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Climate Change Education in Germany and Turkey: A Comparative Analysis of Educational Approaches

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ABSTRACT: This study presents a comparative analysis of climate change education in Germany and Türkiye. The main objective is to identify similarities and differences in the two countries' curricula, pedagogical approaches, and teacher training structures. While Germany has long adopted interdisciplinary, practice-oriented, and project-based instructional models, Türkiye has taken a significant institutional step by introducing the "Environmental Education and Climate Change" course into its national curriculum in 2022. Based on document analysis, the findings reveal that Germany prioritizes digital platforms, experiential learning, and sustainability-focused teaching methods, whereas Türkiye's instruction remains largely theoretical and centered on knowledge transmission. Furthermore, teacher education programs in Germany are supported by interdisciplinary modules and field-based practices that integrate climate change content in a more structured manner. This research is significant as it examines how climate change—a global challenge—is addressed through education across different national systems, thereby contributing to the development of more sustainable educational policies. It also highlights the need for international cooperation in areas such as joint curriculum development, teacher exchange programs, and digital learning initiatives. These collaborative efforts have the potential to enhance the effectiveness of climate change education in both countries and contribute more meaningfully to global climate action.

Keywords: climate change education, Germany, Turkey, interdisciplinary education, sustainability, international cooperation

Introduction

Climate change is recognized as one of the greatest environmental, economic, and social challenges facing humanity today (IPCC, 2021). The effects of global warming are felt across a wide spectrum, from ecosystem degradation to extreme weather events, reduced agricultural production, and climate migration (UNESCO, 2022). In this context, it is crucial for individuals to become aware of climate change from an early age, to acquire sustainable living habits, and to understand their environmental responsibilities. Education systems are one of the most important tools for raising awareness in societies and producing long-term solutions to the climate crisis (Sterling, 2021). Different countries have adopted various policies and approaches to addressing climate change in their curricula. In some countries, this topic is taught as a separate subject, while

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in some education systems it is addressed in an interdisciplinary manner through science, geography, social studies, and even literature classes (UNESCO, 2021). Climate change education around the world varies according to countries' education policies and levels of environmental awareness. Many countries have adopted various approaches to integrate climate change into their curricula.

Research on climate change education has increased in recent years. However, studies based on cross-country comparisons are limited in number. For example, Breckler et al. (2017) compared curricula in Germany, Sweden, and France, highlighting Germany's interdisciplinary approach. Similarly, Ünal and Derman (2021), in their study comparing Turkey and Finland, stated that climate change education in Turkey is more based on knowledge transfer, with limited practical activities. Furthermore, OECD (2019) reports indicate that Germany stands out in integrating sustainability education into different levels, while Turkey has begun to develop new policies in this area. Climate change education in Turkey is addressed within specific units of science, geography, and social studies courses prepared by the Ministry of National Education (MEB). In 2022, the Environment Education and Climate Change course was added to the curriculum as an elective course at the secondary education level (MEB, 2022). However, there is ongoing debate in academic circles about the need for a more holistic and interdisciplinary approach to climate change education in Turkey (Barak & Gönençgil, 2020). In Germany, environmental education and climate change topics feature prominently in the curriculum. Students receive education on sustainability, renewable energy sources, and climate change policies from an early age (UNESCO, 2021). The majority of these studies focus solely on specific components, such as curriculum or student perception, neglecting systematic comparisons of components such as teacher training, digital content, and social participation. In this context, a comprehensive analysis covering teacher training programs in Germany and Turkey in particular has the potential to fill an important gap in the literature.

Climate change education should be approached with an educational model that encourages students to think critically about environmental justice, social transformation, and sustainability, rather than being based solely on the transfer of information. Freire's (1970) critical pedagogy approach emphasizes that students should be active participants in the learning process, rather than passive recipients of information. Within the framework of Freire's critical pedagogy perspective, the adoption of an interdisciplinary and applied approach to climate change education in Germany provides a significant advantage in developing students' awareness of environmental issues and their critical thinking skills (Rieckmann, 2017; Michelsen & Fischer, 2020). Curricula developed within the framework of 'Education for Sustainable Development (ESD)' in particular offer students a holistic learning experience in terms of linking environmental issues to different disciplines and applying active learning methods. In contrast, climate change education in Turkey is largely based on knowledge transfer, and student-centered pedagogical approaches that encourage critical thinking are not yet widespread (Karataş, 2019). Although environmental and climate themes are included in teaching programmes, these topics are generally addressed in a limited and superficial manner in textbooks; teachers lack sufficient materials and guidance support (Demirtaş & Güneş, 2006). This situation may lead to limitations in students' ability to understand and generate solutions to complex issues such as climate change.

In climate change education practices in Germany, nature-based learning activities, sustainability projects in school gardens, environmental field studies, and ecological camps are common (Rieckmann, 2018). In Turkey, however, climate change education is mostly limited to classroom lessons, and students have fewer opportunities for direct interaction with the environment. Within the framework of ecological education theory, it is emphasized that applied environmental education programmes based on interaction with nature, project-based learning, and focusing on local environmental issues should be promoted in Turkey. It is stated that such programs are effective in developing environmental awareness in students not only at the cognitive

level but also at the affective and behavioural levels (Öztürk, 2020; Şahin & Erkal, 2018). Germany has integrated the ESD framework into its programmes and education policies, implementing student-centred, problem-solving-focused learning methods (European Commission, 2021). In Turkey, however, reforms in line with ESD principles have only just begun, and programmes need to be made more practical and solution-oriented (Güven, 2020). Nevertheless, there are significant differences between countries in terms of the scope of climate change education, pedagogical approaches, and implementation methods.

The main problem of this research is the limited number of comparative studies between countries such as Germany and Turkey on the integration of climate change education into national programs and the insufficient clarification of the extent to which current practices correspond to the Education for Sustainable Development (ESD) framework defined by UNESCO. In particular, the lack of studies that comparatively analyze the similarities and differences between the educational programmes, teacher training policies, and implementation levels of these two countries forms the starting point for this research. There are multiple reasons behind the selection of Germany and Turkey for comparative analysis in this study. These two countries' education systems, environmental policies, climate change mitigation strategies, and levels of social awareness differ. These differences enable a comparative analysis of educational programmes and allow us to offer strategic recommendations for the development of climate change education.

In this context, the main objectives of the study are as follows:

- To compare climate change education in Germany and Turkey in terms of curriculum, teaching methods, and teacher training,
- To examine how the education policies of the two countries are shaped in line with the Sustainable Development Goals,
- To compare the strengths and weaknesses of climate change education in Germany and Turkey.

