. In the interpretation, .01 to .09 is a negligible relationship; .10 to .29 is a low relationship; .30 to .49 is a moderate relationship; .50 to .69 is a strong relationship; .70 and above is very strong (Green & Salkind, 2005).

In the analysis of qualitative data obtained from the case text form, one of the data collection tools, it was preferred to use the content analysis method. Content analysis refers to any attempts to reduce and make sense of qualitative data by taking voluminous qualitative material and attempting to identify core consistencies and significances (Patton, 2002). The primary significances found through content analysis were grouped under the research theme, and the qualitative data were analyzed inductively. Expert opinion was taken in creating and analyzing the themes, and the analysis results were presented, in which consensus was provided. Significant differences between the findings were evaluated, and the chi squared test was used. All responses of the participants to the case text were considered. The student's statements were also included in the explanations made in the findings section. All qualitative data are presented according to the themes created. The participants' opinions were coded as K1, K2, ..., E1, E2, ... according to gender.

Research Ethics

Ethics committee and institutional permissions were obtained for the study. Before data collection, all participants were informed regarding the purpose of the research, the process, what is expected of them, and the ethical rights they have (anonymity, volunteering, withdrawal from the study by termination of volunteering, etc.) (Bukova Güzel, 2017) and consent forms were taken.

FINDINGS

Findings related to the research questions are presented in the relevant sub-headings.

Findings on Students' Climate Literacy Levels

In the research, the student's participation in environmental-related activities, the resources that contribute to understanding climate and climate change, the status of following the developments in climate change, the degree of being affected by climate change, the effects of climate change in the place where they live were determined.

While 218 (40.2%) of the students have not participated in any environmental activities yet, 146 (26.9%) of them stated that they actively participated in one environmental activity, 65 (12%) twice, and 113 (20.8%) had three or more environmental activities. It is also observed that about a third of the students (32.8%) are involved in more than one environmental activity. The distribution of students' opinions on the status of following climate change developments and the level of being affected by climate change where they live are presented in Figure 2.

