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Examining Students' Thoughts on Climate Change in the Context of Basic Concept

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Abstract

In this study, our aim was to investigate the beliefs of middle school students about climate change. We conducted study with 183 secondary school students. Within the scope of the study, students were asked two questions about climate change, and written responses were analyzed using an embedded a mixed-method approach. The questions posed were: (1) What is the cause of global warming? (2) What factors influence the climate? Based on the results of the quantitative analysis of the participants' responses, the answers to the first question were "human," "greenhouse effect," and "Earth." The concepts of "pollution," "atmosphere," and "Earth" are used in the second question. As per the qualitative analysis results, the students' responses focused on three elements: "living things, Earth, and atmosphere." The students responses to the second question reveal a more specific or general attitude. The findings indicate that students view climate change not merely as an isolated phenomenon but as a complex system influenced by various components. It is also suggested that students have an understanding of the distinction between weather and climate. The ability to connect climate change with social issues may encourage individuals to make greater efforts in mitigating its effects.

Key Words

Climate literacy • Climate change • Beliefs of middle school students

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Introduction

Enhancing society's knowledge about climate change is a paramount goal for this situation, which affects all living things in the world. Achieving this awareness goal is crucial and the approach taken to achieve it is equally vital. Considering that education plays an important role in preserving natural balances, this process should not be limited to schools (Merenlender et al., 2016; Olander and Olander, 2017; İbret, Demirbaş and Demir, 2019). This situation shows the importance of climate literacy. As Laugksch (2000) states, a sub-dimension of scientific literacy is awareness of the impact of science on society. On the other hand, the ecological footprint method is used to understand the connection between social and personal impact on climate change (Cordero, Todd, and Abellerra, 2008). "The relationship between education and the environment is deeply interconnected, forming a mutually beneficial partnership that plays a critical role in shaping a sustainable future. In a world grappling with increasingly complex environmental issues, it becomes ever more evident that education is a cornerstone in enhancing environmental consciousness, advocating for sustainable behaviors, and empowering individuals to take on the role of responsible caretakers of our planet (Shutaleva, 2023).

Education serves as a potent instrument for raising awareness about urgent environmental concerns. By integrating environmental topics into educational curricula across various levels, institutions of learning can furnish students with the knowledge and insight needed to grasp the consequences of human activities on the natural world. Educators have the opportunity to underscore the significance of key concepts like climate change, biodiversity decline, pollution, and resource depletion, thereby ensuring that students recognize both the immediacy and potential ramifications of these issues (Stevenson et al., 2014).

Education carries the potential to spark systemic transformation by influencing public opinion, shaping policy development, and inspiring collective action. Educational establishments contribute significantly to broader societal shifts toward sustainability by educating forthcoming generations on environmental challenges and the principles of sustainable living (Sterling, 2004).

This perspective has been used to draw attention to students' biological capacities in nature, as well as the connection between resources and demands in the natural world (O'Gorman and Davis, 2013). Burkholder et al. (2017) conducted a study examining the effects of climate change-oriented curriculum on undergraduate students in higher education.

Therefore, the purpose of our research is to elucidate students' attitudes towards climate change, aiming to gain a deeper understanding of how education can drive behavioral changes and enhance comprehension of climate change. We also aim to emphasize that fostering scientific literacy and climate literacy can significantly contribute to utilizing climate change insights for making informed decisions about the future.

Scientific Literacy

Scientific literacy is regarded as an essential factor in preparing the next generation to be responsible for achieving long-term growth (Kurbanođlu, 2010). Information literacy refers to a concept that covers the dimensions of obtaining, evaluating, and sharing information (Andretta, 2007). Understanding what climate change is, what

changes we can make as a society, accepting the responsibilities of our actions, and reducing the damage we do to the environment are important issues for humanity. The concept of scientific literacy emerged in the late 1950s and has been expanding since it was defined by Paul Zurkowski in 1974 (Bybee, 2015; Kurbanoğlu, 2010). The focus of this study is climate change, which students often encounter in different environments and sources in schools and outside school.