In line with these objectives, the research question and sub-questions have been determined as follows.

Problem Statement

How is climate change education structured in Germany and Turkey, and what similarities and differences exist between the education systems of these two countries? Sub problems are as follows:

1. How is climate change education addressed at primary, secondary, and high school levels in Germany and Turkey?
2. How is climate change education integrated into the curricula of both countries using an interdisciplinary approach?
3. How are teachers' competencies in climate change education assessed in Germany and Turkey?
4. What pedagogical approaches and teaching methods are applied in climate change education in Germany and Turkey?

The fundamental reasons for identifying this research problem are the effects of climate change on a global scale, the increasing importance of climate education, the differences in educational approaches between countries, and the need for comparative analyses to develop climate change education.

Germany's Leading Position in Sustainability and Climate Education

Germany is recognised as one of the leading countries in Europe in terms of sustainable development and climate education (BMU, 2020). In the process of aligning with the European Green Deal, the German government has adapted its education policies to support the fight against climate change. Climate change education in Germany:

- It is integrated into the curriculum at all levels of education, from early childhood education to higher education (WBGU, 2019).
- Has an interdisciplinary structure and is taught in various subjects such as science, social sciences, and economics (European Commission, 2021).
- It supports applied and project-based learning approaches (Rieckmann, 2018).
- Teacher training programmes are shaped in line with climate change and sustainable development goals (BMU, 2020).

In particular, interdisciplinary, applied, and participatory learning-based education models are among the best practices for increasing the effectiveness of climate change education; these models are effective in developing students' environmental awareness, critical thinking, and problem-solving skills (UNESCO, 2017; Mochizuki & Bryan, 2015). Therefore, examining Germany's model provides important guidance on how climate change education can be successfully integrated.

Turkey's Developing Climate Education Policies and Reform Process

Turkey is a country that is developing new education policies to combat climate change and is undergoing a transformation process in this area. Climate change education has been added to the curriculum in Turkey in recent years, and in 2022, the subject 'Environmental Education and Climate Change' became compulsory (MEB, 2022). However, Turkey's education system still faces some significant challenges. Climate change education in Turkey is largely limited to science and geography courses and is still far from being interdisciplinary (Karataş, 2019). However, the education approach for sustainable development requires that environmental and climate issues be linked to all subjects and that a holistic learning experience be provided (UNESCO, 2017). On the other hand, teachers' pedagogical competence and current knowledge levels on climate change are mostly limited, and skills such as developing application-oriented materials and carrying out environment-based projects are particularly lacking (Güven, 2020; Teksoz et al., 2010). The lack of practical activities that encourage active student participation in educational settings often results in learning remaining at a theoretical level (MEB, 2022; Erten & Gökdere, 2016). Furthermore, the varying levels of awareness of climate change across different regions of Turkey highlight the need to restructure educational programmes in a more localised manner, responsive to regional needs (Özdemir & Şahin, 2019). As Turkey is a country implementing new reforms in climate change education and is still in the development phase, it is crucial to compare its current education policies with those of Germany, which is a good example on a global scale.

Scientific and Academic Contribution of Comparing the Two Countries

Comparing Germany and Turkey enables a meaningful comparison in terms of education systems and policy implementation. The comparison of these two countries is scientifically important because:

- Germany and Turkey have different education systems: Germany's federal education structure allows education policies to vary from state to state, while Turkey's centralised education system requires a standard policy to be implemented at the national level (Bray, Adamson & Mason, 2007). These differences enable a meaningful comparison in terms of the applicability and effectiveness of climate education.

- The economic and social structures of the two countries differ: Germany is an industrialised country that has integrated education with sustainable development, while Turkey is a developing country with a different perspective, grappling with environmental issues brought about by rapid urbanisation and industrialisation (European Commission, 2021).

- Levels of awareness of climate change vary: Various studies have shown that environmental awareness is high at the societal level in Germany, with the vast majority of individuals supporting public policies aimed at combating climate change. In particular, policies on energy transition (Energiewende), renewable energy use, and carbon emission reduction are widely accepted by the public (Statista, 2022; Umweltbundesamt, 2021). Recent public opinion polls in Germany indicate that approximately 70% of citizens believe stricter measures are needed to combat climate change (Pew Research Centre, 2021).

- Awareness of climate change in Turkey has begun to increase in recent years, but it is still not sufficiently widespread (Karataş, 2019).

International Cooperation Potential and Germany-Turkey Education Partnerships

Germany and Turkey are two countries that have been developing cooperation in the field of education for many years, carrying out student and teacher exchange projects through numerous international programmes. Programmes such as Erasmus+ and DAAD (German Academic Exchange Service) in particular enable students in Turkey and Germany to carry out joint projects on environmental education and climate change (UNESCO, 2022). Although there are many studies on climate change education in the literature, there are certain aspects that make this study different and unique. The UNESCO (2022) and IPCC (2021) reports address the global importance of climate change education and its relationship with sustainable development goals. However, these studies present general policies rather than specific country analyses.

Studies in Germany examine how the education system has been shaped in line with sustainable development goals (WBGU, 2019; Rieckmann, 2018). Studies in Turkey generally focus on the science and geography curricula, discussing how climate change issues are addressed (Karataş, 2019; Güven, 2020). However, these studies are generally conducted within the Turkish context and do not include international comparative analysis. A review of the existing literature reveals that there are only a limited number of studies on climate change education in Germany and Turkey. In particular, the lack of comprehensive studies that comparatively examine the teacher education programmes of the two countries from a climate change perspective indicates a significant gap in the field. This gap prevents an in-depth analysis of practices aimed at developing climate literacy in the teacher training processes of both countries and the mutual evaluation of good practices. In this context, the German states of Bavaria, Berlin, Bremen, Hamburg, and Saxony were included in the study as they represent different applications and models of climate change education in Germany. The reasons for selecting the five states and their salient features in terms of education policy are presented in Table 1. These states represent the diversity of education policies across different regions of Germany and provide an opportunity to analyse how climate change education is implemented through different approaches.