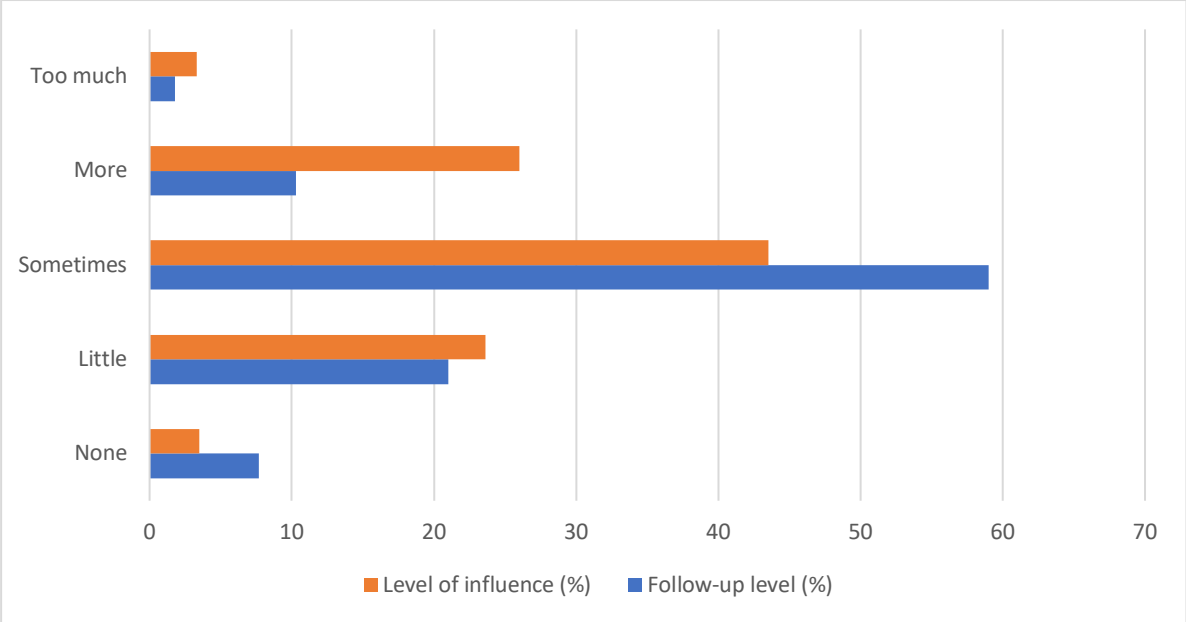

Figure 2. *The level of following climate change developments and being affected by climate change*

As seen in Figure 2, the level of students to follow the developments of climate change and to be affected by climate change in the place where they live is quite high. It is obvious that most of the students (71.3%) follow the developments in climate change; similarly, they think that their level of being affected by climate change is high (72.9%).

The distributions related to the resources that contribute the most to students' understanding of climate and climate change are available in Figure 3.

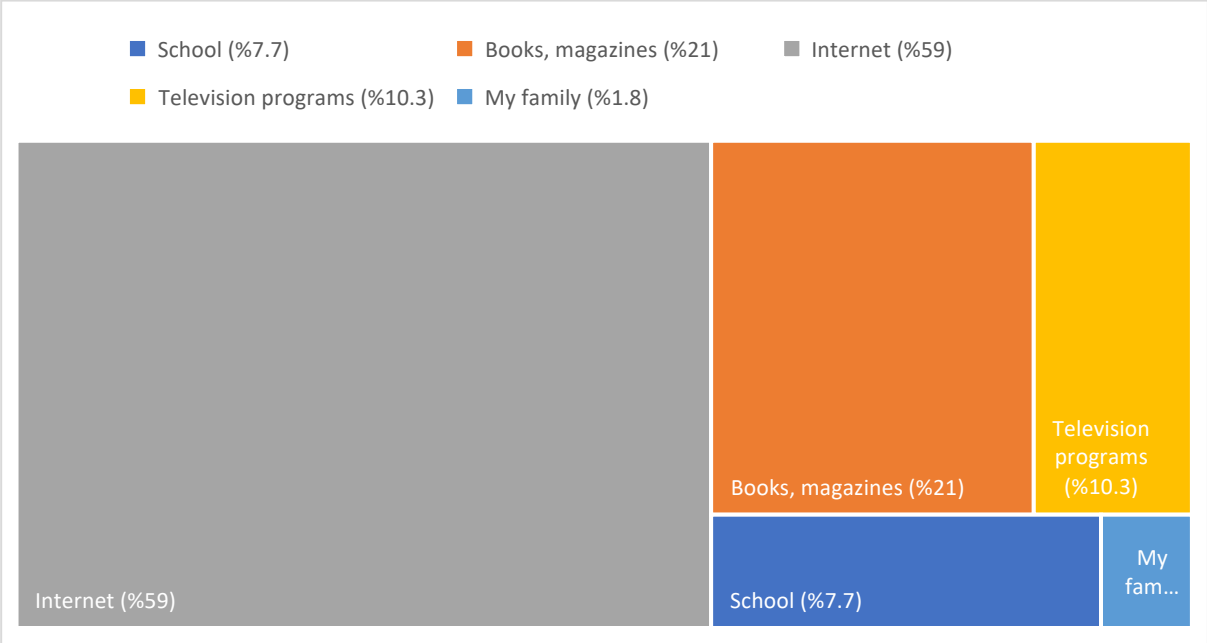

Figure 3. *Resources that contribute to understanding climate and climate change*

As seen in Figure 3, the highest rate among the sources contributing to students' understanding of climate and climate change is the internet (59%). Books, magazines, and television programs follow the internet sources. The findings that students from school and families do not get enough information about climate and climate change are quite remarkable.

The distribution of students regarding the effects of climate change where they live is shown in Figure 4.

