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# Climate change education in elementary grades

Seda Saraç [1], Nihal Yapıcı [2], Hale Güneş [3]

## Abstract

This study aimed to evaluate an eight-week Understanding by Design-based climate change program implemented in 153 elementary schools across Türkiye (65 cities) with a total of 1350 teachers and 35000 students. 402 teachers from 77 schools in 35 cities filled out the teacher opinion form to evaluate the program. Additionally, three focus group interviews with a total number of 26 teachers were conducted in the three biggest cities in Türkiye. In focus group interviews and teacher opinion forms, teachers were asked to evaluate the curriculum in terms of context, input, process, and product. The transcriptions obtained from the focus group interviews and teacher opinion forms were analyzed with content analysis. According to the findings of the study, the curriculum effectively addressed the teachers' needs for climate change education, and the activities helped students to understand and transfer knowledge to their daily lives. However, due to physical limitations and a lack of time, sometimes the activities could not be completed as desired. As a result, this research found that climate change education developed using Understanding by Design is effective for students to comprehend and apply knowledge in their daily lives, which are the ultimate goals of climate change education.

## Keywords

Climate change education
Climate action
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## Introduction

Türkiye is one of the vulnerable countries that is greatly impacted by climate change (CC) (Kadıoğlu, 2012). CC has led to an increase in irregular and rapid precipitation as well as a shift toward a hotter, drier climate more akin to that of the desert. This results in erosion, desertification, and flood disasters. These dangers highlight the significance of including climate change education (CCE) in Turkish curricula. As a result, Türkiye's priorities in the 11th Development Plan include environmental education and awareness-raising initiatives, sustainable production and consumption, and nature and environment protection (Presidential Office of Strategy and Budget, 2019). Indeed, as of 2021, the name of the Ministry of Environment and Urbanization was changed to the Ministry of Environment, Urbanization and Climate Change (MEUCC). A further indication of the importance attached to CCE at the national level is the National Climate Change Action Plan 2011-2023 published by the MEUCC (2011), recommending that topics related to CC be incorporated into the curriculum beginning with

[1] Bahçeşehir University, Faculty of Educational Sciences, Department of Preschool Education, Istanbul, Türkiye, seda.sarac@bau.edu.tr
[2] Ibn Haldun University, Faculty of Educational Sciences, Department of Educational Sciences, Istanbul, Türkiye, nihal.yapici@ihu.edu.tr
[3] Hale Güneş Eğitim & Danışmanlık, Türkiye, erkencocukluk@gmail.com

early childhood education. All of these have led to the inclusion of CC in the national curricula. With a cyclical and interdisciplinary approach, themes about climate and CC are incorporated into the curriculum of Social Sciences and Science and Technology courses (Barak & Gönençgil, 2020).

Additionally, as of 2021-2022, the Environmental Education course, which is an elective course at the middle school level, has been updated as the Environment and Climate Change course and the concepts related to climate and CC have been incorporated into the program. At the high school level, CCE is covered within the scope of the geography courses. For younger age groups, however, there is no systematic instruction about climate change. CC is a problem that impacts all of us, including children, and it will continue to do so. Young children witness conversations about complicated environmental issues, such as CC, on a daily basis. Schools and educators must be ready to help children navigate difficult environmental challenges like CC (Axelrod et al., 2020; Bloch et al., 2014; Elliott & Davis, 2009; Ginsburg & Audley, 2020). As a result, it's critical that CCE begin at a young age, particularly in countries like Türkiye that are vulnerable. At the elementary level CCE remains a relatively underexplored area in both research and practice, despite the increasing exposure of young children to climate-related discussions in their daily lives (Axelrod et al., 2020; Bloch et al., 2014). While some studies have examined CCE in elementary education, these investigations primarily focus on instructional methods and tools rather than evaluating a comprehensive curriculum. For instance, Axelrod et al. (2020) address this gap by exploring the role of picture books as a pedagogical tool for engaging both teachers and students in climate discussions. Their research underscores the potential of picture books as an accessible and developmentally appropriate medium to introduce climate concepts to young learners, fostering curiosity, emotional engagement, and critical thinking. Additionally, the study highlights the importance of such resources in supporting teachers, particularly those who may feel unprepared or lack confidence in addressing climate-related topics in the classroom. By utilizing narrative storytelling and visual representations, students can develop a deeper understanding of abstract climate concepts, while educators can integrate these materials into broader literacy and science curricula. However, the study does not present a structured curriculum but rather investigates how storytelling can facilitate climate change discussions in early childhood education without assessing a large sample of students.

Similarly, Banks and Taylor (2025) examine the integration of arts-based methods in CCE within elementary schools in the United Kingdom. Their findings suggest that conventional science-based instruction often fails to foster emotional engagement, whereas creative approaches—such as storytelling, visual arts, drama, and music—enable students to articulate their understanding of climate change in more meaningful and engaging ways. These strategies help bridge the gap between scientific knowledge and personal experience, promoting critical thinking, empathy, and agency among young learners. However, their study also highlights significant curriculum gaps, noting that climate change is not systematically incorporated into elementary education, and teachers encounter obstacles in implementing CCE due to inadequate resources and professional development opportunities. Despite these challenges, Banks and Taylor (2025) do not propose a comprehensive curriculum but instead focus on how arts-based pedagogical strategies can be effectively integrated into the existing framework of the UK National Curriculum to enhance climate education. Therefore, it can be stated that this study fills a significant gap in the literature by evaluating the effectiveness of an 8-week curriculum on climate change education in elementary grades.

***What of Climate Change Education***

Providing information about nature is not enough to promote sustainability. Children must be provided with the resources they need to recognize the complexity of natural systems and the complicated relationship between nature and life and to undertake societal change (Davis, 2010). Therefore, successful CCE should emphasize children's understanding of this relationship and how to transfer that understanding to daily activities. Thus, effective CCE should impart an understanding of basic climate science, the causes and effects of climate change, as well as adaptation and mitigation strategies (Anderson, 2012; Mochizuki & Bryan, 2015). However, equipping children with this

knowledge will not be enough. Although there are various scenarios about how CC will affect our world in the future, there is uncertainty about what exactly will happen. The development of skills like critical thinking, problem-solving, lifelong learning, and the capacity to adapt to and deal with risks and uncertainties must also be key components of CCE (Mochizuki & Bryan, 2015).