Climate Literacy

Unexpected changes in the average or usual weather cycle of a particular city or region are called climate change (Türkeş, 2001). For example, it is the noticeable change in annual average precipitation and temperatures in a certain season (Öztürk, 2002). Reducing the impact of climate change is possible with the participation of all segments of society in the measures taken and practices (Stevenson et al., 2014). This can be achieved by informing and raising their awareness. For this reason, it is very important to educate students, who are the adults of the future and constitute an important segment of society, on this subject., Shepardson et al. (2012) conducted a study with secondary school students in this context and examined how students conceptualized climate change. They determined that students thought that global warming only affected air temperatures and that they had difficulty distinguishing between climate change and global warming. They could not distinguish the effects of global warming in different climates and the difference between weather and climate. However, it was also revealed that students understood the relationship between the carbon cycle and the greenhouse effect. Cordero et al. (2008) conducted a study on 400 university students and determined that, as a result of lessons on climate and weather, students showed greater awareness of climate change than before the study.

After all this, it becomes clear that climate change literacy, which is a sub-version of scientific literacy, is important and that studies on this subject need to be done. Here, science literacy teaches individuals basic concepts related to climate change, such as energy cycles, greenhouse effect, temperature changes, sea level rise, and climate models. These concepts provide a basis for understanding and discussing the phenomenon of climate change, helping individuals understand the reliability and validity of information about climate change and make informed decisions. Climate change literacy involves understanding the natural sciences, particularly fields such as atmospheric science, oceanography, meteorology, and environmental science. Therefore, knowing about climate change requires an understanding based on these scientific foundations. As a result, science literacy plays a fundamental role in acquiring, evaluating and understanding information about climate change. Climate change requires people to understand the world and environmental changes more deeply. Therefore, science literacy is an important component in the fight against climate change. In light of all this information, the research question of this study was determined by the researchers as follows: “How do the educational experiences of middle school students shape their beliefs about climate change?”. Our main purpose in this study is to investigate the perspectives of secondary school students, who are considered the adults of the future, on climate change.

Method

In this study, the effect of students' educational experiences on their beliefs about climate change was examined. In this study, where mixed methods were used, the integration of qualitative and quantitative data was examined.

Detailed analysis of quantitative and qualitative data was carried out in order to analyze the questions asked to students about climate change in detail. Data were collected and analyzed through open-ended questions. Detailed information about this is included in the subheadings below.

Participants

This study involved 183 eighth-grade students continuing their education in a provincial center in the Western Black Sea Region. The participants of the study take science courses that form the basis of university-level education in natural sciences, mathematics, and technology (MEB, 2018). Participants were selected on a voluntary basis with the consent of their families. 30% (54) of the students receiving education lived in rural areas, while 70% (129) lived in urban areas. The participants were selected randomly from five different classes. Choosing the source for data in a research is important in terms of the representativeness of the research results and their meaningfulness for similar groups or environments (Yıldırım and Şimşek, 2013). In this context, the evaluation of the results obtained from the participants was handled both from a general perspective and independently of each other. However, factors such as students' socioeconomic backgrounds, gender, or academic achievement levels were not considered. Among the study participants, 85 were girls, and 98 were boys.

Data Collection and Analysis

In the data collection phase, two open-ended questions were given to the students and they were asked to answer them. The questions were developed by the researchers and expert opinions were taken for their reliability and validity. Question 1 (Q1) was asked in a defined form: 'How would you describe climate change? Discuss as many possibilities as you can. Question 2 (Q2) concerned the reasons for climate change: "What influences the climate?" Discuss as many possibilities as you can. The data were analyzed utilizing an embedded mixed-method methodology (Ilgar& Ilgar, 2013). In addition, this data set was used to quantitatively analyze the word-forming frequency in a quality design to identify the meaning between answers to two questions by students.