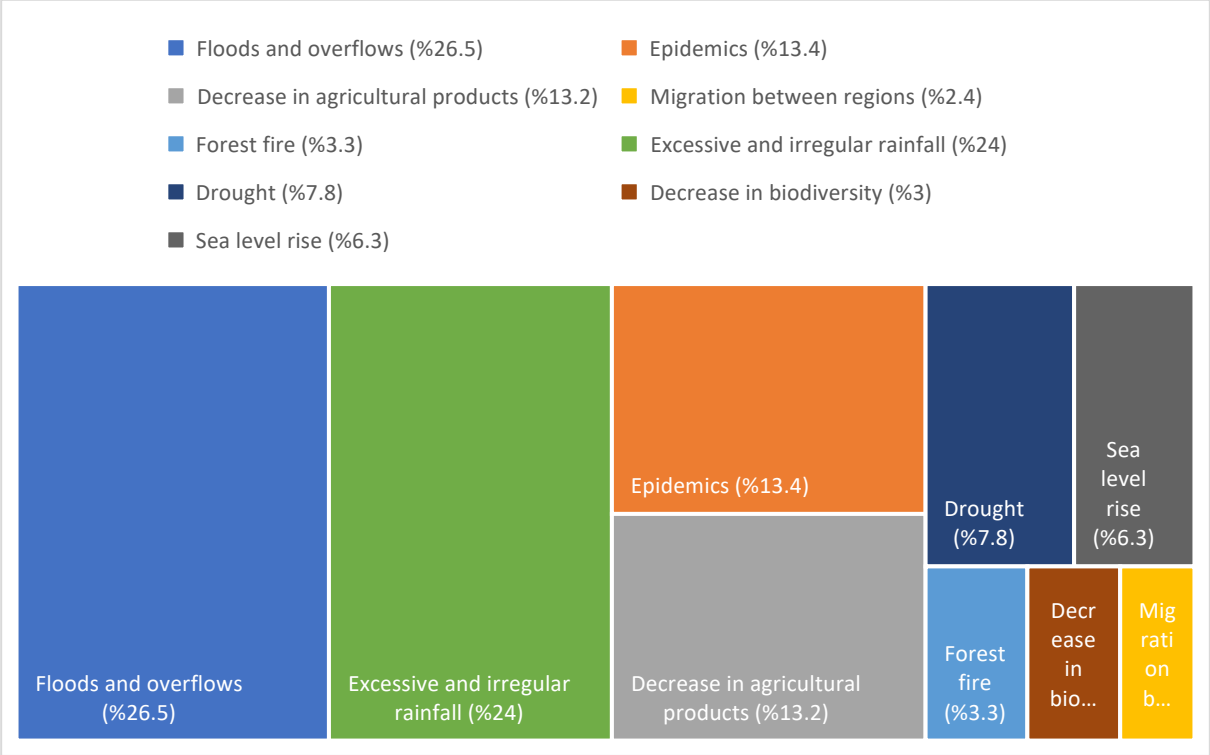

Figure 4. *The effects experienced due to climate change*

As seen in Figure 4, students stated that they are most exposed to floods and overflows due to climate change in their residences (26.5%). This was followed by excessive and irregular rainfall (24%), epidemic diseases (13.4%), and a decrease in agricultural products (13.2%), respectively. Interregional migration, a decrease in the diversity of living things, forest fires, sea level rise, and drought have been expressed as relatively minor climate change effects.

The findings regarding the climate literacy levels of the students are presented in Table 1.