***How of Climate Change Education***

Effective CCE should have a connection to and significance for the student's own life. Instead of covering what is anticipated to occur to strangers in places they are unfamiliar with, it should focus on the students' own lives since learning is more effective and lasting when it is connected to issues that the students are directly affected by and when they frequently apply what they have learned to their actions (Monroe et al., 2019). The instructional methods and strategies to be employed are the other components to be considered when providing an effective CCE. It is crucial to develop constructivist learning settings in which students actively participate and use a learner-centered strategy rather than a teacher-centered strategy (Bardsley & Bardsley, 2007; Monroe et al., 2019). Activities that encourage students' active participation, such as group discussions, role-playing, hands-on learning, and games, both help the learning to be enduring and raise the possibility of transferring to the daily life of the students by raising environmental sensitivity.

***The current study***

This study evaluates the large-scale implementation of an 8-week CC program for elementary grades. To build the framework for the aforementioned *what* and *how* of CCE, there are various instructional design tools available. Understanding by Design (UbD) is one of these tools. UbD is a concept for curriculum design that emphasizes learning transfer and developing understanding. In UbD, the designer chooses the method for evaluating learning before selecting what to and how to teach. In this model, the designer uses a three-step method to define desired learning outcomes or goals, identify the learning evidence, and structure learning experiences (Wiggins & McTighe, 2011). By following these steps, the designer prioritizes students' needs and understanding, assesses student comprehension through performance tasks, and places a high value on transferring knowledge into daily life and other courses (Yurtseven, 2020). Since the transfer of knowledge is the core element in CCE, the authors used UbD to address the gap in the lack of a program for elementary school-aged students in Türkiye. Eight-week UbD plans with a total implementation time of 16 hours were prepared within the framework of the program.

The developed program is implemented in 153 campuses of a private school chain across Türkiye (65 cities) with a total of 1.350 teachers and 35.000 students. This study aims to evaluate this program regarding teachers' views. Teachers were asked to evaluate the implementation according to the dimensions of the Context, Input, Process, and Product (CIPP) model developed by Stufflebeam (1971). According to Stufflebeam (2003), the Context dimension focuses on evaluating whether the objectives and priorities of the program meet the needs of the beneficiaries. The Input focuses on the adequacy of resources for the effective implementation of the program. The process focuses on the actual implementation and includes evaluations regarding working plans. The product evaluation focuses on whether the objectives were met. To our knowledge, there is no such comprehensive CC program at the national or international level for elementary school students. In this vein, the research questions of the study are as follows:

1. What are the teachers' views on the Context dimension?
2. What are the teachers' views on the Input dimension?
3. What are the teachers' views on the Process dimension?
4. What are the teachers' views on the Product dimension?

## Method

### *Research Design*

Using a qualitative descriptive research methodology, this study investigated teachers' views on implementing the UbD-based CC program. In qualitative descriptive research, the experiences, attitudes, and opinions of individuals are defined and described in relation to a certain topic (Willis et al., 2016). This design is consistent with the research questions, which center on teachers' perceptions of each CIPP dimension. By offering extensive descriptions of teachers' experiences, this design provides useful insights into how they interpret and administer the program. The design also made it more straightforward to understand how teachers felt about the UbD-based CC program.

### *Participants*

The data of the study were collected through teacher opinion forms and focus group interviews. All participating teachers had a BA degree in education. A total of 402 teachers from 77 schools across 35 cities participated in the study by completing the teacher opinion form, which was distributed via Google Forms and emailed to the participants. Among the respondents, 366 were female and 36 were male, reflecting a predominantly female sample. The teachers' ages ranged from 21 to 65 years (M = 36.88, SD = 10.83). Their professional experience varied from 1 to 46 years, indicating a diverse range of career backgrounds.

Three focus group interviews were conducted in the second phase. A total number of 26 (Female=23; Male=3) teachers from three different schools in the biggest cities of Türkiye, namely Istanbul, Ankara, and Izmir, participated in the focus groups. Teachers were recruited using the maximum variation sampling method (Creswell, 2012). Attention was paid to the presence of teachers teaching at different grades. The ages of the teachers ranged from 21 to 42 (M=.36.92; SD= 10.78). All the interviews were audio recorded with the teachers' consent. The professional experience of teachers ranged from 1 to 21 years. The focus group information is displayed in Table 1.

**Table 1.** Focus group participants by city, gender, and grades taught

| | | Grade Taught | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Group** | **City** | **Grade 1** | | **Grade 2** | | **Grade 3** | | **Grade 4** | | **Total** |
| | | **Female** | **Male** | **Female** | **Male** | **Female** | **Male** | **Female** | **Male** | |
| Group 1 | İstanbul | 2 | 0 | 2 | 1 | 2 | 0 | 1 | 1 | 9 |
| Group 2 | Ankara | 1 | 1 | 2 | 0 | 2 | 0 | 2 | 0 | 8 |
| Group 3 | İzmir | 2 | 0 | 2 | 0 | 3 | 0 | 2 | 0 | 9 |

### *Data collection tools*

*Teacher opinion form*

The form was divided into two sections. Demographic information, including gender, age, the school the participants work at, seniority, and grade level taught, was included in the first section. The CIPP framework (Stufflebeam, 2003) was selected due to its comprehensive structure for evaluating educational programs, aligning with the aim of the study to evaluate multiple dimensions of curriculum implementation. Specifically, the CIPP model allows for a systematic examination of program design (Context), resources and strategies (Input), implementation (Process), and outcomes (Product), making it a suitable lens for capturing teachers' perspectives on the UbD-based CC program.