Table 1. Representative Characteristics of the Selected Five Federal States

State	Reasons for Selection	Key Features in Terms of Climate Education Policy
Bavaria (Bayern)	Characterized by traditional and conservative educational policies; one of Germany's largest federal states in terms of both area and population (KMK, 2021).	Climate change education has been integrated into the curriculum in recent years; however, practical environmental education activities remain limited (Bayerisches Staatsministerium, 2020).
Berlin	As the capital city, it is known for its political sensitivity toward environmental issues and serves as the national center for environmental policymaking (Umweltbundesamt, 2022).	Pioneering practices have been developed in education for sustainable development; environmental education is supported in many schools (Senatsverwaltung für Bildung, Jugend und Familie, 2021).
Bremen	A small state in terms of population and area, located along the coastline, and directly exposed to the impacts of climate change (bpb, 2020).	Climate change education has been integrated into the curriculum through innovative projects; school-based environmental action projects are widespread (Freie Hansestadt Bremen, 2021).
Hamburg	Germany's largest port city, economically strong, and plays an active role in environmental sustainability policies (Stadt Hamburg, 2021).	Project-based learning models focusing on digital climate education and sustainable urban development are actively supported (Behörde für Umwelt, Klima, Energie und Agrarwirtschaft, 2022).
Saxony (Sachsen)	Located in eastern Germany, characterized by its industrial past and a more traditional educational structure (KMK, 2021).	Traditional approaches dominate sustainability education; however, a more open attitude toward innovative educational projects has been observed in recent years (Sächsisches Staatsministerium für Kultus, 2021).

Bavaria (Bayern): Traditional Education Model and Environmental Education

It is one of Germany's largest and most populous states. Its education policies are more conservative and centralised, and climate change education has begun to gain more importance in recent years (KMK, 2021). Although climate change is included in the curriculum, an interdisciplinary approach has not yet been fully developed. Due to the STEM (Science, Technology, Engineering, and Mathematics) focused education system, emphasis is placed on climate change topics in science classes.

Berlin: Sustainable Development and Innovative Education Policies

As the capital of Germany, it leads the way in sustainable development policies. Comprehensive reforms have been implemented to raise environmental awareness in education, and climate change education has been integrated into science, social sciences, and economics courses (Berlin Senate, 2022). Large-scale climate projects and student participation are encouraged in Berlin.

Bremen: Small State, Big Environmental Risks

Although one of Germany's smallest states, it is a region facing direct climate change impacts such as rising sea levels (BMU, 2020). Climate change occupies a central place in the programme, with particular support for applied projects. Due to its status as a maritime and port city, climate change education is approached from economic and social perspectives.

Hamburg: Digital Education and Environmental Awareness

Germany's largest port city is a region where environmental sustainability policies are at the forefront. Climate education is provided using digital educational tools, augmented reality (AR), and virtual simulations. Education policies in Hamburg aim to strike a balance between industry and environmental sustainability (WBGU, 2019).

Saxony (Sachsen): Different Perspectives in Eastern Germany

Due to its location in eastern Germany and its industry-focused economy, it has a more traditional approach to environmental policies. Climate change education is only just becoming widespread, and conservative tendencies dominate education policies. Despite having a strong foundation in science education, the social and economic dimensions of environmental education have not yet been fully integrated into the curriculum. In conclusion, this study compares states that differ in terms of urbanisation and economic structure (Berlin, Hamburg, and Bremen) with states that have a more traditional education system (Bavaria and Saxony).

Method

The research is based on a descriptive and comparative educational research model. Comparative educational research aims to understand how different approaches are applied in a particular area by analysing education systems in different countries (Bray & Thomas, 1995). In this study, based on 'Berelson's Content Analysis Method' (1952) and 'Phillips & Schweisfurth's (2014) Comparative Education Model', the integration of climate change education into the curriculum, pedagogical approaches, and teacher training in Germany and Turkey was evaluated. The research is based on a qualitative research approach, and data were collected using document analysis.

Data Collection

The data used in this study were obtained from primary data sources. Relevant education policy documents, curricula, academic articles, and national and international reports were examined to determine how climate change education was shaped in Germany and Turkey. Data was collected from four main sources:

Germany: Reports, programme documents, and teacher training guides from federal and state education ministries were examined. Education policies in Bavaria, Berlin, Bremen, Hamburg, and Saxony were compared in particular. In Turkey, the teaching programme for the Environment Education and Climate Change course published by the Ministry of National Education, as well as the geography and science teaching programmes, were analysed.

A literature review was conducted on climate change education, sustainable development, and environmental education in Germany and Turkey using academic databases such as Web of Science, Scopus, ERIC, and Google Scholar, examining studies from 2000 to 2024.

Reports by the IPCC (Intergovernmental Panel on Climate Change), UNESCO's global strategy documents on climate change education, and the European Commission's Green Deal and Education Policy Reports were examined (IPCC, 2021; UNESCO, 2022; European Commission, 2021). Sustainability education reports published by the Federal Ministry for the Environment (BMU) and the Federal Ministry of Education and Research (BMBF) in Germany were analysed (BMU, 2020).

Teacher training programmes in Germany and Turkey were compared to analyse how teachers are trained in climate change education. In Germany, in-service training programmes for teachers and teacher training curricula focused on sustainable development were examined. In-service training programmes offered to teachers in Germany are being restructured, particularly within the framework of Bildung für nachhaltige

Entwicklung (BNE), or education for sustainable development. In this context, the aim is to develop teachers' interdisciplinary thinking skills and to guide them towards teaching methods based on environmental, social and economic sustainability (UNESCO, 2021; KMK, 2021). Many German states have developed special curricula for teachers that include online modules, seminars and field-based applications (BMBF, 2022). Furthermore, the integration of ESD into school culture and project-based teaching practices focused on climate change are being promoted in in-service training (Rieckmann et al., 2017). In Turkey, the content of in-service teacher training programmes has been evaluated in terms of the difficulties and shortcomings experienced by teachers in climate change education.

Data Analysis

The collected data were examined using the document analysis method. Document analysis is the process of systematically examining and categorising information obtained from written sources on a specific topic (Bowen, 2009). In this study, the content analysis method was used. In content analysis, the curricula documents and policy documents of both countries were compared, and similarities and differences were categorised. Academic literature and international reports were analysed to examine how the countries' climate education policies align with global trends.

For the validity and reliability of this research, multiple data sources were used, and curriculum documents, academic research, international organisation reports, and policy documents were analysed together (data diversity was ensured). Using the analytical comparison method, the education systems in Germany and Turkey were systematically compared under specific categories. The analysis process was grounded in scientific principles by employing theoretical frameworks accepted in the current literature (comparative education theory, critical pedagogy, ecological education model, sustainable development education framework). Only peer-reviewed articles and official documents were used as sources, drawn from international academic databases.