Table 1. The Level of Climate Literacy of Students

Dimension/Scale	N	$\bar{X}$	ss
The dimension of the climate concept	542	4.18	.635
The dimension of climate awareness	542	4.38	.710
The dimension of climatic consciousness	542	3.45	.960
The climate literacy scale	542	4.07	.611

When the findings related to the Climate Literacy Scale and its sub-dimensions are analyzed in Table 1, it is clear that the highest mean is in the "climate awareness" sub-dimension ($\bar{X}$=4.38), which includes items related to climate change. This is followed by "climate concept" ($\bar{X}$=4.18) and "climate awareness" ($\bar{X}$=3.45). It can be claimed that the overall mean of the Climate Literacy Scale ($\bar{X}$=4.07) is "high". A remarkable finding is that the highest mean of students' climate literacy levels is in the dimension of climate change-related awareness items. In addition, the low mean for the "climate awareness" dimension, which includes statements about students' following developments related to climate and climate change and behaviors to reduce the effects of climate change, is an issue that needs to be considered and improved.

Findings According to Variables in Students' Climate Literacy Levels

The findings regarding the comparison of the climate literacy levels of the students according to gender are available in Table 2.

Table 2. According to Gender, Mann-Whitney U Test Results

Group	N	X̄sıra	∑sıra	U	Z	p	r
1. Female	332	297.29	98700.00	26298.000	-4.822	.000	.20
2. Male	210	230.73	48453.00				

According to Table 2, there is a significant difference in climate literacy levels between the mean rank of female students (297.29) and the mean rank of male students (230.73), and the effect size is low (U=26298; Z= -

4.822; p<0.05; r = -.20). It is also seen that the significant difference is in favor of female students. This finding also shows that the climate literacy levels of female students are higher than those of boys.

The findings regarding the comparison of students' climate literacy levels according to school type are indicated in Table 3.

Table 3. According to the Type of School, Kruskal Wallis H Test Results

Type of school	N	X̄sıra	Df	x^2	p
1. General High School	348	267.09	2	2.082	.353
2. Science High School	79	294.94			
3. Vocational High School	115	268.74			

As can be seen in Table 3, there is no significant difference between the mean scores for climate literacy levels according to the type of school ($X^2_{(2)}$=2.082; p=.353, p>.05). The fact that there was no significant difference according to the type of school the students attended is consistent with their opinions that they did not learn enough about the developments and information about climate and climate change at school. This situation can also indicate that students are not getting enough information, especially in schools, about climate change.

The findings regarding the comparison of the students' climate literacy levels according to the location of the school are observed in Table 4.

Table 4. According to the Location of the School, the Kruskal Wallis H Test Results

Location of the school	N	X̄sıra	Df	x^2	p
1. The Village	68	282.66	2	1.094	.579
2. District center	27	245.44			
3. Province center	447	271.38			

As can be seen in Table 4, there is no significant difference between the mean scores for climate literacy levels according to the location of the school ($X^2_{(2)}$=1.094; p=.579, p>.05). The fact that there is no significant difference according to the location of the school where the students study may be because the same climatic conditions are effective in the village and district and provincial centers where the participants live, as well as the floods and flood events experienced are effective throughout the province.

The findings regarding the comparison of the climate literacy levels of the students according to the class being studied are shown in Table 5.

Table 5. Kruskal Wallis H Test Results by Grade

Grade	N	X̄sıra	Df	x^2	p
1st.9th grade	137	243.86	3	20.418	.000
2.10th grade	202	251.96			
3.11th grade	84	296.65			
4.12th grade	119	318.74			

As can be seen in Table 5, there is a significant difference between the mean scores for climate literacy levels according to the grade, and it was found out that the calculated effect size was small ($X^2_{(3)}$=20.418; p=.000, p<.05; η^2=0.037). According to the results of the Mann-Whitney U Test conducted to determine between which groups there is a significant difference:

There is a significant difference between the students in the 9th grade in favor of those in the 11th grade, and the effect size is low (U=4536; Z= -2.641; p = .008; p<0.05; r = -.11). There is also a significant difference between the students in the 9th grade in favor of those in the 12th grade, and the effect size is low (U=5839.5; Z= -3.914; p = .000; p<0.05; r = -.16). Furthermore, there is a significant difference between the students in the 10th grade in favor of those in the 12th grade, and the effect size is low (U=9228; Z= -3.476; p = .001; p<0.05; r = -.14). These findings can be said to disclose that there is an increase in students' climate literacy levels, which includes climate and climate change, albeit small, as the grade level increases.