*Focus group interview questions*

Focus group interviews encourage participants to speak freely and share their thoughts since the casual setting of the group discussion encourages discussion among all participants (Yin, 2011). In focus group interviews, teachers were asked questions aligned with the context, input, process, and

product dimensions of Stufflebeam's (2003) evaluation model. The researchers initially drafted the questions, which were then refined by expert opinions.

***Data collection***

The data collection of the study was carried out in April-May 2022. All teachers received the teacher opinion forms through email at the beginning of May 2022, and they had two weeks to respond. The first researcher performed all focus group interviews face-to-face. After setting a date for the interview, the researcher went to the school that day to conduct the interviews. Each interview lasted approximately 60 minutes.

The study adhered to ethical principles to ensure the rights of all participants. The study was approved by Bahçeşehir University's Institutional Review Board (Date: 27.10.2021 No: 2021/09) prior to its initiation. All participants supplied informed consent after being instructed on the study's objectives, methodology, and their rights, which included the ability to withdraw at any time with no consequences. To maintain anonymity, all identifying information was anonymized and data was securely stored. Furthermore, participants were informed that audio recordings from focus group interviews would be utilized solely for research reasons and deleted after transcribed.

***The Climate Change Program***

The CC Program is an 8-week program that consists of four modules. UbD offers a monthly framework for designers to think critically about the essence of each unit by illuminating the big idea and essential questions and the transfer of ideas elaborately. Furthermore, designers work on a performance task that helps teachers understand whether students have acquired the learning objectives and think about active learning experiences that will help students learn in the best way. The CC Program begins with the fundamentals of climate and proceeds to CC, underlying reasons for climate change, its effects, and strategies to deal with it. The first module, named *What is Climate?* introduces weather conditions and climate by establishing a relationship between climate and living things. The second module, *Climate Change,* helps the students learn about CC by drawing attention to the effects of human activities on the natural cycles and the warming of the earth. In the third theme, *The Effects of Climate Change,* students learn about the impact of CC on Earth and living creatures. In the last module, *Coping with Climate Change,* students explore actions to reduce the effects of CC by taking personal initiatives. Each module is accompanied by a performance task by which students delve into some inspiring activities to develop their own perspective, think critically, and explore activities to develop solutions to related problems. In each module, students are supported with active learning experiences such as drama, games, experiments, the Six Hats thinking technique, 5E's model, the SCAMPER technique, and so forth.

***Data analysis and Trustworthiness of the study***

A graduate student verbatim transcribed each interview. The transcriptions were then compared to the audiotapes by one of the researchers. Content analysis was used to examine the data. Two researchers conducted the analysis simultaneously to ensure reliability, as Joffe (2012) suggested. The same approach was adopted for the analysis of the data obtained from the teacher opinion forms. Since similar perspectives were discovered through forms and focus group interviews, the results were presented together.

The credibility, transferability, dependability, and confirmability criteria from Schwandt et al. (2007) were applied to gauge the trustworthiness. Credibility is the extent to which the researchers are expressing a truth shaped by the perspective of the participants. The researchers asked three professors from the university's educational sciences department for their professional judgments to ensure credibility. The interview questions were revised after the suggestions of the experts. Then, to make sure that teachers understand the questions as intended, three pilot interviews were held with three teachers who were not research participants. These three teachers also completed and commented on the opinion forms. After the pilots, all the questions were improved accordingly. Additionally, the first and second researchers independently coded the data and found themes and categories. The researchers

then discussed how they interpreted the main themes. The researchers turned to the data when they were unable to reach an agreement. This process was repeated until the researchers reached a consensus. The third author gave all the themes and categories a fresh look after the first and second authors had done the coding. Transferability refers to how well findings can be applied in other situations. As detailed in the Participants section, there were teachers from all cities and all grade levels (first, second, third, and fourth grades) among the respondents. Also, the focus group interviews were held with teachers from different schools and included teachers from every grade level. Confirmability is the extent to which results are based on data rather than the study team's prior knowledge or bias. To ensure confirmability, the researchers discussed the codes with a professional who is an accomplished teacher education researcher. Finally, dependability is the degree to which the study could be replicated by other researchers. To ensure dependability, a thick description of the data collection and analysis process was provided.

## Findings

Four primary questions drove this research. Below, the findings were organized by the research questions.

### *Findings regarding the Context dimension*

According to Stufflebeam (2003), the Context dimension focuses on evaluating whether the objectives and priorities of the program meet the needs of the beneficiaries. The content analysis revealed that two themes emerged under this dimension, *teacher readiness* and *teacher contentment*. More explanation is presented in Table 2.

**Table 2.** The Content Analysis about the Context Dimension

| Theme | Category | Sample Code |
|---|---|---|
| Teacher Readiness | Background Knowledge | Personal awareness |
| | | Interests |
| | | Membership to NGOs |
| | | Previous trainings |
| | | Being an environmentalist |
| | Obstacles | Misconceptions |
| | | Poor background knowledge |
| | | Insufficient training |
| | Preparation | Finding visuals |
| | | Making research |
| | | Reading articles |
| | | Watching videos |
| | Peer Collaboration | Group work |
| | | Elaborating on the plans |
| | | Collaborating with STEM teachers |
| Teacher Contentment | Student Awareness | CC |
| | | Environmental literacy |
| | | Global problems |
| | Social Responsibility | Protecting the nature |
| | | Changing habits |
| | | Informing others |

Four categories emerged under the teacher readiness theme: *background knowledge, preparation, peer collaboration,* and *obstacles*. In the background knowledge category, some of the teachers stated that they were ready to implement the program since they were sensitive to the environment, they believed in the importance of providing CCE, and they received some previous training. On the other hand, there were some teachers stated that they had a lack of knowledge and misconceptions about CC as the obstacles. In the preparation category, they mentioned the measures that they took to fill in their knowledge gaps, such as researching online, reading articles, watching videos, and finding some visuals to better understand the concept. In the peer collaboration category, they emphasized the value of collaborating with their peers and STEM teachers at school as well as elaborating on the plans as a team to create the best learning atmosphere in their classes.