A qualitative and quantitative analysis of the responses was carried out. During the research process, students' awareness of climate change was examined to establish educational guidelines on climate-related sustainability initiatives. The quantitative research includes critical details such as the frequency of word usage in students' responses. This process was carried out using the "Word Analysis Tool" of Text Finder (2007) Qualitative analysis was supported by identifying the major categories that stand out in the students' answers. Qualitative analysis was carried out to determine the principal subjects and subgroups characterized in the students' answers. The answers to the two questions were first read to the students many times separately by each of the two researchers. It was then used to examine qualitative discrepancies in students' perceptions of climate change across the major identified categories. These sets of meanings are also verified according to a framework developed by Shepardson et al. (2012). Here, he defines conceptual elements to contextualize climate change. This study's conceptual structure is focused on students' interpretation of the climate system. This comprises some notional components that have been used to describe the climate system, such as "climate, weather, energy, feedback, Earth, sun, atmosphere, ice, oceans, and vegetation". Each element encompasses the three-stage level, which refers to a progression from the least advanced to the most advanced understanding of another. For example, 'feedback' is a conceptual element of climate change,

and this event that occurs in nature is feedback given by nature to human or environmental factors. As stated by [Shepardson et al. \(2012\)](#), changes in the sun, atmosphere, oceans, ice, soil, and vegetation are the principal reasons for the change in the Earth's climate system, and these changes can occur for natural or human reasons. According to the same study's findings, human actions such as the use of coal and oil and the loss of forests can also contribute to climate change. In addition, a clear sense of the effects of changes in these systems on the general climate is associated with feedback from other constituents of the climate system. According to the findings of the same study, it was determined that changes in conceptual elements in the same category, but at the third level, can destabilize the system and even give rise to Earth's orbit changing. It has been stated that human activities such as solar flares, natural changes in the Earth's climate, the use of fossil fuels, and the loss of forests may also be reasons for the change in the climate system. The clear impact of these changes on the overall climate will be associated with feedback from other constituents of the climate system.

An embedded mixed approach in this study ([Ilgar and Ilgar, 2013](#)) was applied. As a result, the same data set was subjected to both quantitative and qualitative analyses. The students' submitted responses were evaluated by revealing the main themes in the responses. We then subjected the themes to further qualitative analysis of what climate change is. The system established by Shepardson et al. progressed from the least advanced responses to the most advanced responses in this study. The quantitative analysis findings revealed three major categories connected to the reasons for climate change. We also looked at these themes to see if there were any contextual variations in students' beliefs.

Findings

Descriptive Findings

Quantitative analysis results indicate that the 183 student responses contained 12,286 words ($m = 89.53$) for the first question and 12,491 words ($m = 92.21$) for the second question. Of the 24777 words obtained from the students' responses, the most used word is "Earth" 142 times (0.7%) (Table 3). During the analysis phase, renditions and conjunctions such as "and", "with", "if", and "this" and repeated words in the questions are excluded. As shown in Table 1, the three most commonly used words to respond to the first question were 'human,' 'greenhouse effect,' and 'Earth,' while Table 2 indicates that the most frequently used words to address the second question were 'pollution,' 'atmosphere,' and 'Earth.'

The word 'Earth' is the most frequently used term to describe climate change. This can be attributed to the 'greenhouse effect,' which leads to the melting of glaciers and rising temperatures. Furthermore, words such as 'air pollution,' 'pollution,' 'atmosphere,' and 'greenhouse gases' are commonly used terms associated with the causes of climate change. As a result of the analysis, it was revealed that "greenhouse effect", "heat" and "air pollution" are often used by students to express their understanding of climate change. According to the results of the quantitative analysis, the main categories in the students' responses are 'Humans,' 'Earth,' and 'Atmosphere' (including the greenhouse effect).