There is no significant difference between the mean scores for climate literacy levels according to the mother's education level ($X^2_{(3)}$=2.047; p=.563, p>.05). Similarly, there is no significant difference between the mean scores for climate literacy levels according to the father's education level ($X^2_{(3)}$=.613; p=.894, p>.05). This is consistent with the finding that students see their families at a very low level as a source contributing to understanding climate and climate change. There is no significant difference between the mean scores for climate literacy levels according to the student's participation in any environmental-related activities ($X^2_{(3)}$=4.672; p=.197, p>.05). This finding is remarkable. In a sense, environmental activities are important opportunities for nature conservation, gaining knowledge and skills, and positively developing behavior change in the context of ecological sustainability. It could also be argued that these opportunities have not been sufficiently emphasized or achieved their objectives.

The findings regarding comparing students' climate literacy levels according to following climate change developments are presented in Table 6.

Table 6. Kruskal Wallis H Test Results According to Following Developments Related to Climate Change

Degree	N	X̄sıra	Df	x2	p
1. Never	42	111.93	4	94.147	.000
2. Less	114	204.47			
3. Sometimes	320	298.74			
4. Much	56	351.95			
5. Too much	10	383.80			

According to following the developments related to climate change, as clear in Table 6, there is a significant difference between the mean scores for climate literacy levels, and it has been found that the calculated effect size is very high ($X^2_{(4)}$=94.147; p=.000, p<.05; η^2=0.17). According to the results of the Mann-Whitney U Test conducted to determine between which groups there is a significant difference:

Students who did not follow the developments related to climate change were at a low level and with a low effect size (U=1331; Z= -4.250; p = .000; p<0.05; r = -.11), against those who did not follow the developments related to climate change, at occasional level and medium effect size (U=2156.5; Z= -7.160; p = .000; p<0.05; r = -.30), at high level and low effect size (U=252; Z= -6.637; p = .000; p<0.05; r = -.28), at a very high level and low effect size (U=58.5; Z= -3.520; p = .000; p<0.05; r = -.15). As in these findings, it has been found out that the level of climate literacy also increases as the level of following developments related to climate change tends to increase. In line with these results, it can be stated that as the frequency of following climate change developments increases, it also shows an increase in climate literacy levels. It can also be said that students are particularly affected by the climate change developments that they follow from the internet and television programs that have appeared in previous findings, which they consider to be the most important sources.

The findings regarding the comparison of students' climate literacy levels according to the degree of being affected by climate change are available in Table 7.

Table 7. Kruskal Wallis H Test Results According to the Degree of Impact of Climate Change

Degree	N	X̄sıra	Df	x^2	p
1. Never	19	148.39	4	18.402	.001
2. Less	128	262.37			
3. Sometimes	236	266.04			
4. Much	141	300.95			
5. Too much	18	307.33			

As clear in Table 7, there is a significant difference between the mean scores for climate literacy levels according to the degree of being affected by climate change, and the calculated effect size was found to be small ($X^2_{(4)}$=18.402; p=.001, p<.05; η^2=0.03). According to the results of the Mann-Whitney U Test conducted to determine between which groups there is a significant difference:

Among the students, those who are not affected by climate change are at a low level, and the effect size is low (U=768.5; Z= -2.585; p = .010; p<0.05; r = -.11), at the level of sometimes and the effect size is low (U=1216.5; Z= -3.317; p = .001; p<0.05; r = -.14), at an excessive level and the effect size is low (U=542.5; Z= -4.206; p = .000; p<0.05; r = -.18) level. According to these findings, it can be suggested that as the frequency of exposure to climate change increases, there is also an increase in climate literacy levels. This result can be said to be consistent with previous findings that students associate with climate change, such as floods and overflows,

and excessive and irregular precipitation. Moreover, it can be stated that those who experience the events they attribute to climate change also have higher climate literacy or are more interested in climate and climate change-related issues.