> "I started working about environmental issues voluntarily at a local NGO when I was a teenager. Participating in clean-up projects and awareness campaigns helped me understand the importance of sustainability, which I now incorporate into my lessons." (T5, Female, 26)

> "Although I am eager to teach about climate change, I struggle with misconceptions from outdated resources and feel that my limited background knowledge leaves me unprepared to address students' complex questions." (T10, Female, 40)

> "Preparing for my lessons involves background research. I always spend some time watching videos, reviewing scientific articles, and gathering visuals that make the concepts more relatable and engaging for my students." (T20, 32, Female)

> "As a group, we evaluated the plans a week ahead. We did research on issues that we might have difficulty with and exchanged ideas with our vice school principals." (T17, 37, Female)

The second theme was *teacher contentment*. Under this theme, *student awareness* and *social responsibility* categories were reached. In the student awareness category, they stated that their students' awareness was raised about CC and other environmental issues. They also noted that this program helped students gain knowledge about sustainability and develop environmental literacy. In the social responsibility category, the teachers stated that they observed student behaviors in relation to protecting nature, making use of the resources more carefully, and informing others and raising awareness of their parents.

> "We enjoy using the program, which has been prepared to draw attention to climate change, starting from the first graders. It makes me happy to make my students aware of an important issue for our world at this age." (T2, 25, Female)

> "It's incredibly fulfilling to see my students take action beyond the classroom—initiating recycling drives, educating their families about sustainability, and making small changes in their daily habits to reduce waste." (T25, 33, Male)

All in all, drawing attention to its possible catastrophic consequences, the teachers said that CCE is necessary and that this 8-week program effectively addresses this need. Additionally, teachers stressed the importance of such a program on CCE as it contributes to informing the larger society and developing pro-environmental habits.

***Findings regarding the Input dimension***

The Input dimension of evaluation focuses on the adequacy of resources for the effective implementation of the program (Stufflebeam, 2003). Teachers' views on this dimension centered around three themes, *learning activities*, *performance tasks,* and *content*. The content analysis of the Input dimension is presented in Table 3.

**Table 3.** The Content Analysis of the Input Dimension

| Theme | Category | Sample Code |
|---|---|---|
| Learning Activities | Active learning | Students' participation |
| | | Experiential learning |
| | | Critical thinking |
| | | Creative thinking |
| | Individual differences | Learning styles |
| | | Differentiation |
| | | Station technique |
| | Methods of teaching | Storytelling |
| | | Drama |
| | | Experiments |
| | | Art activities |
| Performance Tasks | Scope | Roles given to students |
| | | Active learning |
| | | Saving the earth |
| | | Climate crisis |
| | Suitability | Fun |
| | | Consciousness raising |
| | | Searching |
| | | Students' grade |
| Content | Life | The balance in nature |
| | | Endangered animals |
| | | Cycles |
| | | Food |
| | | Waste |
| | | Saving |
| | Climate Change | Carbon cycle |
| | | Greenhouse effect |
| | | Global warming |
| | | Disruption of ecological balance |
| | | Melting of glaciers |

The learning activities theme yielded three categories; *active learning, individual differences,* and *methods of teaching*. In the active learning category, participating teachers pointed out that the activities allowed student participation, created experiential learning opportunities and supported students' creative and critical thinking skills. In the individual differences category, they stated that the program enriched the learning environment by allocating enough space for differentiation and optimizing the learning process by giving students alternatives to choose with help of differentiation techniques such as station technique. Regarding the methods of teaching category, the participating teachers stated that the activities such as storytelling, drama, and experiments were well-chosen learning activities to foster students' learning.

> "In 1st grade, we designed a newspaper and presented it to our friends. It was a good experience in peer teaching as it created interaction among students." (T14, 30 Female)

> "Recognizing that students learn differently, I use various techniques like learning stations and differentiated assignments. This approach ensures that every learner, regardless of their style, finds a way to engage and succeed." (T1, 27, Female)

> "Storytelling is one of my favorite teaching methods. I weave real-life examples into my lessons to help students see the relevance of what they learn. I also integrate drama activities where students role-play scenarios, making abstract topics more concrete and memorable., of course with the help of our hero, Butterfly Azur." (T16, 24, Female)

Two categories, *scope* and *suitability*, were reached under the performance tasks theme. In the scope category, teachers mentioned that these tasks allowed students to research the climate crisis and their responsibilities in overcoming it and share what they learned so that students had a learning experience in which they could control their learning. They also noted that the tasks motivated students to explore and acquire new knowledge. In the suitability category, they pointed out that the tasks were eligible for students' grades, adding that they were fun and consciousness-raising.

> "The tasks increase the students' environmental sensitivity and contribute to the reflection of it to the students' behaviors. It enhances enduring understanding." (T7, 28, Female).

> "The performance tasks are enjoyable and purposeful. For example, students are given tasks and also different roles which make the activities both fun and insightful. Their understanding of sustainability grows, while their creativity and research skills develop." (T19, 35, Female)

In the last theme, two categories, namely, *life* and *climate change,* were reached. In the life category, the teachers mentioned the abundance of life-related content, adding that there was a wide spectrum of endangered animals, cycles, and the balance in nature. In the second category, the teachers expressed that the program was rich enough to include topics such as the greenhouse effect, the carbon cycle, global warming, and so forth.

> "They gained awareness of energy saving, sustainable living, recycling activities, and endangered animals." (T12, 29, Female).

> "To help students understand the balance in nature, I connect lessons to everyday life. This way, students leave class with a deeper appreciation for nature and a stronger sense of responsibility to protect it." (T18, 27, Female)

In summary, as part of the input dimension, the teachers believed that the 8-week program had enough resources to be implemented effectively. They referred to the adequate use of effective learning activities, convenient performance tasks, and enriched content.