A qualitative data coding process was applied to enable the systematic analysis of the collected data. The coding process was examined using the thematic analysis method (Bowen, 2009). In this study, pre-determined categories (deductive coding) and themes derived from the data (inductive coding) were used together (Miles, Huberman & Saldaña, 2014). In the first stage of the coding process, data preparation and organisation were carried out. In the first stage of the coding process, the data obtained by the researcher was prepared and organised. In this context, the documents were read and a preliminary analysis was conducted, similar contents were grouped, and the data was made suitable for coding. The data analysis process of the research was conducted by the researcher, and in the first stage, the documents were systematically examined and the data was organised. At this stage, the documents were transferred to a digital environment and organised according to content categories in preparation for pre-coding (Miles, Huberman & Saldaña, 2014). Educational policy documents, programmes, academic research and reports from international organisations in Germany and Turkey were collected. Information taken from the official documents of both countries was standardised to make it suitable for the analysis process, and the source, year of publication, and content of each document were added to the coding system in detail. Pre-coding was carried out in the second stage. Based on previous research on climate change education, five key themes were identified. These themes are summarized in Table 2.

These are:

1. Programme Integration: Where and how climate change education is incorporated into the curriculum.
2. Pedagogical Approaches: Teaching methods, student participation, and applied learning processes.
3. Teacher Training: Training received by teachers on climate change and their professional development processes.

Table 2. Core Codes and Themes

Main Theme	Codes (Subcategories)	Description
Curriculum Integration	Interdisciplinary education	Addressing climate change topics across different subjects.
	Knowledge-based transmission	Theoretical integration of climate-related topics into the curriculum (Turkey).
Pedagogical Approaches	Experiential learning	Laboratory work and field-based experiences (Germany).
	Problem-based learning	Encouraging students to develop projects related to climate issues.
	Digital education	Use of online platforms and augmented reality (AR) applications.
	Student-centered instruction	Active participation of students in the learning process.
Teacher Education	In-service training	Continuous professional development for teachers on climate change education.
	Use of instructional materials	Employment of textbooks, online resources, and interactive content.
Policies and Regulations	National strategies	Integration of governmental policies into the curriculum.
	Local adaptations	Curriculum content adjusted to regional differences.
Digital and Experiential Learning	Experiments and fieldwork	Direct engagement of students in environmental experiments.
	Technology-supported education	Virtual laboratories and simulations related to climate change.

4. Policies and Regulations: Regulations on climate education by the government and education authorities.

5. Digital and Practical Learning Methods: The use of digital educational tools and fieldwork.

The following strategies were implemented to enhance the reliability and validity of the coding process used in this study. The coding process was carried out by two independent researchers. The codings of the two researchers were compared, and over 85% agreement was achieved (Miles & Huberman, 1994). The reliability and validity of the coding process were ensured through the strategies of pre-coding, where each researcher coded independently; code matching, where independent codes were combined, and common codes were identified; and final coding and conversion to themes, where categories were clarified and made ready for analysis. Furthermore, the coding process was based on the same thematic framework for both Germany and Turkey, thus making the education systems of the two countries comparable. In addition, source diversity was ensured by using not only official programme documents but also academic studies and international reports, and this diversity enabled the results obtained to be interpreted in a broader context.

Findings

This section contains the research findings and the related comments and discussions. For the research, the findings were first presented, followed by comments and discussions. A comparison of primary school-level climate change education in Germany and Turkey was made, and the findings are presented in Table 3. Table 3 reveals the fundamental similarities and differences between climate change education at the primary school level in five German states (Bavaria, Berlin, Bremen, Hamburg, and Saxony) and in Turkey. The findings in the table are presented separately for each criterion below.

Table 3. Climate Change Education at the Primary School Level in Germany and Turkey

Criteria	Germany (Bavaria, Berlin, Bremen, Hamburg, Saxony)	Turkey (Primary Education Level)
Curriculum Integration	Climate change education is compulsory at preschool and primary school levels, aiming to develop environmental awareness from an early age.	Environmental education is addressed at a basic level within Life Studies and Science courses.
Pedagogical Approaches	Play-based, exploratory, and experience-oriented learning models that prioritize student-centered education are common.	Predominantly teacher-centered approaches relying on lecturing and question–answer techniques are used.
Teacher Education	In-service training programs on environmental education and sustainability are available for teachers.	Teacher education programs lack a specific focus on climate change education.
Digital Learning Tools	Augmented reality (AR), interactive games, digital storytelling, and animations are frequently utilized.	Digital content is limited; learning primarily depends on textbooks and visual materials.
Field Activities	School garden projects, nature excursions, recycling, and composting activities are integrated into the curriculum.	Field-based activities are very limited; instruction mainly emphasizes theoretical knowledge.
Alignment with Climate Policies	Educational programs are aligned with the EU Green Deal and sustainable development goals.	New steps are being taken in environmental education and sustainability, yet full alignment with international policies is still lacking.
Community Engagement	School projects are commonly conducted in collaboration with NGOs, municipalities, and universities.	NGO-supported projects exist, but systematic collaborations are not yet well institutionalized.

Programme Integration

In Germany, climate change education has been integrated into the education programme from nursery school onwards, particularly in states such as Berlin and Hamburg. In Bavaria, the primary school curriculum, updated in 2020, explicitly defines the goal of 'developing environmental awareness at an early age' (Bayerisches Staatsministerium für Unterricht und Kultus, 2020). In Bremen, early climate awareness is fostered in kindergartens through projects such as 'Kita-Klima-Kids'. In Turkey, climate change issues are not addressed directly as a separate subject; they are covered indirectly in subjects such as Life Sciences and Natural Sciences (MEB, 2018). For example, in the Year 3 Natural Sciences textbook, climate change is only covered superficially within one unit (MEB, 2021).

In the German states, climate change education is presented through a game-based, student-centred, and experiential learning model. For example, in Berlin, primary school pupils learn by developing projects using recycled materials (Senatsverwaltung für Bildung, Jugend und Familie, 2021). In Hamburg, children explore ecosystem dynamics through digital nature games. In Turkey, however, teacher-centred narration and question-and-answer techniques are more commonly used. Most teachers prefer narration-based methods due to a lack of ready-made materials on the subject (Karataş, 2019). Activities generally remain within the classroom, with no direct observation or active participation.