Findings on the Relationship between Students' Climate Literacy Levels and Variables

The study attempted to determine the relationship between students' climate literacy levels and gender, grade, participation in environmental activities, following climate change developments, and the degree of being affected by climate change. In this context, the correlation results showing the relationships between the students' climate literacy levels and the determined variables are available in Table 8.

Table 8. Spearman Rank Difference Correlation Results Showing the Relationship of Variables

Variables	01	02	03	04	05	06
01. Climate Literacy	1.000	-.207**	.182**	.089*	.403**	.141**
02. Gender		1.000	.012	-.064	-.086*	-.012
03. Grade			1.000	.007	.125**	.035
04. Participation in environmental activities				1.000	.175**	.030
05. Following climate developments					1.000	.232**
06. Being affected by climate change						1.000
*p<0.05 ; **p<0.01						

As in Table 8, there is a low and negative correlation between students' climate literacy levels and gender (r = -.207), a low and positive correlation between grade (r = .182), a low and positive correlation between participation in environmental activities (r = .089); a moderate and positive correlation between following climate developments (r = .403); and a low and positive correlation between being affected by climate change (r = .141). It is also observed that there is a low-level and positively significant relationship between following climate developments and being affected by climate change (r = .232). According to the research findings, the significant relationship between students' climate literacy levels, particularly the degree of following climate developments and being affected by climate change, is noteworthy and in line with the correlation values.

Findings Related to Students' Opinions on Climate Change

In the research, the students were told, "A village and its surroundings were investigated, and it was discovered that the rocks in the area contained a large amount of gold ore and rich coal reserves. Following this discovery, a thermal power plant and gold mine processing facilities will be built in the region. Especially in the regions where olive groves and forest areas are dense, the local people are taking the situation to court with the start of tree cutting, and the court decides to stop the construction of the facilities. A case text is given in the form stating that "the gold mine and coal investors, who caused the cutting of approximately 6000 olive trees in the region, have been trying to talk the villagers out of their complaints after the court has decided to halt the mining by promising them that the facilities to be opened will provide jobs for the local people and that they will get richer." They were asked to complete this case text according to whether or not they decided to withdraw or not to withdraw their complaints and to explain the reasons for their decision. The distribution of the responses to this case text, which was completed to reveal students' opinions on climate change, is presented in Table 9.

Table 9. Completing the Case Text on Climate Change Chi squared Result

Answers	N (Observed)	Df	x2	p
Yes, I would take the complaint back.	85	1	232.899	.000
No, I would not take the complaint back.	432			

In Table 9, it is apparent that a large part of the students (432 people) stated that they would not withdraw their complaints. According to the results of the single sample chi-squared test, there is a significant difference between the students' answers to complete the case text, and it was found that the calculated effect size is very high ($X^2_{(1)}$=232,899; p=.000, p<.05; η^2=0.45).

According to the results of the two-way Chi squared test conducted to determine whether there is a relationship between students' opinions on completing the case text and the grade level they study, there is a significant relationship between the grade level and their opinions on climate change, and it was found that the calculated effect size is small ($X^2_{(3)}$=8.625; p=.035, p<.05; η^2=0.01). According to the results of the two-way Chi-squared test conducted to determine if there is a relationship between students' opinions in completing the event text and participation in the environmental activity, it is observed that there is a significant relationship between

participation in the environmental activity and the opinion on climate change, and the calculated effect size was found to low ($X^2_{(3)}$=10.044; p=.018, p<.05; η^2=0.01).). Based on the results of the two-way Chi squared test conducted to determine whether there is a relationship between students' opinions on completing the case text and being affected by climate change, there is a significant relationship between being affected by climate change and their opinions on climate change, and it was found that the calculated effect size is small ($X^2_{(4)}$=11,240; p=.024, p<.05; η^2=0.02). In line with these findings, it can be said that in the dilemma of deciding on the outcome of the case text about climate change, as the grade level, frequency of participation in environmental activities and the level of being affected by climate change increase, students tend to show more behavior towards reducing the effects of climate change.