***Findings regarding the Process dimension Subsection***

The process dimension focuses on the actual implementation. The aim is to evaluate whether the implementations are carried out as planned (Stufflebeam, 2003). For the actual implementation, the teachers' evaluations centered around three themes: *barriers*, *facilitators*, and *suggestions*. The content analysis about the Process dimension is seen in Table 4.

**Table 4.** The Content Analysis of the Process Dimension

| Theme | Category | Sample Code |
|---|---|---|
| Barriers | Physical | Small classrooms |
| | | Large population |
| | | Lack of green areas |
| | | Weather conditions |
| | Equipmental | Material |
| | | Smart board |
| | | The internet |
| | | Slides |
| | | Videos |
| | Pedagogical | Students' level |
| | | Abstract terms such as climate, greenhouse gases etc. |
| | | Managing emotions such as anxiety and fear |
| | Academic | Designated time |
| | | Pacing |
| | | Heavy schedule |
| Facilitators | Peripheral | The school |
| | | The conditions |
| | Technological | Equipment |
| | | Materials |
| | Educational | Interdisciplinary approach |
| | | Integrating activities to existing programs |
| Suggestions | Curricular activities | Teaching CCas a separate subject |
| | | Teaching CC in other grades |
| | Extracurricular activities | Gardening |
| | | Touching the soil |
| | | Planting |
| | Collaboration | Being a project partner |
| | | Finding partner schools |
| | | More parent involvement |

The *barriers* to implementation were gathered around four categories: *physical, equipmental, pedagogical,* and *academic*. Regarding the physical barriers, teachers complained that the activities could not be carried out as desired because both the classrooms and the school garden were small and the classrooms were crowded. Regarding the equipmental barriers, some teachers mentioned internet connection problems and the absence of smart boards, which made it difficult for them to implement the plans fully. As part of pedagogical barriers, they stated that they sometimes had difficulties conveying abstract concepts such as climate and CC to the students. In the academic barriers category, they noted that they also had trouble dealing with students who were highly concerned about climate change. Teachers also reported feeling stressed because the school curriculum was too demanding, the academic expectations of the school administration and parents were too high, and they did not have enough time to devote to climate change. However, teachers also remarked that because CC is interdisciplinary, they were able to blend it with the material and activities of other courses.

> "I think that students should work in a more comfortable environment while doing group work. Therefore, I thought that the physical environment of the classroom was not sufficient for group work to be created in this module." (T13, 31, Female)

> "There is no space in our school where our students can grow plants by observing, and our classrooms are very narrow. In general, we have to proceed through the videos. I feel incomplete in the application part by living by doing during the application phase." (T24, 30, Male)

> "Students often struggle to grasp abstract concepts like the greenhouse effect or carbon footprints. Additionally, discussing issues like climate change can sometimes cause anxiety or fear, so I carefully manage their emotions while encouraging hope and action." (T6, 42, Female)

> "The tight curriculum and heavy schedule leave little room for in-depth discussions on climate issues. I often find myself rushing through topics, which prevents students from fully engaging and understanding the material. This is also challenging for students as they never want these lessons to end." (T3, 34, Male)

Despite the various obstacles to implementation cited by the teachers, they also acknowledged that there were *facilitating factors*. These factors were clustered under three categories, namely, *peripheral, technological*, and *educational* facilitators. As part of peripheral facilitators, teachers frequently mentioned the school administration and the parents' support. According to them, the school administration viewed the climate problem as a social responsibility; thus, they equipped the teachers with various resources to help them execute their plans. It was also motivating for teachers to receive positive feedback from parents, expressing their delight in providing such education at school. As technological facilitators, the teachers referred to all the equipment and material provided by the school administration. Lastly, the teachers mentioned that they experienced the convenience of the program being interdisciplinary in the educational facilitators category. They said that it was also easy to integrate the learning activities into the already existing programs.

> "We received positive feedback from parents as we raise awareness of children about a global problem of our day." (T16, 24, Female)

> "Having access to digital tools, such as smart boards and online platforms helped my teaching. Students could visualize the impact of climate change through interactive videos better." (T17, 37, Female)

> "Integrating climate change topics into science and social studies through interdisciplinary activities has been highly effective. It is also quite easy to integrate the learning activities to our ongoing programs." (T14, 30, Female)

As the last theme, the teachers offered suggestions based on their experiences during the implementation. Those suggestions were gathered under three categories: *curricular activities, extracurricular activities,* and *collaboration*. As part of curricular activities, the teachers offered that CCE should be a year-long course that continues in subsequent years rather than being confined to eight weeks. In the extracurricular activities category, they emphasized the importance of outdoor activities such as planting, constructing a school garden, and touching the soil by spending time in the nature to support students' learning in the program. In the collaboration category, the teachers noted that being part of a project or finding partner schools to implement the program and exchange experiences would increase the efficacy of the program.

> I believe climate change should be taught as a separate subject with its own curriculum. It would ensure students gain comprehensive knowledge about the issue from an early age. (T13, 31, Female)

> "Students may be asked to develop projects to elaborate on the subjects they have learned. After students have videotaped their research, ideas can be exchanged on good projects by collaborating with different schools." (T26, 29, Female)

> "Forming partnerships with other schools and involving parents in sustainability projects can create a strong community committed to climate action." (T5, Female, 26)

All things considered; the process dimension offered important tips about the implementation of the program. The barriers, the facilitators, and the suggestions were worth considering evaluating the program.

***Findings regarding the Product dimension***

The product dimension is the dimension in which the implementation is evaluated to see if it has succeeded in meeting the program's objectives (Stufflebeam, 2003). This dimension yielded three themes: *awareness, knowledge transfer,* and *parent involvement.* More explanations can be seen in Table 5.