Table 1

Frequency of words derived from students' answers to the first question

Word	Frequency
Human	%72
Greenhouse Effect	%32
Earth	%31
Melt	%29
Heat	%26
Hot Air	%24
Animals	%23
Atmosphere	%18
Water Supply	%16
Air	%16

Table 2

Frequency of words derived from students' answers to the second question

Word	Frequency
Pollution	%48
Atmosphere	%41
Earth	%37
Air Pollution	%35
Greenhouse Gases	%31
Radiation	%29
Heat	%26
Sun	%25
Human	%20
Nature	%19

Table 3

Frequency of total answers to students' first and second question

Word	Frequency
Earth	%77
Human	%66
Greenhouse Effect	%65
Heat	%63
Air Pollution	%60
Pollution	%57
Sun	%55
Atmosphere	%42
Animals	%32
Melt	%32
Nature	%31
Radiation	%30
Agriculture	%27

Findings of Qualitative Analysis

The first qualitative question was examined from the most sophisticated to the most advanced interpretation of climate change. "Living things (humans or animals and their effects on climate change), Earth (reasons and conclusions), and atmosphere (causes or consequences)" are the categories that arise from the quantitative analysis of the second problem. This situation is clearly seen when Table 2 is examined. Here, the word 'pollution' was expressed most frequently with 48%. Later, the word 'atmosphere' emerged from the students' statements with a rate of 41%. Thirdly, the word 'earth' was used frequently by the students with a rate of 37%.

An analysis of the students' answers to the first question revealed their different interpretations. We analyzed these results based on the "conceptual elements" framework developed by [Shepardson et al. \(2012\)](#). There are some differences in the explanations of the students. Here, especially between the first and second questions, the word world is seen to be in the third place among the most frequently used words by the students. The fact that the word world was among the most frequently used words with a rate of 31% in the first question and 32% in the second question also shows that our study differs from other studies in the literature. While human aspects are prioritized in some explanations, aspects related to the natural environment are pushed into the background or not mentioned at all. Some statements did not give any views on which factors are affecting climate change. Student 2 stated the following about this finding: *'Temperature and weather patterns can cause climate change. On average, this change is in months, and this is the change in a general year.'*

Shepardson and others supported this view (2012). In his study, he stated that the air and atmosphere are in daily conditions and stated that the average temperature, precipitation, humidity, and wind conditions for long periods make up the climate.

While discussing natural changes, the student mentioned below did not delve into the root causes of climate change. Nevertheless, this student has a pessimistic attitude about climate change: *'Recent excessive climate changes have affected the natural environment and our world. Especially in recent years, extraordinary weather events in different geographies of the world and the rapid melting of glaciers have caused the effects and extent of global climate change to be felt. As global warming increases, polar ice caps melt. As glaciers melt, the Earth's water content increases, increasing the likelihood of flooding, and even some land conditions occur underwater. This can lead to people being homeless or even unable to farm. Climate change: The puncture of the ozone layer also causes the spread of bad and harmful gases into the atmosphere, the passage of the sun's rays to the earth without filtering, and the rays become very harmful.'*

This section corresponds to the conceptual elements described in the third level by [Shepardson et al. \(2012\)](#). In their study, the researchers asserted that the atmosphere's daily conditions (in the troposphere) encompass aspects such as temperature, precipitation, humidity, and wind. From these conditions, the climate must be long-term average and variable. He stated that climate differences occur globally because of changes in the climate system and at different time intervals.

Several responses also assessed natural climate change in the pace's context of change: *'The climate can constantly have some minor changes. Climate change consistently ranks among the fastest changes that have negative impacts on the world.'*

Finally, several responses include the different causes of climate change, the temporal aspect without attribution to them: *'One of the world's biggest problems is climate change. Air temperature or low temperature increases because of changes. As weather changes become more extreme, people use air conditioning, which brings up climate change more globally. As global warming increases, polar ice caps melt. As glaciers melt, the Earth's water content increases, increasing the likelihood of flooding. This causes ecosystems to deteriorate. Because of the deterioration of the climate, plant, animal, and soil yields decrease, and natural resources are depleted. Animals whose natural habitats are changing cannot adapt to their environment and as a result, are extinct.'*