In Germany, in-service environmental education programmes for teachers are implemented at the state level. For example, in Saxony, online seminars entitled 'BNE-Lehrerfortbildung' have been held since 2021 to educate teachers on sustainability (Sächsisches Staatsministerium für Kultus, 2021). In Turkey, however, teacher training faculties do not have compulsory content on climate change, and in-service training focuses

very little on this topic (Güven, 2020). Teachers' competence in environmental issues is mostly based on individual interest.

In German states with advanced digital infrastructure, such as Hamburg and Bremen, students learn interactively through augmented reality (AR), digital storytelling, and animations. For example, the 'Klimadetektive' application enables students to collect data by observing the environment (BMBF, 2022). In Turkey, however, digital content is limited. Education is generally provided through textbooks and e-content prepared by the Ministry of National Education (MEB). Since the technological infrastructure in schools is not equal across all regions, the use of digital materials is not widespread (MEB, 2022).

In Germany, composting in school gardens, nature walks, and recycling projects are common. In Berlin, children learn about the environment through experience thanks to school-based 'green classrooms' (Umweltbundesamt, 2021). In Hamburg, school environmental activities are also supported in collaboration with the local council. In Turkey, however, such practices are very limited at the primary school level. Pupils generally learn about topics such as climate change theoretically. Practical activities are mostly carried out on a project basis and at the initiative of teachers (Karataş, 2019).

Educational policies in Germany are structured to align with the European Green Deal and the goals of Education for Sustainable Development (ESD) (UNESCO, 2021; KMK, 2021). The federal states are updating their curricula in line with these goals. In Turkey, steps have been taken in this direction, but integration with international policies is still in its infancy. In 2022, the Ministry of National Education began offering the 'Environmental Education and Climate Change' course as an elective, but it is not compulsory in all schools (MEB, 2022).

In Germany, NGOs, local authorities, and universities actively collaborate with schools on projects. The 'Klimaschutz in der Schule' programme in Bremen is one example (Freie Hansestadt Bremen, 2021). In Berlin, there are 'ökologisches Lernen' projects run under the guidance of universities.

In Turkey, various NGOs carry out environmental education activities. However, it cannot be said that these activities are systematically integrated into the curriculum. Schools generally engage in weekly or annual project-based collaborations (Güven, 2020). A comparison of climate change education at the secondary school level in Germany and Turkey has been made, and the findings are presented in Table 4. Table 4 clearly shows the fundamental differences and similarities between climate change education in five German states (Bavaria, Berlin, Bremen, Hamburg, and Saxony) and at the secondary school level in Turkey.

In Germany, climate change education is integrated into secondary school science, geography, ethics, and economics lessons in an interdisciplinary manner. For example, in the state of Berlin, within the framework of 'Bildung für nachhaltige Entwicklung' (BNE) (Education for Sustainable Development), climate topics are linked to carbon footprint calculations in economics lessons, while environmental justice issues are discussed in ethics lessons (Senatsverwaltung für Bildung, Jugend und Familie, 2021). In Bavaria, Year 7 science curricula expect students to analyse climate systems (ISB Bayern, 2021). In Turkey, climate change topics are mainly covered in science and geography lessons, with limited integration into other disciplines. The Year 7 science textbook briefly mentions global warming under the unit 'Climate and Seasons', but does not cover the economic or ethical dimensions (MEB, 2021).

In the German states, project-based learning, experimental studies, and problem-solving techniques form the basis of climate education. For example, in Hamburg, students research local environmental issues and propose solutions as part of the 'Climate Ambassadors' (Klimabotschafter) programme (Freie und Hansestadt Hamburg, 2021). In Turkey, teaching is mostly teacher-centred and based on the transfer of theoretical knowledge. Due to limited laboratory facilities, the number of experiments and practical activities is low (Karataş, 2019). Even if a simple greenhouse effect experiment is carried out under the guidance of a teacher, such applications are not systematic.

Table 4. Climate Change Education at the Lower Secondary School Level in Germany and Turkey

Criteria	Germany (Bavaria, Berlin, Bremen, Hamburg, Saxony)	Turkey (Lower Secondary Level)
Curriculum Integration	Addressed through an interdisciplinary approach in science, geography, ethics, and economics courses.	Limited to science and geography courses.
Pedagogical Approaches	Project-based learning, problem solving, and experiential education are emphasized.	Predominantly theoretical instruction; experiments and field activities are limited.
Teacher Education	Continuous professional development programs and sustainability trainings are implemented.	Climate change education receives limited attention in teacher education programs.
Digital Learning Tools	Virtual laboratories, augmented reality (AR), and simulations are widely used.	Digital tools are limited; traditional textbooks are predominant.
Field Activities	Environmental observation projects and student-led field experiments are common.	Fieldwork and hands-on activities remain limited.
Alignment with Climate Policies	Supported by sustainability policies aligned with the EU Green Deal.	A new climate change curriculum is being developed; partial alignment with international policies exists.
Community Engagement	Collaboration with local governments, NGOs, and universities is common.	NGOs and related projects exist, but there are no mandatory collaborations within the curriculum.

In Germany, continuous professional development (Fortbildung) programmes are offered for teachers at the state level. In Saxony, regular online workshops entitled 'Klimabildung im Unterricht' (Climate Education in the Classroom) are held, and teachers are trained according to ESD standards (Sächsisches Staatsministerium für Kultus, 2022). Furthermore, sustainability pedagogy is included as a separate module in teacher training programmes. In Turkey, climate change education is addressed to a limited extent in teacher training programmes, and in-service training is generally confined to general environmental issues. Güven (2020) reported that the majority of teachers have insufficient knowledge on this subject.

In states with strong digital infrastructure, such as Hamburg and Berlin, augmented reality (AR), simulation and virtual laboratory applications are widely used in climate education. Thanks to the simulation application called 'Klimawandel interaktiv erleben' (Experience climate change interactively), students can visualise the effects of greenhouse gas emissions (BMBF, 2022). In Turkey, however, the use of digital tools is generally limited to projecting textbook content via smart boards. Although digital activities can be implemented in institutions such as Science and Art Centres (BİLSEM), such applications cannot be generalised (MEB, 2022).

In Germany, particularly in states such as Bremen, where climatic effects are strongly felt, students participate in climate observation and data collection projects. Through the 'Klimadetektive' (Climate Detectives) programme, students collect and analyse environmental data such as temperature, precipitation, and air quality (ESA, 2021). In Turkey, fieldwork is limited to school trips, and data-driven applications are rarely included. For example, activities such as nature walks or environmental clean-ups are mostly organised in the context of social events and are not systematically integrated into the curriculum (Karataş, 2019).