Sample sentences of students' opinions on completing the case text are shown in Table 10 according to the themes.

Table 10. Sample Sentences for Opinions on Completing the Case Text on Climate Change

Themes	N	Example Sentences
Yes, I would take the complaint back.	85	"Yes, I would withdraw my complaint. Because: people prioritize job opportunities, that is, earning an income, above everything else. It is more important that we do not withdraw the complaint regarding climate change, but financial income is in people's first plan..." (E115) "… I would take back my complaint because he would give me a job." (E219) - "Yes, I would take it back because I think gold and coal would be more useful to people than 6000 olive trees." (K454)
No, I wouldn't take the complaint back.	432	"No, I would not withdraw my complaint. Because the main wealth is nature, I will not let it deteriorate." (K13) - "No, I would not. Because the damage and exposure of the region to poison in general is much more important than a few job opportunities." (E108) "I would not withdraw my complaint. I liked the questions very much. I think more studies like this should be done; the necessary channels should be consulted, people should be more aware, climate change impacts all people and living things." (E274) - "No, I would not, because I am aware of the damage that thermal power plants can cause to nature." (K460)

In Table 10, most students declare that they will behave sensitively toward the environment and climate change. As seen in the example sentences, economic concerns and financial conditions, such as unemployment problems negatively affect some students' attitudes towards being environmentally friendly and sensitive to climate change, and it can be said that they prioritize individual and social-economic benefits in the shorter term.

DISCUSSION AND CONCLUSION

In this research conducted to examine the climate literacy levels of students studying in secondary education in terms of some variables and to reveal their opinions on climate change, it was found that the majority of students (71.3%) follow the developments related to climate change and think that they are exposed to the effects of climate change (72.9%). While the internet is considered the most essential source of information about climate and climate change, it is followed by books, magazines, and television programs. School and family ranked last as sources of information. Similarly, in the studies conducted, it has been revealed that the two most important sources of information about climate change are television news and the internet, and the participation rates of students in research and projects are very low (Inel Ekici, 2017; Saracoglu & Kahyaoglu, 2018; Okumuş & Yetgil, 2020; Işık & Ulus, 2021; Altınbilek, 2022). In the World Youth Report prepared by the United Nations (2010), the importance of youth's active role in the steps to be taken to reduce the effects of climate change, in which young people create sensitivity to climate change, primarily through media and education, was emphasized. In the studies conducted, young people are the most affected by the effects of climate change, including the consequences that changing climate conditions will have on the food and agriculture sectors (UN, 2021, 2023). The fact that young people in secondary education are one of the most important target groups to raise awareness and take action on climate change should not be ignored.

The students stated that they are exposed to the most floods and overflows and excessive and irregular rains in the place where they live (Turkey-Bartın) and are also affected by epidemics and a decrease in agricultural products. Nonetheless migration, decrease in the diversity of living things, forest fires, sea level rise, and drought have been mentioned to a lesser extent as the effects of climate change. In the studies conducted, it has also been concluded that students are aware of the effects, such as floods and forest fires related to climate change in the place where they live (Kılınç et al., 2008; Aksan & Çeliker, 2013; Aydın, 2015; Eroğlu & Aydoğdu, 2016). These

results imply that climate change awareness is important locally and that solutions should be developed in the context of ecological sustainability appropriate to local conditions.