The student who defines a conceptual aspect at level three in the following excerpt not only describes climate change but also analyzes and focuses on each individual's impact on climate change. Natural modifications are often accepted by the student: *'Changes in climates, deterioration, and differentiation of the climates of different regions of the world over time, destruction of water resources means climate changes. We can also express changes in the atmosphere as a result of the chemicals used today as the Earth warms, and the air temperature is below or above normal. Changing climates means changing seasons. It is a destabilization of the natural balance. Melting glaciers, extreme temperatures or extreme cold seasons, and climates around the world are intertwined. The depletion of water resources because of the decrease in the heat balance of the air here affects the regimen of water sources. Water potential decreases with excessive evaporation at high temperatures, water supplies may decrease, and drought may occur. With this decrease, the rates of fresh water and saltwater in the world are also changing, and water resources are disappearing due to the imbalance of rain and snow falls. It causes a decrease in the diversity of plants and animals. Climate change remains the world's problem. Unfortunately, this will affect our future generations as well.'*

The second question about climate change causes was designed to get students thinking about the reasons for climate change. The answers are formulated as open-ended so that their statements do not affect those who answer the questions. The following excerpt contains an ordinary response to this question. Here, at the macro level, people are hypothesized as important reasons for climate change. However, this perspective is rarely expressed from a personal or individual standpoint. Several expressions here have been found as feedback of the conceptual element (Shepardson et al. 2012). *'Humans play the biggest role in climate change. Uncontrolled sprays, excessive nylon, exhaust use. These are all products consumed because of production. There's so much production that it is already overdue. Of course, no one's calming the return of that. Everyone's consumer oriented. Unfortunately, it covers the entire world. For example, the garbage that comes out from under the sea shows that not only the land, but our waters are in great danger.'*

Only fourteen of all answers have touched on what everyone can contribute to mitigating negative climate change. The other answers are about what people can do. Participants view society as responsible for negative climate change at the macro level and have been observed to neglect individual responsibility. The following

excerpt is an exclusion since the student listed the options that everyone should think when acting to protect the climate: *'First, it is necessary to inform the community about this issue through various activities. We should pay more attention to recycling. Attention should be given to the use of energy (water, electricity). Industrialization should take measures against pollution and destruction. We must prevent rapid and distorted urbanization. Improper land use should not be allowed. We should put limitations on the use of substances affecting the ozone layer. Using fossil fuels should be reduced.'*

Although such responses are rare, the analysis conducted by [Shepardson et al. \(2012\)](#) on the students' statements revealed a more nuanced way of understanding how individuals perceive their everyday life situations in the data. Students have highlighted energy from fossil fuels and ecosystem degradation, but they have also been observed to highlight other aspects. Students shared their opinions on climate change through systemic thinking that included a variety of constituents: *'Environmentalists should be preferred in fuels used by industrial plants and vehicles. Electric modelers should be selected in cars. Otherwise, it is causing global warming. In this case, seasonal temperatures remain above normal, the waters evaporate, and water consumption increases. Thus, water supplies are reduced and the water level in our dams decreases.'*

Upon examining word frequencies, it was observed that the word 'earth' was frequently used in all three questions. This word was used with a rate of 31% in Table 1, with a rate of 37% in Table 2, and the highest rate was used with a rate of 77% in Table 3. When we look at the themes here, the word 'world' also appears in the themes. It can be said here that students think that this word is most related to climate change. Based on this, it can be said that our qualitative and quantitative findings are consistent with each other. In addition, the word 'human' appears as a highly used word in the first and third tables. Here, it can be thought that the students have stated that they have a significant impact on humanity in terms of climate change or sustainability. In Table 3, where the total responses are examined, it is observed that the word 'greenhouse effect' is perceived by the students as an important component in climate change with a rate of 65%.