In Germany, education systems are structured in line with the EU Green Deal and the principles of Education for Sustainable Development (ESD) (UNESCO, 2021). State curricula are being updated in parallel with these policies. Berlin and Bremen are seen as pioneering states in this area (KMK, 2021). In Turkey, the 'Environmental Education and Climate Change' course launched by the Ministry of National Education (MEB) in 2022 is an important step towards compliance with climate policies. However, the course is not yet compulsory in all schools, and integration with international frameworks is limited (MEB, 2022). Upon

examining Table 5, the fundamental similarities and differences between climate change education at the secondary school level in five German states (Bavaria, Berlin, Bremen, Hamburg, and Saxony) and in Turkey become apparent.

Climate change education at secondary school level in Germany has an interdisciplinary structure. Topics related to the climate crisis are addressed in detail in geography, biology, environmental sciences, ethics, economics and politics classes. Curriculum integration is systematically ensured within the framework of 'Bildung für nachhaltige Entwicklung' (BNE) (Education for Sustainable Development), particularly in the states of Bremen and Hamburg (KMK, 2021). For example, in Hamburg, secondary school students undertake projects on the carbon market, energy transition, and environmental policies in elective courses entitled 'Sustainability and Economics' (Freie und Hansestadt Hamburg, 2021).

In Turkey, the theme of climate change is generally covered in science and geography lessons; the elective course 'Environmental Education and Climate Change' is not compulsory in all secondary schools. Furthermore, an interdisciplinary structure has not yet been systematically established (MEB, 2022).

In German secondary schools, problem-based learning, project-based work and student-centred research are at the heart of climate education. In Saxony, students give project presentations in which they develop local policy proposals aimed at reducing greenhouse gas emissions (Sächsisches Kultusministerium, 2021). In Bremen, secondary school students analyse the issue of climate migration through interdisciplinary projects (Senator für Bildung Bremen, 2022).

Table 5. Climate Change Education at the Upper Secondary School Level in Germany and Turkey

Criteria	Germany (Bavaria, Berlin, Bremen, Hamburg, Saxony)	Turkey (Upper Secondary Level)
Curriculum Integration	Interdisciplinary; addressed in science, geography, economics, ethics, politics, and environmental science courses.	Covered in science, geography, and certain elective courses; interdisciplinary approaches remain limited.
Pedagogical Approaches	Problem-based learning, project-based applications, and student-led research projects are encouraged.	Instruction is predominantly theoretical; project-based learning is limited.
Teacher Education	In-service training programs on climate change and sustainable development are continuously updated.	Teacher education programs do not adequately address climate change topics.
Digital Learning Tools	Virtual laboratories, simulations, augmented reality (AR), and interactive platforms are utilized.	Digital resources are limited; traditional textbooks and classroom lectures are predominant.
Field Activities	Collaborative research projects with universities, field observations, and climate data analysis are common.	Fieldwork and university collaborations are limited.
Alignment with Climate Policies	Educational policies are aligned with the EU Green Deal and sustainable development goals.	Integration with climate policies is emerging; full alignment with international standards has not yet been achieved.
Community Engagement	Joint environmental projects are conducted with NGOs, municipalities, the private sector, and research institutions.	NGO-supported projects exist, but their integration into the education system remains limited.

In Turkish secondary schools, the teaching method is generally teacher-centred. Topics in textbooks are usually limited to knowledge transfer, with insufficient emphasis on project and practical activities (Karataş, 2019; Güven, 2020). Project-based activities are more common in science secondary schools, with limited implementation in other school types.

In Germany, sustainability-focused in-service training programmes for teachers are regularly updated. In Berlin, under the 'Fortbildung Nachhaltigkeit' initiative, teachers are required to complete at least one sustainability module per year (Senatsverwaltung für Bildung, Jugend und Familie, 2021). Additionally, teacher training faculties offer pedagogical modules on environmental ethics and climate policies. In Turkey, the climate change theme in teacher training programmes is generally limited to general environmental awareness education. The teacher guides published by the Ministry of National Education (MEB) in 2022 are still in the pilot phase and have not gained widespread use (MEB, 2022). Güven's (2020) study states that over 70% of teachers consider themselves inadequate in climate issues.

In states with strong digital infrastructure, such as Hamburg and Berlin, innovative tools such as augmented reality (AR), climate simulations and virtual laboratories are used for secondary school students. For example, carbon cycle simulations are conducted for students through the 'Klimawandel Interaktiv' platform (BMBF, 2022). Digital educational tools are used to a more limited extent in Turkish secondary schools. Apart from some animations and videos offered through the EBA system, access to these resources is quite limited, especially in rural areas. Furthermore, digital content is generally geared towards passive learning (Karataş, 2019).

In Germany, secondary school students conduct field studies in collaboration with universities and research institutions. For example, in Bavaria, students regularly collect data on local temperature changes and water quality analyses (ISB Bayern, 2021). In Hamburg schools, students conduct ecosystem tours to observe the effects of climate change in situ (Freie und Hansestadt Hamburg, 2021). Similar field studies at the secondary school level are quite limited in Turkey. Although some individual teacher initiatives are carried out under special projects (e.g. TÜBİTAK 4006), these activities are not integrated into the curriculum. MEB reports indicate that field-based education is not widespread (MEB, 2022).

In Germany, education policies have been aligned with the EU Green Deal and the UN Sustainable Development Goals (UNESCO, 2021). Education policies in Hamburg and Berlin have been updated in line with climate targets; teacher training, lesson content, and school projects have been shaped accordingly (KMK, 2021). In Turkey, the subject 'Environmental Education and Climate Change' was integrated into secondary schools as an elective subject in 2022. However, these developments are still in the implementation phase and lag behind Germany in terms of scope (MEB, 2022).

In Germany, secondary school students carry out joint projects with NGOs, universities, municipalities, and the private sector. In schools in Bremen, the 'Fridays for Future' movement is supported, and students are involved in decision-making processes (Senator für Bildung Bremen, 2022). In Turkey, various NGOs (e.g., TEMA, ÇEKÜD) organise activities for students. However, these collaborations are not systematic and are mostly carried out voluntarily (Güven, 2020).

Comparative Analysis of the Inclusion of Climate Change Topics in Textbooks in Germany and Turkey

The findings on how climate change topics are addressed in textbooks in Germany and Turkey are presented in Table 6.