**Table 5.** The Content Analysis about the Product Dimension

| **Tema** | **Kategori** | **Örnek Kod** |
|---|---|---|
| Awareness | Environmental Awareness | Effective use of sources |
| | | Recycling |
| | | Sorting garbage |
| | | Making compost at home |
| | | Saving energy |
| | | Being careful about plastic waste |
| | | Not wasting water |
| | | Conscious consumption |
| | Social Responsibility | Shooting inspiring videos |
| | | Informing parents |
| | | Making presentations to raise awareness |
| | | Organizing campaigns |
| | Theoretical Awareness | Global warming |
| | | Renewable energy resources |
| | | Greenhouse gases |
| | | Fossil fuels |
| | | Nature and energy saving |
| | | Recycling |
| Knowledge Transfer | Home | Applying newly learned things at home |
| | | Demonstrating more conscious behaviors |
| | | Conversations with parents about climate change |
| | School Life | Interpreting knowledge |
| | | Games |
| | | Saving materials |
| | | Conscious use of resources |
| Parent Involvement | Support | Parental contentment |
| | | Cooperating with children about developing projects |
| | | Offering solutions to existing problems |
| | Household Activities | Sorting materials for recycling |
| | | Saving resources |
| | | Contributing to recycling |

The *awareness* theme yielded three categories: *environmental awareness, social responsibility,* and *theoretical awareness*. In the environmental awareness category, the teachers mentioned that the children gained an understanding of the importance of pro-environmental behaviors such as resource

conservation, minimizing plastic consumption, saving the forests, and recycling. In the social responsibility category, they stated that children recognized the need for both communal and individual efforts in combating climate change. In the theoretical awareness category, they expressed that the students acquired knowledge about content-specific terms, such as greenhouse gasses, fossil fuels, renewable energy, and so forth.

> "By enabling children to be more conscious; the program provided the opportunity to raise individuals who know what they can do to reduce the effects and who are sensitive to global problems." (T3, 34, Male)

> "Our students' awareness has raised a lot about energy conservation and plastic waste reduction. They started informing their parents at home and took the initiative to use energy efficiently. They warn their parents about the fact that no matter how small, personal actions collectively create a significant impact." (T22, 37, Female)

> "During class discussions they learned a lot about concepts such as renewable energy, fossil fuels, and greenhouse gases. It was rewarding to see that they have also gained some theoretical awareness." (T25, 33, Male)

Under the *knowledge transfer* theme, two categories, namely, *home* and *school life,* were reached. The teachers said that children transmitted what they learn in the classroom to school and home environments. Children began to use less paper, water, electricity, and plastic at home and school. They also mentioned that they started warning their parents and siblings, as well.

> "Our parents told us that the awareness of our students improved. For example, after we talked about the fumes coming out of the exhausts of the cars, one of our students talked about this with his family in the car and learned about "AdBlue" and came back with his drawings and told it to the class the next day." (T18, 27, Female)

> "In class, students have started to merge their learning with action. They show their sensitivity about energy conservation and being more careful about using sources, such as using both sides of paper and reducing waste." (T7, 28, Female)

Parent *involvement* was another significant theme in this dimension. *Support* and *household activities* were the emerging categories. In the support category, the teachers stated that the parents collaborated on projects with their children and began composting, separating trash, and recycling at home. In the household activities category, the teachers were happy to share that the parents were quite eager to sort materials for recycling and saving resources.

> "In the monthly meetings we had with our parents, they said that they were happy that the students shared what they learned at school at home. They stood by us by supporting our process with their research at home." (T24, 30, Male)

> "Several parents have told me that their children's enthusiasm for environmental issues has motivated the whole family to adopt greener habits, like sorting recyclables and conserving water. I'm glad to see my students' learning influence household practices." (T12, 29, Female)

In summary, the product dimension gave clues about the reflections of the program on students both in and outside of the classroom. The teachers' comments indicated that the program was effective in helping children gain awareness about climate change, internalize what they learned, and transfer this knowledge to new environments.

## Discussion, Conclusion and Suggestions

In this study, the elementary school CC program developed using the UbD framework was evaluated based on teachers' views. Overall, it is possible to conclude that the CC program has succeeded in its stated objectives.

One of the most important findings worth discussing is the program's potential response to the needs in the field of CCE, that is, to help students transfer acquired knowledge to real life. Teachers claimed that the program could address this need effectively. Their students' understanding of CC has grown, and they are more motivated to exhibit pro-environmental behaviors and are able to transfer these behaviors to daily life. A transfer is the student's completion of tasks in new contexts without anyone telling him what to do by making use of an experience that has been gained. From this point of view, the transfer of knowledge requires the student to act autonomously in decision-making and on the axis of his own thinking habits (Wiggins & McTighe, 2005; 2011). According to Davis (2010), environmental education should empower children to grasp the complexity of their own natural systems and comprehend the intricate relationship between nature and living things, as well as engage them in social action for change. Similarly, Chang (2015) asserts that the approach to teaching CC would need to strike a balance between educating students who can critically engage with the latest information on CC as well as developing them as empathic people who are motivated to take action to make their environment better. To engage in social action, students must be able to transfer what they learn in the classroom to their daily life. The findings of the study indicate that the program has visible and observable reflections on student behaviors. They started showing ideal behaviors at home by saving energy, making use of resources wisely, and attempting to recycle materials. This finding is consistent with the nature of the UbD instructional design model in the sense that the transfer of knowledge is only possible through meaningful learning and enduring understanding of the concepts that are taught in the lessons (Wiggins & McTighe, 2007).

The findings of this study indicate that, from teachers' perspectives, parental support plays a crucial role in the successful implementation of CCE. Teachers reported that positive feedback from parents served as a strong source of motivation for them, as families welcomed the inclusion of CCE in the curriculum. These finding align with Madden et al. (2023), emphasizing parents' enthusiasm for CCE. It is well known that parental interest and participation in the learning process significantly contribute to children's education. Active parental involvement and enthusiasm in educational processes enhance children's motivation, improve learning outcomes, and support cognitive development, thereby fostering more effective learning both inside and outside the classroom (Dowd et al., 2017). Similarly, in the context of CCE, parental engagement plays a significant role in helping children develop a deeper understanding of climate-related issues and raising their awareness. Lawson et al. (2019) emphasize that involving families and communities in the CCE process broadens its impact. Parents' participation in discussions and activities related to CC deepens students' comprehension of the topic and encourages them to take informed action. Teachers also highlighted that parental support is a critical factor in reinforcing climate-related concepts at home. This perspective is further supported by Parth et al. (2020), who advocate for integrating intergenerational learning into CCE programs. The researchers suggest that initiatives such as school-community collaborations, homework assignments, and climate action projects help increase family involvement, thereby enabling students to grasp CC issues more effectively. Overall, these findings suggest that future climate education efforts should actively engage parents in the learning process. Community-based workshops, school-led sustainability initiatives, and home-based learning activities are potential strategies to enhance parental involvement. Expanding CCE beyond schools and adopting a holistic, community-wide approach will not only boost student engagement but also strengthen long-term climate awareness.