Results, Discussion And Suggestions

As a result of our study, when the answers given by the students and the main themes in the answers were revealed, three main categories regarding the causes of climate change emerged. These are as follows:

- Living things
- World
- Atmosphere

The noteworthy findings garnered from this study necessitate responsible action on the part of all members of society to mitigate the deleterious consequences of climate change. The findings of our study showed that participants had various basic knowledge about climate change, such as the differences between weather events and climate change. Participants also emphasized social factors among the causes of climate change. This finding is similar to the findings of [Ratinen \(2021\)](#) and [Özdem et al. \(2014\)](#) in another study on this subject, it was observed that students emphasized social issues related to the causes of climate change. This supports the result of our study.

Prokopy et al. (2015) and Plutzer et al. (2016) stated in their study that teachers lack knowledge on basic issues related to climate change, such as the factors affecting the climate and how to slow down climate change. Another study found that there is a poor understanding of how to prevent climate change among teachers who have difficulty determining what affects climate change, and teachers do not have the necessary skills to teach their students how to develop a healthy world. Papadimitrou (2004) obtained findings in his research that are compatible with the findings of this study. Bozdin et al. (2014) conducted research pertaining to the comprehension of climate change among secondary school students. The study discerned that the participants exhibited an understanding of the distinction between fluctuations in weather conditions and the phenomenon of climate change, and they articulated global warming as a contributing factor to climate change (Bozdin et al. 2014). Leiserovitz et al. (2011) and Lombardi and Sinatra's (2012) study conducted with high school and higher education students found that the participants had a general lack of knowledge about climate change. This result differs from our study result. Because it was concluded that the participants of our study could evaluate the historical repetition or speed of climate change and express different levels of knowledge about climate change, that is, they had knowledge on the subject. The findings of Lombardi and Sinatra (2012) are similar to the findings of Olander and Olander (2017).

The investigation yielded the conclusion that the diversity and quantity of terminology employed by participants in a separate study to convey the concept of climate change serve as indicators of their vested interest in and familiarity with this subject matter. In their study with secondary school students, Olander and Olander (2017) asked the students two questions. According to the findings of the research, students used an average of 85.81 words in the first question and 93.01 words in the second question. From this perspective, it was determined that the findings of this study (S1, E: 89.53 and S2, E: 92.21) were similar to the findings of Olander and Olander (2017).

In our study, the answers given to the question "What affects the climate" showed that a social or general perspective emerged. The ability to relate social or general problems to personal problems can enable students to take more individual responsibility for climate change. The results of this investigation demonstrate an elevation in students' levels of knowledge. Similar findings were also obtained by Bozdin et al. (2014) in their research, as reported by Özdem et al. (2014) and Shepardson et al. (2012). However, it is necessary to investigate and determine which factors are effective in the formation of students' beliefs and attitudes regarding climate change and ecological balance. This aspect can be clarified by researching this issue in the future

In addition to all these, sustainability should be taken into consideration when providing climate change training. In particular, these trainings will be significantly effective in growing sustainable societies. Climate change education is very important for sustainable development. When elucidating the subject of climate change to students or instilling these concepts in them, it is imperative to incorporate notions associated with sustainability. The inclusion of these concepts not only enhances the comprehension of sustainable development but also underscores its significance. As sustainability becomes more prevalent in people's minds, awareness of climate change will increase significantly. Here, it is expected that the student's skills regarding sustainable development and climate change will increase. This expectation will enable them to establish a connection between the concepts of sustainability and climate change (Barak and Gönençgil, 2020).

Considering all these, it has emerged that students need to be informed more about climate change. Our study contributed to revealing this situation. Given the persistent escalation in discourse surrounding this matter in contemporary society and in successive generations, it ensues that this issue assumes paramount importance, necessitating a thorough and comprehensive elucidation to students. It should be emphasized that the problem is not just about weather events, but also that many facts and events related to human life are due to climate change. More research should be done on the subject. It is recommended to explain the subject more to students and to carry out different studies on climate change, especially using artificial intelligence tools.

Ethic

It should be stated which ethics committee approval was obtained from the research data. (25.03.2021, 1-57, Kastamonu University)

Author Contributions

All processes of the article (Introduction, Method, Results and Conclusion) were carried out by the author.

Conflict of Interest

The author declare that they have no conflict of interest.

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