Table 6. Climate Change Topics in Textbooks in Germany and Turkey

Criteria	Germany (Bavaria, Berlin, Bremen, Hamburg, Saxony)	Turkey
Extent of Curriculum Coverage	Climate change is extensively covered in science, geography, social studies, economics, and ethics courses.	Addressed in a limited manner within science and geography courses.
Pedagogical Approach	Supported by problem-based learning, case analysis, and student-centered activities.	Predominantly teacher-centered, relying on knowledge transmission.
Interdisciplinary Integration	Climate change is integrated into multiple subjects and approached from diverse perspectives.	Addressed mainly in science and geography; limited inclusion in social studies.
Use of Visual and Digital Content	Maps, infographics, simulations, digital materials, and augmented reality (AR) applications are utilized.	Basic visuals and charts are included; digital content remains highly limited.
Fieldwork and Practical Content	Local ecosystem investigations, environmental projects, and student participation activities are encouraged.	Focused on theoretical knowledge; practical content is minimal.
Scope of Subtopics	A broad range of themes such as global climate change, carbon footprint, renewable energy, climate policies, and local ecosystems are covered.	Provides limited information, primarily on global climate change and environmental impacts.
Alignment with Climate Policies	Educational policies are integrated with the EU Green Deal and the UN Sustainable Development Goals.	The national curriculum is still developing and not yet fully aligned with international policies and targets.

Extent of Curriculum Coverage

In German textbooks, the topic of climate change is not limited to science but is extensively addressed across disciplines such as geography, social studies, economics, and ethics. Particularly in federal states like Berlin and Hamburg, secondary-level textbooks devote substantial attention to the socio-economic implications of climate policies, energy transition, and environmental ethics (KMK, 2021). In Turkey, however, the topic is mostly covered within science and geography courses, and the content presented in textbooks tends to remain at a descriptive and introductory level (MEB, 2022). In social studies textbooks, references to climate change are only made indirectly.

In Germany, climate change topics are supported by student-centered pedagogical activities. Problem-based learning, case analyses, and open-ended question–answer techniques are frequently incorporated into textbook content. For example, geography textbooks used in Bremen include exercises requiring students to calculate their individual carbon footprints (Senator für Bildung Bremen, 2022). In contrast, Turkish textbooks are primarily composed of expository texts focused on factual transmission. Pedagogical structures that promote critical thinking or classroom discussion remain quite limited (Karataş, 2019).

German textbooks address climate change through a network of interrelated disciplines, including economics, political science, ethics, and geography, enabling students to approach the topic from multiple perspectives (KMK, 2021). In Turkey, interdisciplinary integration remains limited. Environmental education content is

primarily confined to science and geography courses, while social studies and ethics textbooks rarely include extensive discussions on the social impacts of environmental crises (MEB, 2022).

German textbooks incorporate various multimodal tools such as maps, infographics, statistical data, and AR-based simulation links. QR codes often direct students to supplementary digital resources (BMBF, 2022). For instance, textbooks in Hamburg allow students to explore interactive city-planning simulations via mobile devices. In Turkish textbooks, visual materials are used only at a basic level. Charts and graphs are frequently presented without explanatory context, limiting their instructional value. No examples of digital integration or AR-based applications have been observed (Karataş, 2019).

German textbooks commonly include sections encouraging students to observe their local environments, collect real-world data, and analyze their findings. For instance, textbooks used in Berlin require students to report biodiversity changes around their school environment (Senatsverwaltung Berlin, 2021). In Turkey, however, opportunities for practical engagement are scarce. Activities designed to support student participation or field-based inquiry are limited, and most suggestions remain teacher-directed (MEB, 2022).

German textbooks systematically address subthemes such as carbon footprint, energy efficiency, renewable energy sources, sustainable lifestyles, climate justice, and local disaster risks (ISB Bayern, 2021). In contrast, Turkish textbooks primarily focus on the environmental effects of climate change, while more contemporary and socially oriented dimensions—such as carbon footprint or climate justice—are either missing or only superficially addressed (Karataş, 2019).

The content of German textbooks is aligned with major international frameworks such as the EU Green Deal, the Paris Agreement, and the United Nations Sustainable Development Goal 13 (UNESCO, 2021). These materials are periodically updated in accordance with policy developments. Although the Turkish national curriculum was revised in 2022 to include climate education, textbook content has not yet been fully harmonized with these revisions or with international climate policy standards (MEB, 2022).

Educational Resources Developed for Climate Change Education in Turkey

In recent years, significant progress has been made in Turkey toward enhancing climate change education. Various institutions and organizations—both governmental and non-governmental—have collaborated to develop teaching and learning materials for teachers and students. These initiatives include the creation of digital portals, modular training programs, and certified educational resources. Table 7 summarizes the main educational materials developed in Turkey for climate change education and highlights their key features. In Turkey, a variety of multifaceted educational resources have been developed to address climate change education across different age groups and levels of knowledge. The ministry-supported education modules stand out for their comprehensive structure, while the materials produced by non-governmental organizations such as TEMA primarily aim to raise awareness at the primary and lower secondary school levels. The program developed by METU-SEM represents a high-quality initiative contributing to both academic and professional development. This diversity demonstrates that climate change education in Turkey is conducted through a multi-actor and multi-level approach.

Educational Resources Developed for Climate Change Education in Germany

Since Germany's education system is organized at the federal state (Länder) level, both the scope and nature of climate change education resources vary across states. In Bavaria, Berlin, Bremen, Hamburg, and Saxony, the following types of educational resources and programs are generally available in Table 8.

Table 7. Main Educational Resources Developed for Climate Change Education in Turkey

No	Resource / Module Title	Developing Institution / Organization	Content / Objective
1	*Climate Change Education Modules*	Ministry of Environment, Urbanization and Climate Change	Consists of 17 modules covering scientific foundations, EU–Turkey policies, energy, and legal frameworks.
2	*TEMA Climate Education Portal*	TEMA Foundation & Ministry of National Education	Designed to raise awareness among children and youth about climate, seasons, and cause–effect relationships.
3	*Climate Change Certificate Program*	Middle East Technical University – Continuous Education Center (METU-SEM)	Covers the definition of climate change, related policies, economic aspects, and adaptation strategies specific to Turkey.