While the high mean scores of students in the "climate awareness" dimension, where the items related to climate change are included refer to a significant result, the low mean scores in the "climate consciousness" dimension, where the items related to reducing the effects of climate change and taking action are included, are a result that needs to be studied. Although the mean for the "climate concept" dimension is relatively high, it should be considered that students do not see school as an important source of information about climate change. Considering the issue of climate change at the secondary education level in Turkey as an achievement in the geography course curriculum (Gülersoy, 2022), the lack of ecological sustainability issues (Ünal & Kaygın, 2020; Ünal & Ünal, 2023) may be an important reason for this result. In studies on climate, climate change, and related topics, it has also been determined that students have insufficient knowledge and misconceptions (Bord et al. l., 2000; Demirkaya, 2008; Choi et al. l., 2010; Coşkun, 2010; Meehan et al., 2018; Arslan & Görgülü Arı, 2021; Kılıçoğlu & Akkaya Yılmaz, 2021; Altınbilek, 2022). Another study concluded that although there are information deficiencies, young people's awareness of climate change is high (Henden Şolt, 2022). In many countries (Canada, USA, Spain, South Africa, Turkey, Germany, Finland, Australia, England, and Sweden), climate and climate change topics are taught in schools with an interdisciplinary or disciplinary approach (Barak & Gönencgil, 2020). Education is of great importance among the measures to adapt to climate change and mitigate its consequences (Dalelo, 2011). Certainly, the inclusion of more achievements in secondary education climate change education programs in Turkey (Kahraman & Şenol, 2018; Türkeş, 2022, Gülersoy, 2022) and the implementation of activities and studies involving climate action related to this issue will play an important role in improving this situation.

The analyses conducted according to variables found that the climate literacy levels of female students were higher than male students. There was no significant difference in the climate literacy levels of students according to the type of school, the location of the school, the educational level of parents, and the frequency of participation in environmental activities. In a study conducted, it was also stated that there is no significant difference in climate change awareness according to age, marital status, education level, welfare level, and place of residence variables other than gender (Ağıralan & Sadioğlu, 2021). In a study on ecological sustainability, there was no difference according to the place of residence (Ünal & Ünal, 2023). On the other hand, it was also determined that there was an increase in climate literacy levels as the grade levels, the frequency of following the developments related to climate change and the degree of being affected by climate change increased. In various studies, it has been found that female students and other women are more concerned about climate change, and their awareness is higher (Ağıralan & Sadioğlu, 2021; Berker, 2021; Işık & Ulus, 2021).

In contrast to this research, another study indicates that those in rural or low socio-economic positions are disadvantaged in climate change awareness, and their awareness is low (Berker, 2021). This can be explained by the fact that climate conditions and climate change impacts are similar in rural or urban areas in Bartın Province where the research was conducted, i.e., local conditions. Generating solutions suitable for local conditions in adaptation to climate change and mitigation of its impacts will also align with the United Nations "Climate Action" goal. It will provide an opportunity for a more sustainable ecological life locally.

Based on the results of the research, there is a positive and significant relationship between the climate literacy levels of the students and the status of following climate change developments and being affected by climate change. A similar result was found when students' opinions on climate change were evaluated. It was found that as the grade level, frequency of participation in environmental activities, and level of exposure to climate change increased, they tended to exhibit behaviors aimed at reducing the effects of climate change more. However it is also noteworthy that some students tend to put behaviors and actions that are not environmentally friendly and aimed at reducing climate change on the back burner due to economic concerns and financial problems like unemployment. While economic concerns of individuals and problems including unemployment are important obstacles to exhibiting environmentally friendly behaviors, legal regulations and the production of national solutions with government incentives and support are the most critical solutions in ecological sustainability (Eriksen & O'Brien, 2007; UN, 2016; Tarhan et al. l., 2017; Ünal & Kaygın, 2020; Ünal & Ünal, 2023; UN, 2023) and climate action.

Implications

Although climate literacy and climate change awareness are among young people, there is a need for education and interdisciplinary studies on the subject.

Limitations

This study was carried out in a city in Turkey.

Statements of Publication Ethics

In this study, the principles of publication ethics were followed and necessary permissions were obtained with the approval of Ethics Committee document numbered 022-SBB-0384.

Conflict of Interest

This study does not have any conflict of interest.

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