Another finding worth discussing is the teachers' full cooperation in implementing the program. The teachers who took part in this study did not hesitate to discuss CC with their students. It is widely accepted in the literature that for CCE to be successful, teachers must avoid shielding the students from the issues and disagreements that arise in the CC discourse out of blind advocacy. The topic of CC is thought to be controversial, and numerous studies indicate that teachers are reluctant to discuss it in their classes due to their personal convictions and/or parental reactions (Elliott & Davis, 2009; Ginsburg & Audley, 2020; Seow & Ho, 2016). Similarly, Baker et al. (2021) highlighted that teachers are hesitant to discuss the topic of climate change with children due to difficulties in managing their own anxieties, limited knowledge, and a lack of adequate institutional support within schools. This finding of the study, however, indicates that the situation in Türkiye may be slightly different. According to the current study findings and the study by Higde et al. (2017), teachers and teacher candidates in Türkiye appear to recognize CC as a scientific fact and are willing to include CC in their practices. In Türkiye, the state and the Ministry of Education both formally recognize climate change as a scientific fact. Within centralized education systems like that of Türkiye, teachers' perspectives are highly influenced by the state's point of view. Thus, the source of the difference in teachers' perspectives in Türkiye may be due to the highly centralized structure of education in the country.

Among the findings, another important one was about barriers to implementing the program. Although most teachers agreed that teaching about CC was important and the program was effective, many cited limited resources, time, and space as obstacles. Contradictory or challenging conditions always affect teachers' instructional processes negatively. Limited time, limited resources, lack of financial support, and many others can be mentioned to hamper teaching effectively. It is also evident that the performance of a school system as a whole is frequently correlated with the educational resources available in that school (OECD, 2013). Our finding is consistent with the findings of several international studies (e.g. Colston & Ivey, 2015; Foss & Ko, 2019; Gillenwater, 2011). Even though Turkish schools are required to have schoolyards, these spaces are typically unsuitable for outdoor activities (Temel, 2020; Yılmaz & Ertürk, 2016). Additionally, classrooms might be very packed (approximately 25 to 30 children). Teachers may have difficulties in settings where there are many children, and their classes are relatively small because all the program's activities—such as group discussions, drama, and educational games—require active participation from the children.

These findings indicate that various measures should be taken to overcome the challenges encountered in implementing CCE. Firstly, increasing resource allocation to provide schools with adequate teaching materials, digital tools, and scientific resources would be beneficial. Optimizing learning environments and classroom arrangements by incorporating small-group activities, flexible seating arrangements, and more efficient use of open spaces can help mitigate spatial limitations. As a solution to time constraints, integrating CCE into the existing curriculum and developing modular lesson plans could be effective. Additionally, promoting outdoor and experiential learning opportunities—such as field trips to ecological centers, collaborations with local communities, and school-led sustainability projects—can help compensate for the lack of suitable open spaces in many schools. By implementing these strategies, the barriers to effectively incorporating CCE can be overcome, enabling students to gain meaningful and practical climate literacy.

One crucial finding of this study was that teachers reported a lack of knowledge about CC. In Türkiye, elementary school teacher training programs include only a single course on environmental education, typically offered for two hours per week in the first year of undergraduate study. This limited exposure is insufficient to cover the complexities of CC comprehensively. Consequently, teachers expressed concerns about their inadequate understanding of CC, a finding consistent with studies from other countries. Research has shown that both in-service and preservice teachers often lack sufficient

knowledge and hold misconceptions regarding CC (e.g., Arslan et al., 2012; Demant-Poort & Berger, 2021; Foss & Ko, 2019; Lambert & Bleicher, 2013; Papadimitriou, 2004).

For instance, Demant-Poort and Berger (2021) explored the presence of CC education in teacher training programs in Greenland and Canada. Their study revealed that preservice teachers in both countries had limited knowledge of climate change, highlighting a critical gap in their preparedness to teach the subject. Despite this, many preservice teachers expressed a strong interest in incorporating CC topics into their future teaching. The authors emphasized the necessity of formally integrating CC education into teacher training programs to equip educators with the required knowledge and confidence. Similarly, Foss and Ko (2019) examined the challenges and potential opportunities for CC education in the Dallas-Fort Worth area of Texas. Through surveys conducted with the general public and science teachers, they identified key barriers such as widespread misconceptions about climate science, limited public awareness, and a lack of institutional support and resources for educators. Despite these challenges, the study highlighted opportunities for improving CC education by fostering community engagement, offering targeted professional development for teachers, and integrating climate change topics into existing curricula. These findings underscore the need for systemic changes to overcome societal and institutional barriers and promote effective climate literacy.

To bridge the knowledge gap, teachers in this study reported relying on peer collaboration, particularly working with STEM educators, to enhance their understanding of CC. This aligns with Carrier's (2012) assertion that robust professional networks and structured professional development are vital for equipping teachers with the expertise needed to effectively teach CC. Furthermore, research indicates that teachers' confidence in CC education directly impacts student engagement and learning outcomes. When teachers feel well-prepared, students are more likely to engage actively in discussions and take initiative in sustainability efforts. Monroe et al. (2019) demonstrated that teachers with strong CC knowledge can foster a sense of agency in students, encouraging them to participate in climate action beyond the classroom. This suggests that equipping teachers with a deeper understanding of CC is not only essential for improving their instruction but also for promoting long-term behavioral changes in students.