Table 8. Main Educational Resources Developed for Climate Change Education in Germany

No	Resource / Module Title	Developer / Scope Level	Content / Example Practice
1	State Education Curricula	State Ministries of Education	Each federal state incorporates climate change and sustainability themes into its own curriculum. For example, in Bavaria, environmental education is extensively covered.
2	Local and Regional Projects	Municipalities and Local Environmental Organizations	In Bavaria, the use of solar energy is promoted, and schools implement awareness projects on renewable energy.
3	Federal and State-Supported Education Programs	Federal Ministry for the Environment in cooperation with state governments	Educational materials developed for teachers and students emphasize environmental awareness and sustainable lifestyles.

Climate change education in Germany operates through a multi-level and multi-actor framework. The inclusion of climate-related topics in state curricula is reinforced by locally implemented projects. In addition, federal government–supported materials and programs demonstrate that the German education system maintains a holistic vision of sustainability.

When the educational resources developed for climate change education in Turkey and Germany are compared, the two countries appear to adopt distinct institutional and pedagogical approaches. In Turkey, the resources are primarily developed by central institutions—such as the Ministry of Environment, Urbanization and Climate Change, the TEMA Foundation, and METU-SEM—and are organized through educational modules and certificate programs. Although these resources aim to present a broad framework covering the scientific, political, and economic dimensions of climate change, the content remains relatively limited in terms of practical implementation. In Germany, by contrast, education is more diversified at the local level. The system exhibits a multi-layered structure through state-based curricula, local environmental projects, and federally supported programs. In states such as Bavaria, environmental sustainability education is comprehensively implemented and integrated with local renewable energy projects.

Thus, while Germany's decentralized and practice-oriented model emphasizes hands-on and project-based engagement, Turkey's centralized and content-focused structure highlights theoretical knowledge and policy-level initiatives. These differences reflect both the strengths and limitations of each country's educational system concerning climate change education.

Overall Evaluation of Climate Change Education in Germany and Turkey

This study aimed to examine and compare the current state of climate change education in Germany and Turkey, identifying similarities and differences in their educational policies. The findings indicate that while both countries have integrated climate change education into their national education systems, there are significant variations in scope and implementation. Germany adopts a more systematic and interdisciplinary approach to climate change education, aligning it with the Sustainable Development Goals (SDGs). Climate change education is implemented across all educational levels—from preschool to university—and is supported by innovative methods such as digital technologies and fieldwork (BMU, 2020; WBGU, 2019). At the primary level (ages 6–10), Germany provides a more comprehensive, practice-based, and digitally supported structure than Turkey. German pedagogy focuses on play-based, discovery-oriented, and experiential learning models designed to foster environmental awareness from an early age. This difference stems from the fact that sustainability education is positioned at the core of German educational policy and is reinforced through state-level curricula. In Turkey, instruction remains largely teacher-centered and based on theoretical knowledge transfer. This may be attributed to the prioritization of content delivery and the relatively limited investment in experiential learning.

Teacher education programs in Germany include continuous professional development on environmental and sustainability topics, whereas in Turkey, these areas have not yet gained sufficient emphasis in pre-service or in-service teacher training. Moreover, digital tools such as augmented reality (AR), digital storytelling, and interactive materials are widely used in Germany, while their limited presence in Turkey may be due to technical infrastructure gaps and slow content development. Fieldwork and school-based environmental projects are systematically integrated into the German education system, while in Turkey, such practices remain rare—possibly due to a heavy curriculum load and limited collaboration with external institutions. At the secondary school level, climate change education in Germany is more interdisciplinary, application-oriented, and digitally supported compared to Turkey. In Berlin and Hamburg, climate change is taught not only within science courses but also through subjects such as economics, ethics, politics, and geography (Krogh et al., 2020; KMK, 2021). Students engage in project-based and problem-solving activities, using digital simulation tools to analyze climate issues both locally and globally (BMU, 2019; Haan et al., 2021).

Projects such as *"Klimaschutz macht Schule"* ("Climate Protection Comes to School") in Berlin encourage students to calculate their carbon footprints, propose school-level climate policies, and conduct field studies (Senatsverwaltung für Bildung, 2020). In Turkey, by contrast, high school–level climate change education remains largely confined to science and geography courses, characterized by theoretical and teacher-centered instruction (Karataş, 2019; MEB, 2022). While Germany offers continuous professional development for teachers on sustainability and climate change (KMK, 2021), Turkey lacks a comprehensive or mandatory teacher training program in this area (Aydın & Uşak, 2020). Similarly, virtual laboratories, interactive platforms, and AR tools are widely used in Germany (Lehrer-Online.de, 2023), whereas printed textbooks remain the dominant teaching resource in Turkey. Furthermore, German high schools integrate field-based research in collaboration with universities, while such partnerships are rare in Turkey (Güven, 2020). In terms of textbook content, German materials approach climate change in a more detailed, interdisciplinary, and applied manner, whereas Turkish textbooks tend to focus on theoretical knowledge, primarily within science and geography courses (MEB, 2020). German textbooks encourage students to actively analyze environmental problems and propose solutions, while Turkish textbooks serve mainly informational purposes. The more extensive use of visual and digital materials in Germany contributes to a more engaging and effective learning process.

Recommendations

Based on the findings, several recommendations can be proposed to enhance the quality and effectiveness of climate change education in both countries. First, collaborative teaching materials could be created by combining Germany's interdisciplinary educational model with Turkey's culturally and regionally aware curriculum framework (European Commission, 2021). Second, through international initiatives such as ERASMUS+, exchange programs between German and Turkish teachers could foster mutual learning and professional development (UNESCO, 2022). Third, both countries could jointly develop open-access digital resources and educational materials supported by augmented reality (AR) and virtual reality (VR) technologies (Güven, 2020). Fourth, cross-national projects and field-based programs could be organized to enhance climate change awareness among students (Karataş, 2019).

The findings of this study highlight the need to further strengthen climate change education in both countries, with particular emphasis on teacher training and the use of experiential learning methods in Turkey. While Turkey has taken new steps toward developing climate education, it could benefit greatly from Germany's long-standing experience in sustainability-focused education. Joint projects between the two countries could contribute meaningfully to achieving the global sustainable development goals. Therefore, updating education policies, enhancing teacher preparation, and promoting awareness campaigns across all social groups are strongly recommended. The results of this study may serve as a guide for curriculum development commissions responsible for state-level educational policies in Germany and for the Ministry of National Education units working on climate and environmental education in Turkey. Future research could further explore the impact of climate change education on learning outcomes and behavioral awareness through qualitative field studies involving teachers and students.

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