A critical component of improving teachers' CC knowledge and instructional confidence is professional development. Anderson (2012) highlights that professional development initiatives centered on climate literacy significantly enhance teachers' confidence and competence in delivering climate-related instruction. By providing structured learning experiences, workshops, and curriculum resources, these initiatives can help teachers integrate CC education more effectively into their teaching. Several studies have explored the role of education in both preservice and in-service teacher training. Lambert and Bleicher (2013) investigated the impact of a structured educational intervention within an elementary science methods course on preservice teachers' perceptions of CC. The intervention included structured coursework integrating scientific literature, discussions, and hands-on activities aimed at dispelling misconceptions and aligning participants' perspectives with the scientific consensus. The course provided explicit instruction on the causes and consequences of climate change, incorporated data analysis exercises using real-world climate data, and facilitated guided discussions on climate-related pedagogical strategies. As a result, participants demonstrated a stronger understanding of human-induced climate change and a clearer recognition of the scientific consensus. This study underscores the importance of a structured curriculum in addressing misconceptions and enhancing climate literacy among future educators. The authors advocate for the integration of CC education into teacher preparation programs to ensure that preservice teachers are adequately prepared to teach this critical subject.

Similarly, Berger et al. (2015) examined the implementation of *Climate Change Pedagogy*, a nine-week elective course within a Bachelor of Education program designed to enhance teacher candidates' comprehension of CC and equip them with effective instructional strategies. The course incorporated interactive learning activities, interdisciplinary discussions, and experiential learning approaches, emphasizing the complexity of climate issues across various subjects. Participants engaged in hands-on projects, reflective discussions, and resource development to prepare for real-world classroom applications. A key finding from this study was the importance of a supportive and open learning environment, which fostered confidence in discussing climate-related topics. However, teacher candidates also identified several challenges, including limited knowledge of climate science, concerns about the controversial nature of CC education, and uncertainty regarding its integration into their teaching practices. Many participants recommended making the course a mandatory component of teacher education programs and extending its duration to ensure comprehensive preparation. The authors stress the necessity of embedding CC education systematically within teacher preparation curricula to ensure that future educators are adequately equipped to teach this pressing and complex issue.

Thus, to ensure the effective implementation of climate change education (CCE) in schools, further research should first focus on strengthening preservice and in-service teacher training before introducing interventions at the classroom level. Studies should explore the development of comprehensive CCE modules within teacher education programs to assess how early integration of climate literacy affects future teaching practices. Research should examine the impact of embedding climate change education in core teacher training courses rather than treating it as an elective or supplementary subject. Longitudinal studies tracking preservice teachers from training to their first years in the profession would provide insights into how well they retain and apply climate change concepts in their teaching.

For in-service teacher professional development, further studies should evaluate the effectiveness of structured, research-based professional development programs in improving teachers' climate literacy and instructional competence. Investigating various models, including workshops, certification courses, and collaborative learning networks, could help determine the most effective approaches for scaling up professional learning opportunities. Additionally, research should explore how providing teachers with ongoing access to up-to-date scientific resources, instructional materials, and interdisciplinary support from climate scientists and environmental educators enhances their ability to teach complex climate concepts.

A key area for further study is the role of policy frameworks and institutional support in sustaining professional development efforts. Examining how different countries or educational systems implement and fund mandatory climate-focused professional development can inform best practices for broader adoption. Comparative studies could assess the effectiveness of different pedagogical strategies, such as inquiry-based learning, experiential education, and interdisciplinary approaches, in preparing teachers to deliver high-quality climate change instruction. By addressing these research gaps in preservice and in-service teacher education, future studies can provide the foundational knowledge necessary for designing scalable, evidence-based climate education interventions at the school level.

All in all, despite some implementation-related minor problems such as physical conditions and lack of time, this study showed that the UbD is an effective framework for students to understand and transfer knowledge to their real lives, which are the most important aims of CCE. The findings emphasize the UbD-based CC program's capabilities in promoting enduring understanding and knowledge transfer to real life. However, problems such as time constraints, physical problems, and the need for sufficient training were noted. Addressing these challenges has the potential to improve the usefulness of UbD framework, making it more adaptable and sustainable in a variety of educational settings. Future study should investigate alternatives to overcome these challenges and improve UbD implementation procedures.

Several limitations should be acknowledged. Firstly, the study primarily relied on teacher evaluations without incorporating direct student feedback. Including student perspectives could provide more comprehensive insights into the program's effectiveness. Future research should consider integrating student feedback and/or direct assessments of student learning outcomes. Secondly, the study was conducted exclusively in private schools across Türkiye, which may not fully represent the experiences of teachers and students in public schools or other educational settings. To improve generalizability, future studies should examine the curriculum's implementation in a broader range of school environments. Thirdly, the study mainly focused on the program's short-term effects, which may not be sufficient to evaluate its long-term impact on students' behaviors and understanding. There was no follow-up to assess whether students retained and applied their knowledge over time. Future studies should incorporate longitudinal assessments to measure the program's lasting effects. Fourthly, in this study, some teachers reported gaps in their climate change knowledge, which may have impacted the quality of instruction and the overall effectiveness of the program. Future studies should evaluate teachers' prior knowledge of CC and CCE before program implementation. This approach would ensure that teachers have a comparable level of understanding, allowing for a clearer assessment of the program's effectiveness and minimizing variations caused by differences in teacher knowledge. Lastly, some teachers cited challenges such as limited green spaces, large class sizes, and a lack of necessary materials, which may have affected the program's full implementation. These constraints could limit the applicability of the findings to schools with different infrastructural conditions. Future research should address these limitations by including schools with diverse resources and exploring solutions to overcome these barriers.

Overall, future studies should adopt a longitudinal approach, incorporate student perspectives, extend research to public schools, and examine a variety of educational settings to strengthen the validity and transferability of the findings.

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